Dallas to Houston High-Speed Rail
Final Environmental Impact Statement

Final EIS:
Main Text I

Federal Railroad
Administration

Dallas to Houston High-Speed Rail

Final Environmental Impact Statement

May 2020

Prepared by the Federal Railroad Administration

DEPARTMENT OF TRANSPORTATION
UNITED STATES OF AMERICA
Federal Railroad Administration

Dallas to Houston High-Speed Rail

Final Environmental Impact Statement

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Dallas to Houston High-Speed Rail

Final Environmental Impact Statement

Pursuant to the:

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); Endangered Species Act of 1973 (16 U.S.C. § 1531-1544); Clean Water Act (33 U.S.C. § 1251-1387; and 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 Record of Decision subsequent to the release of this Final Environmental Impact Statement (Final EIS).

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

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Abstract: This document evaluates and documents the potential beneficial and adverse environmental impacts of FRA's proposed rulemaking to enable effective safety oversight of the operation of a high-speed passenger rail (HSR) system based on the Japanese N700-Series Tokaido Shinkansen technology that is described in a Petition for Rulemaking for a Rule of Particular Applicability (RPA) submitted by Texas Central Railroad, LLC (TCRR). TCRR's petition for rulemaking contains TCRR's proposal to construct and operate an approximately 240-mile, for-profit HSR system connecting Dallas and Houston based on the Japanese N700-Series Tokaido Shinkansen technology (the Project).

FRA has broad authority to prescribe regulations and issue orders, as necessary, for every area of railroad safety. FRA's existing regulations do not adequately address the safety concerns and operational characteristics of the HSR system proposed by TCRR. Therefore, FRA has proposed minimum federal safety standards through an RPA (regulations that apply to a specific railroad or a specific type of operation) to ensure the TCRR's proposed system is operated safely. This regulatory action constitutes a major federal action and triggers the environmental review under National Environmental Policy Act (NEPA).

This document evaluates and documents the reasonably foreseeable potential beneficial and adverse environmental impacts of implementing TCRR's HSR system in any location, including a No Build Alternative and six Build Alternatives between Dallas and Houston. 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 Final EIS.

This Dallas to Houston HSR Project Final EIS is being made available to the public in accordance with NEPA. Visit the FRA website (https://railroads.dot.gov/current-environmental-reviews/dallas-houston-high-speed-rail/dallas-houston-high-speed-rail) where you may:

- View and download the Final EIS
- Provide comments on the Final EIS
- Locate a library near you to review a hard copy of the Final EIS

Printed copies of the Final EIS have also 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

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

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

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
318 E Main 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

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

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

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

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EXECUTIVE SUMMARY

PREAMBLE

Since the close of the public comment period for the Draft Environmental Impact Statement (EIS) for the Dallas to Houston high-speed passenger rail (HSR) Project in March 9, 2018, the Federal Railroad Administration (FRA) has reviewed public comments and updated analysis of the Project as appropriate. FRA's consideration of comments helped to inform the development of this Final EIS. FRA's responses to comments received during the public comment period are documented in **Appendix H**.

This Final EIS incorporates modifications, including refinements to engineering and updated resource data, that have been released since the publication of the Draft EIS. Shaded areas in the Final EIS are intended to provide the reader with a simplified way to identify the revised language, modifications and/or refinements that differ from the text in the Draft EIS. However, the shading is not a word-for-word representation and not all modifications are shaded. For example, although not specifically shaded, all tables and figures in the Final EIS have been updated as appropriate. Furthermore, **Appendix D, Mapbooks,** and **Appendix E, Technical Memoranda,** have been updated in the Final EIS, though not specifically shaded.

Additionally, due to reorganization of text, expansion and/or updates to both methodology and data, the revisions in some sections and chapters of the Final EIS are not shaded. These include:

- **Section 3.10, Aesthetics and Scenic Resources**
- **Section 3.18, Environmental Justice**
- **Chapter 4.0, Indirect Effects and Cumulative Impacts**
- **Chapter 7.0, Section 4(f) and Section 6(f) Evaluation**

ES.1 Introduction

The United States Department of Transportation's (USDOT) FRA prepared this EIS in compliance with the National Environmental Policy Act (NEPA).[1] This EIS assesses the potential beneficial and adverse environmental impacts of FRA's proposed rulemaking to enable effective safety oversight of the operation of an HSR system based on the Japanese N700-Series Tokaido Shinkansen technology that is described in a Petition for Rulemaking for a Rule of Particular Applicability (RPA) submitted by Texas Central Railroad, LLC (TCRR). TCRR's petition for rulemaking contains TCRR's proposal to construct and operate an approximately 240-mile, for-profit, high-speed passenger rail (HSR) system connecting Dallas and Houston based on the Japanese N700-Series Tokaido Shinkansen technology (the Project). In addition to the purpose and need for the Project, this executive summary discusses the Project background and history, and outlines the organization of this EIS.

This EIS evaluates and documents the potential environmental impacts of FRA's proposed action as required by NEPA, Council on Environmental Quality (CEQ) NEPA regulations[2] and FRA's *Procedures for Considering Environmental Impacts*[3]. FRA is the lead agency for the preparation of this EIS, in cooperation with the United States Environmental Protection Agency (EPA), the Federal Highway Administration (FHWA), the Federal Transit Administration (FTA), the Surface Transportation Board

[1] 42 U.S.C. 4321 et seq.
[2] 40 C.F.R. 1500-1508.
[3] 64 Federal Register 28545 (May 26, 1999) as updated in 78 Federal Register 2713 (January 14, 2013).

(STB), the United States Army Corps of Engineers (USACE) and the 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 the EIS process, as detailed in **Chapter 9.0, Public and Agency Involvement**.

FRA has broad authority to prescribe regulations and issue orders, as necessary, for every area of railroad safety.[4] FRA's existing regulations do not adequately address the safety concerns and operational characteristics of the HSR system proposed by TCRR. Therefore, FRA has proposed minimum federal safety standards through an RPA (regulations that apply to a specific railroad or a specific type of operation), to ensure the TCRR's proposed system is operated safely. This regulatory action constitutes a major federal action and triggers the environmental review under NEPA.[5]

Additionally, TCRR (including its affiliated companies) may pursue financial assistance from USDOT, including but not limited to, a direct loan under the Railroad Rehabilitation and Improvement Financing Loan Program,[6] credit assistance under the Transportation Infrastructure Finance and Improvement Act[7] or other federal assistance to finance a portion of the Project. Should USDOT provide credit or other financial assistance, such activity would also constitute a major federal action.

Texas Central Partners, LLC (TCP) and its affiliated/subsidiary entities, as detailed in **Table ES-1**, are collectively referred to as "Texas Central." Together, they are responsible for Project development and implementation (i.e., design, construction, financing and operation). TCRR is a private, Texas-based company and a wholly owned subsidiary of Texas Central Rail Holdings, LLC (TCRH), which, in turn, is a wholly owned subsidiary of TCP, a Delaware limited liability company. Other wholly owned subsidiaries of TCRH include Texas Central Railroad & Infrastructure, Inc. (TCRI) and Integrated Texas Logistics, Inc. (ITL). TCRR submitted a petition for a Rule of Particular Applicability to FRA (discussed further in **Section 1.1.2.1, Introduction, Rule of Particular Applicability**). As the entity responsible for the petition for an RPA, TCRR is specifically identified as the Project Proponent throughout this EIS. The Project Proponent (or applicant) is the entity proposing a major federal action subject to NEPA and seeking federal regulatory approvals for the Project. TCRR is assisting with the planning and coordinating with FRA for the NEPA compliance for the Project, which would include a Record of Decision (ROD) for the EIS and related permits.

[4] 49 U.S.C. 20101 et seq.; 49 C.F.R. 1.89, Parts 200-299.
[5] A major federal action, as defined by 40 C.F.R. 1508.18, includes actions with effects that may be major and that are potentially subject to federal control and responsibility.
[6] 45 U.S.C. 821 et seq.
[7] 23 U.S.C. 601-609.

Table ES-1: Texas Central and Affiliates/Subsidiaries [a]		
Company		**Role**
Texas Central Partners, LLC	TCP	Parent company and a Delaware limited liability company
Texas Central Rail Holdings, Inc.	TCRH	Wholly owned subsidiary of TCP with overall responsibility for the Project's development and implementation
Texas Central Railroad, LLC [b]	TCRR	• Project Proponent as defined by NEPA • Wholly owned subsidiary of TCRH • Submitted petition for the Rule of Particular Applicability to FRA • Submitted petitions jointly with TCRI to the STB • Submitted permit applications to the USACE • Will be the entity with TCRI responsible for operation and maintenance of the railroad after placement into revenue service • Incorporated as a railroad and registered as such with the Texas Comptroller of Public Accounts
Texas Central Railroad & Infrastructure, Inc.	TCRI	• Wholly owned subsidiary of TCRH • Submitted petitions jointly with TCRR to the STB • Responsible for acquisitions of land and property required to comprise the limits of disturbance (LOD) and support TCRH in delivery of the Project • Will be the entity with TCRR responsible for operation and maintenance of the railroad after placement into revenue service • Incorporated as a railroad and registered as such with the Texas Comptroller of Public Accounts
Integrated Texas Logistics, Inc.	ITL	• Wholly owned subsidiary of TCRH • Responsible to support TCRH in delivery of the Project • Acting as signatory to agreement with project management consultant • Incorporated as a railroad and registered as such with the Texas Comptroller of Public Accounts
Texas Central Infrastructure, LLC	TCI	• Wholly owned subsidiary of TCRH • Will be signatory to main design-build contracts used to deliver Project and services contract(s) for operation and maintenance of railroad after placement into revenue service

[a] Responsible for Project development and implementation (i.e., design, construction, financing and operation)

[b] Texas Central High-Speed Railway, LLC (TCR) initially promoted the development of the Project. The roles and responsibilities of TCR have been assumed by TCRR.

ES.2 Description of the Project

The Project includes the deployment of an electric-powered HSR system based on Central Japan Railway Company's Tokaido Shinkansen system. Accident statistics are not available for systems operating technology comparable to the Project; however, Japan's Tokaido Shinkansen HSR, which operates a similar technology, has had no passenger fatalities resulting from a trainset accident, such as a derailment or collision, since the service began over 50 years ago.[8, 9] The technology has a proven safety record with only one earthquake-related derailment since the service began, which resulted in no passenger injuries.

The trainset technology would be adapted to meet the regulatory requirements, as established by an FRA RPA to ensure the system is operated safely. To minimize risk and enhance passenger safety, the

[8] The only injuries and/or fatalities reported in association with the Tokaido Shinkansen HSR system was a single passenger suicide by self-immolation on June 30, 2015. This instance is unrelated to the design, operation and overall safety of the system. BBC News Online, "Japan bullet train passenger 'self-immolation' fire kills two," June 30, 2015, accessed November 2019, https://www.bbc.com/news/world-asia-33322794.

[9] JRC, "About the Shinkansen," FY 2016, accessed November 2019, https://global.jr-central.co.jp/en/company/about_shinkansen/.

alignment is proposed to be a "closed system." A "closed system" is one that is not interconnected with any other railroad system and the HSR trainset operations are independent and separated from existing roadways and other infrastructure (i.e., no at-grade crossings). Operating a "closed system" contributes to the HSR trainset's ability to safely achieve speeds not to exceed 205 miles per hour (mph) and to attain an approximate 90-minute travel time between Dallas and Houston. Additionally, TCRR would only provide passenger rail service. Hazardous materials and other conventional heavy freight would not be transported on the trainsets or within the HSR right-of-way (ROW).

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 Final Conceptual Engineering Design and Constructability Reports,** and **Appendix G, TCRR Final Conceptual Engineering Plans and Details**) completed as of July 1, 2019, 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. The HSR ROW would vary in width with an average width of 328 feet and a minimum ROW of 100 feet that would include the track, overhead catenary system, 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/embankment, retained fill, retained cut and bridge-like structure, called viaduct. Approximately 55 percent of the HSR line would be constructed on viaduct.

A typical trainset would consist of eight 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 eight-car trainset would carry up to 400 seated passengers.

Power would be distributed to the trainset via the overhead catenary system, which is the electrical wiring that runs above each track and provides electricity from the traction power substation (TPSS) to the trainset. The HSR system would be monitored and controlled from a system-wide Operations Control Center located at the Trainset Maintenance Facility (TMF) in Dallas.

ES.2.1 Rule of Particular Applicability

As previously stated, FRA's existing regulations do not adequately address the safety concerns presented by the Project's proposed system. Therefore, TCRR cannot operate the system without FRA regulatory action.[10] Generally, during its rulemaking process, including for an RPA, 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, or in response to a rulemaking petition).
2. Developing the proposed rule.
3. Publishing the Notice of Proposed Rulemaking (NPRM) in the Federal Register and soliciting public comment.
4. Evaluating written comments from the public and, if a public hearing is convened, comments made during a public hearing on the NPRM.
5. Developing the Final Rule.
6. Publishing the Final Rule in the Federal Register.

[10] TCRR will need to demonstrate compliance with the requirements of the RPA and other applicable FRA requirements in order to operate the system.

Information on FRA's rulemaking process can be found online at https://railroads.dot.gov/legislation-regulations/regulations-rulemaking/regulations-rulemaking.

To establish minimum safety requirements for the Project, on April 15, 2016, after extensive consultation with FRA's Office of Railroad Safety, TCRR submitted a rulemaking petition to FRA for an RPA, a regulation that applies to its specific railroad operation.[11] TCRR updated its petition in subsequent submittals on August 12 and 16, 2016, with updated vehicle track interaction information. On September 27, 2017, TCRR provided an updated petition, combining previous supplementals and superseding all previous submittals (see Docket Number FRA-2019-0068).[12] FRA granted TCRR's rulemaking petition on August 30, 2019. On March 10, 2020, FRA published an NPRM proposing a set of minimum federal safety standards to enable effective safety oversight of the operation of TCRR's HSR system within the United States.[13]

On March 10, 2020, FRA published the NPRM in the Federal Register opening the comment period for the public to provide comments on the proposed technical safety requirements. In addition, FRA held three telephonic public hearings on Monday, May 4 through Wednesday, May 6, 2020. Each meeting offered telephone attendees the opportunity to provide oral comments on the NPRM. As of the execution of this Final EIS on May 15, 2020, oral comments made during the public hearings and written comments submitted to the Docket[14] have raised no new substantive issues relevant to environmental concerns from those received during the public comment period of the Draft EIS (discussed in **Section 9.6.2, Public and Agency Involvement, Draft EIS Comment Period,** and **Appendix H, Response to Draft EIS Comments**) or on topics not already covered within this Final EIS. FRA will continue to evaluate comments received during the comment period for the Proposed Rulemaking. FRA will address comments on technical safety requirements proposed in the NPRM in the Final Rule, which will be published in the Federal Register.

ES.2.2 Stations

TCRR is proposing three stations as part of the Project: an approximately 90-acre terminal station in Dallas, an approximately 60-acre terminal station in Houston; and an approximately 115-acre Brazos Valley intermediate station in Grimes County, near the town of Roan's Prairie. Each terminal station could accommodate six tracks and three island platforms that would measure 30 feet wide and 705 feet long. Provisions would need to be made for any future expansion of the HSR system, should there be a future plan to extend service beyond the Dallas and Houston Terminal Stations. Although Dallas Area Rapid Transit (DART) or Trinity Railway Express (TRE) or future high-speed service could not operate on extensions of the HSR tracks or along HSR station platforms, it is possible that cross platform connections could be made at both terminal stations.[15,16] The Brazos Valley Intermediate Station would have two mainline tracks with side platforms, measuring 20 feet wide and 705 feet long. Two additional tracks (one on each side of the mainline tracks) are planned to allow for express service trainsets to

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[11] TCRR's rulemaking petition was for a rule for the Dallas to Houston FRA's proposed rule.

[12] Available at https://www.regulations.gov/docket?D=FRA-2019-0068.

[13] 85 Federal Register 14036 (March 10, 2020).

[14] As of May 15, 2020, 221 comments were submitted within the public comment period for the Proposed Rulemaking to https://www.regulations.gov/docketBrowser?rpp=25&so=DESC&sb=commentDueDate&po=0&D=FRA-2019-0068.

[15] As discussed in more detail in **Chapter 4.0, Indirect Effects and Cumulative Impacts**, there are no current planned or programmed expansions of DART, TRE or light rail operations. However, the operation of the HSR station could result in expanded operation of these systems to complement transit connectivity and provide enhanced commuter benefits. Any expansion of DART, TRE or light rail operations near the station would be a separate project and would require its own separate environmental and planning evaluation.

[16] City of Dallas, "High Speed Rail Update," October 8, 2018, accessed December 2019, https://dallascityhall.com/projects/high-speed-rail/DCH%20Documents/2018-10-8%20MSIS%20High%20Speed%20Rail%20-%20Final.pdf

bypass the station as described in **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports (Section 6.7, Stations, Brazos Valley Station)**.

ES.3 Purpose of and Need for the Project

ES.3.1 Purpose

The purpose of the privately proposed Project is to provide the public with reliable and safe HSR transportation between Dallas and Houston.[17]

ES.3.1.1 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 for the Project 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

ES.3.1.2 TCRR Objectives

TCRR identified the Dallas to Houston corridor as an ideal distance to implement high-speed intercity passenger rail that is financially sustainable and 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**: vehicle and operating procedures based on the N700-Series Tokaido Shinkansen system
- **Operational**: approximate 90-minute travel time between Dallas and Houston, with achievable speeds not exceeding 205 mph in a "closed system" corridor[18]
- **Environmental**: minimal impacts to the natural and built environments by maximizing adjacency to existing infrastructure ROW

ES.3.2 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 the growing demand between Dallas and Houston. Current direct route transportation options between Dallas and Houston are limited to vehicular and air travel.[19] Due to increasing congestion on Interstate Highway (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 (60 to 75 minutes); however, the overall trip duration when

[17] 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.

[18] A "closed system" corridor means the corridor is not interconnected with any other railroad system; operations would be independent and separated from existing roadways and other infrastructure. There are no at-grade crossings, which means a car would not have to wait for a trainset to pass and then drive over the tracks to the other side of the system.

[19] TCRR estimates in 2017 that 94 percent of the traveling public use private automobiles to travel between Dallas and Houston; 6 percent use air or bus, see **Appendix J, Ridership Demand Forecasting Methodology Assessment Technical Memorandum**

considering pre-arrival time more than doubles. Pre-arrival time refers to the time recommended by airlines (approximately 1 to 2 hours[20,21,22]) to arrive at the airport to allow for parking, checking in, checking luggage and passing through Transportation Security Administration security checkpoints. Additionally, flights are more sensitive to inclement weather such as severe rain and snowstorms or other delay-causing events from inside and outside of Texas[23], while HSR may be affected only by extreme weather events such as tornados or straight-line winds between Dallas and Houston as described in **Sections 2.2.1, Alternatives Considered, Technology,** and **3.16.5.2, Safety and Security, Build Alternatives**.

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 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 in **Section 1.2.2, Introduction, Need**.

ES.4 Alternatives Analysis

The first step in the alternatives development process for this EIS was to evaluate proposed corridor alternatives. **Section 2.4, Alternatives Considered, Development and Evaluation of Proposed Corridors,** summarizes the process that FRA undertook to identify corridor alternatives. **Figure ES-1** depicts the four HSR corridor alternatives evaluated.

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://railroads.dot.gov/elibrary/dallas-houston-high-speed-rail-project-corridor-alternatives-analysis-technical-report.

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.

Based on FRA's identification of the Utility Corridor, TCRR developed 21 potential alignment alternatives for FRA's consideration. **Section 2.5, Alternatives Considered, Development and Evaluation of Initial Alignment, Station and TMF Alternatives** details the process that FRA undertook to identify the alignment alternatives that are evaluated in this Final EIS.

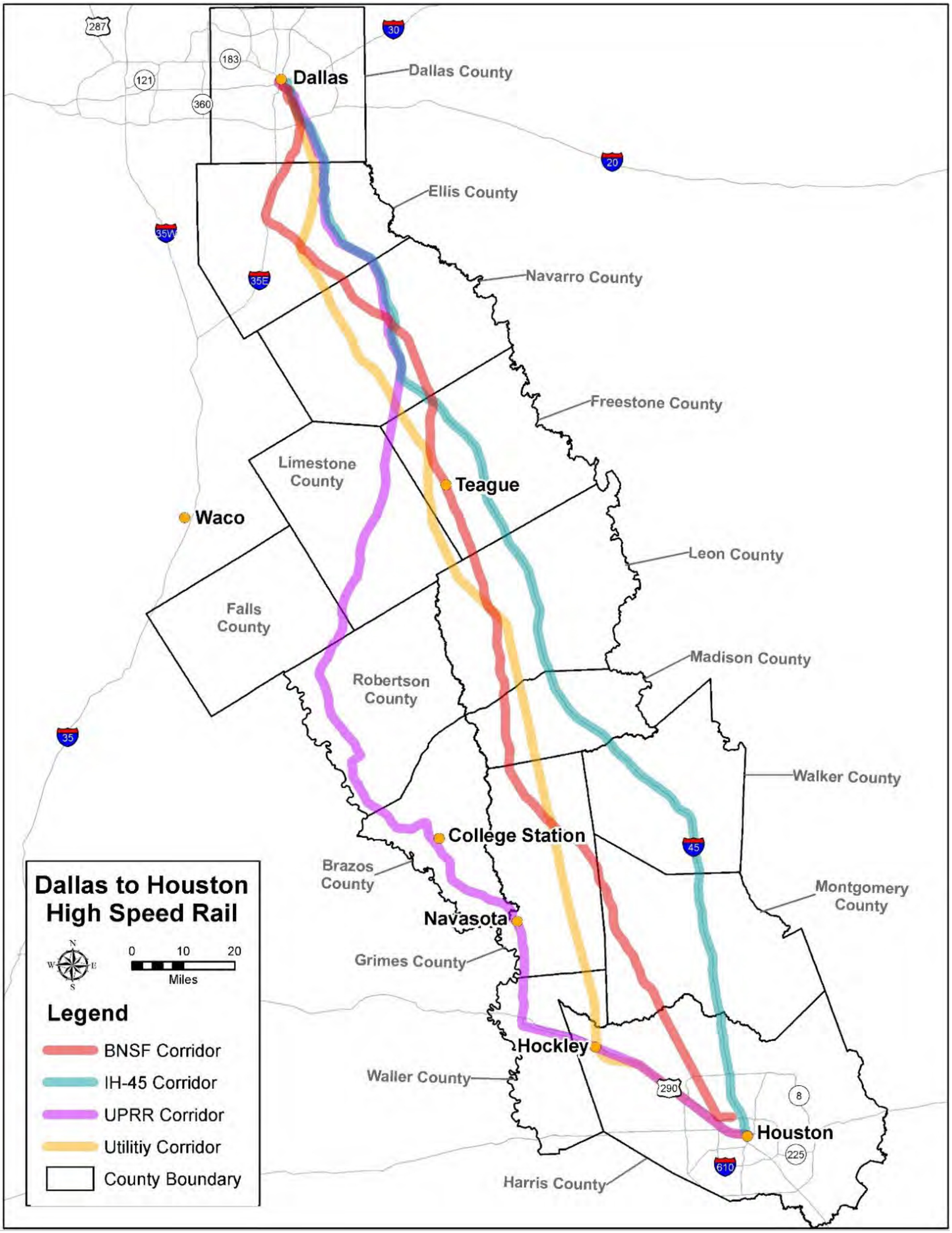
[20] Delta Air Lines, Inc., "Check-in Times at U.S. Airports," accessed November 2019, https://www.delta.com/us/en/check-in-security/check-in-time-requirements/domestic-check-in.

[21] American Airlines, "Check-in and arrival," accessed November 2019, https://www.aa.com/i18n/travel-info/check-in-and-arrival.jsp

[22] United Airlines, Inc., "Check-in and airport processing times," accessed November 2019, https://www.united.com/ual/en/us/fly/travel/airport/process.html?irgwc=1&clickid=Rj9TON0CDxyORS2wUx0Mo3cjUkn1g12mtXwu3Y0

[23] The Federal Aviation Administration (FAA) reports that approximately 70 percent of flight traffic delays (with times greater than 15 minutes) are due to inclement weather (seasonal storms, rain thunderstorms, low visibility and winds), and that delays in high-volume areas (such as New York) can ripple throughout the country. FAA, "FAQ: Weather Delay," August 29, 2017, accessed November 2019, https://www.faa.gov/nextgen/programs/weather/faq/.

Figure ES-1: Four HSR Corridor Alternatives



Source: AECOM 2016

FRA's *Dallas to Houston High Speed Rail Project, Alignment Alternatives Analysis Report*, is available on the FRA Project website:

https://railroads.dot.gov/elibrary/dallas-houston-high-speed-rail-project-alignment-alternatives-analysis-report.

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, Alternatives Considered, 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 system (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 detailed in **Section 2.5.1.2, Alternatives Considered, Level II Screening**. 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://railroads.dot.gov/elibrary/dallas-houston-high-speed-rail-project-alignment-alternatives-analysis-report.

With the Build Alternatives identified, TCRR identified one Dallas Terminal Station near IH-30 just south of downtown Dallas, one Brazos Valley Intermediate Station near SH 30 and three Houston Terminal Station Options – Houston Industrial Site (south of Hempstead Road), Houston Northwest Mall Site (north of Hempstead Road) and Houston Transit Center Site (west of IH-610). For this Final EIS, the Houston Northwest Mall Terminal Station Option has been identified as the preferred station in Houston.

The operation of the Project would be supported by a collection of maintenance facilities to repair and maintain the trainset and track. These facilities include two TMFs and seven maintenance-of-way (MOWs) facilities.

The TMFs would be located in proximity to the terminal stations to serve as cleaning and maintenance facilities of the HSR trainsets. The two TMFs would provide for all periodic inspections, scheduled maintenance, scheduled overhaul 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 trainset storage, trainset car wash facilities and other facilities. A trainset shed will be located at the TMF in Houston and a workshop would be located at the TMF in Dallas. As previously mentioned, the Dallas TMF would also house the Operations Control Center for the system.

TCRR proposed two locations for the TMF in Dallas County, the Dallas North TMF and Dallas South TMF. The Dallas North TMF site would be located north of IH-20 within the City of Dallas, about 7.5 miles from the Dallas Terminal Station. The Dallas South TMF site would be located north of Belt Line Road, approximately 12 miles from the Dallas Terminal Station. The Dallas South TMF would require an additional MOW facility between the TMF and the Dallas terminal station, while the Dallas North TMF site would not. For the Draft EIS, FRA evaluated these Dallas locations. However, TCRR's ongoing coordination with stakeholders indicated that the Dallas International Intermodal Terminal and related developments in south Dallas have continued to progress since the release of the Draft EIS. Because of these ongoing developments, TCRR determined that the Dallas South TMF site was not a viable option for the Project. Both the Dallas North and South TMF sites based on TCRR's updated Project LOD are assessed in this Final EIS.

TCRR also proposed three locations for the TMF in Harris County. The Harris North TMF site would be located on Castle Road in northern Harris County, approximately 34 miles from the Houston Terminal Station Options. The Houston North TMF site would be located near U.S. Highway (US) 290 and Katy Hockley Road, approximately 27 miles from the Houston Terminal Station Options. The Houston South TMF site would be located east of Beltway 8 and south of Hempstead Road, approximately 8.5 miles from the Houston Terminal Station Options. The Harris North TMF site and the Houston North TMF site would require an additional MOW facility between the TMF and the Houston Terminal Station, while the Houston South TMF site would not. In the Draft EIS, FRA evaluated the Houston North and Houston South TMF sites. However, due to ongoing stakeholder outreach and engineering design updates detailed in **Section 2.5.4, Alternatives Considered, Engineering Refinements**, TCRR proposed a new location for the Houston TMF, the Harris North TMF site on Castle Road. Therefore, all Harris County TMF sites based on TCRR's updated Project LOD are assessed in this EIS.

ES.5 Modifications incorporated in the Final EIS since the Draft EIS

Modifications including refinements to engineering and releases of updated resource data have occurred since the publication of the Draft EIS. These modifications, as described in the following paragraphs, are incorporated into this Final EIS.

As detailed in **Section ES.6, Engineering Refinements**, TCRR continued to refine the conceptual design after the release of the Draft EIS based on the results of environmental and engineering surveys, stakeholder engagement, design development and the findings of the environmental analyses. These modifications included:

- Alignment and profile refinements and optimizations
- Station refinement and optimizations
- General HSR program refinements and optimizations (e.g., TMF relocations and additional emergency access points)
- LOD refinements and optimizations

Due to TCRR's continued refinement of the Preferred Alternative, approximately 27.5 miles (12 percent) of the centerline of Build Alternative A shifted to a location outside of the LOD assessed in the Draft EIS. Additionally, the LOD of Build Alternative A in the Final EIS is approximately 9,173 acres, a reduction of approximately 9 percent from the Draft EIS. This updated conceptual design (included as **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports,** and **Appendix G, TCRR Final Conceptual Engineering Plans and Details)** completed as of July 1, 2019, is the basis for the evaluation included in this Final EIS.

In addition to the engineering refinements, this Final EIS includes updated publicly available data, additional data gathered through recent field work and revised modeling based on the updated/additional data. For example, on September 23, 2019, the DFW and Houston-Galveston-

Brazoria (HGB) nonattainment areas were redesignated from moderate to serious nonattainment for the 2008 ozone National Ambient Air Quality Standards, which resulted in a reduction of applicable *de minimis* levels, namely nitrogen oxide (NO_x) from 100 tons per year (tpy) to 50 tpy. **Section 3.2, Air Quality,** has been revised to include updated construction emissions modeling and estimates based on modifications to the proposed construction activities.

Furthermore, as noted in **Appendix H, Responses to Draft EIS Comments**, data and analysis of resources throughout this chapter have been clarified, updated and/or expanded in response to public comments received during the Draft EIS public comment period. For instance, a property in Harris County was identified from public comments as a visual receptor and an updated analysis has been incorporated into **Section 3.10, Aesthetics and Scenic Resources.**

After the release of the Draft EIS, FRA conducted additional listening sessions and outreach to minority and/or low-income communities impacted by the Project. The summary of these discussions and analyses, including updated census data, have been incorporated into **Section 3.18, Environmental Justice**.

FRA also modified the approach to describing potential impacts in this Final EIS. Specifically, this Final EIS no longer describes impacts as "significant" or "not significant." However, the significance of the potential impacts continues to be described in terms of their context and intensity. Where adverse impacts would occur, FRA has identified ways to mitigate those impacts. By conducting the EIS, FRA acknowledges that the Project has the potential to significantly impact the natural and human environment.

In some resource areas, compliance and mitigation measures are presented differently in the Final EIS than in the Draft EIS. Redundant compliance and mitigation measures were removed from the Final EIS. Others were revised to apply more broadly than contemplated in the Draft EIS, to better identify the entity responsible for mitigation and to more precisely describe the measures, including the geographic area within which they apply. FRA also added new measures where appropriate to mitigate impacts.

ES.6 Engineering Refinements

Throughout the NEPA process, TCRR has continually refined the design of the Build Alternatives to reduce the Project footprint, or LOD, and avoid or minimize impacts to the socioeconomic, natural, cultural and physical environment. These engineering refinements were based on environmental and engineering surveys, stakeholder engagement, public input, design development and the findings of FRA's environmental analyses. Therefore, the Build Alternatives depicted in this EIS differ from the alignment alternatives presented in the Draft EIS.

Based on input received by TCRR through their stakeholder engagement efforts, these refinements resulted in the use of viaduct on approximately 55 percent of the Project, which would allow for greater movement around and under the HSR system. Additionally, TCRR designed 48 percent of the Build Alternatives adjacent to existing infrastructure, which typically includes areas that have previously been disturbed by past development. This design approach minimizes impacts to more environmentally sensitive areas and reduces 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 that may affect or be affected by the Project. TCRR's coordination efforts with the USACE focused on fee lands, streams, wetlands and floodplains. Through coordination with utility infrastructure owners TCRR identified expected approaches to maintenance and protection of utilities along the Build Alternatives. Through coordination with electrical transmission service providers within the Study Area, including Oncor Electric Delivery (Oncor) and CenterPoint Energy (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 (although these modifications and connections would ultimately be determined by Oncor and CenterPoint, as well as the Public Utility Commission of Texas). 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 the Dallas Floodway Extension, Trinity River Parkway and 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*.[24] TCRR also coordinated design development with various transportation providers within the corridor, such as DART, Gulf Coast Commuter Rail District and the Metropolitan Transit Authority of Harris County (METRO) (see **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports**). These planned projects and others are discussed in more detail in **Chapter 4.0, Indirect Effects and Cumulative Impacts**.

Design modifications made by TCRR since the Draft EIS resulted in approximately 17.5 percent of the track centerline being shifted to an area outside of the previous LOD. Also, as a result of these design modifications, the overall footprint of the Build Alternatives evaluated was reduced by approximately 23 percent.

ES.6.1 Updated LOD Definition

The LOD in this Final EIS has been updated to include areas where modifications to existing electrical transmission line infrastructure would also be required. This aspect of the Project was generally described in the Draft EIS in **Chapter 4.0, Indirect Effects and Cumulative Impacts,** as an activity that would be designed and led by impacted utilities. Through further coordination with transmission providers (e.g., Oncor and CenterPoint), TCRR has refined (1) anticipated modifications to electrical transmission infrastructure along all Build Alternatives and (2) anticipated connections with existing power grid to serve the traction power demand of the Project. FRA's independent coordination with these utility providers (summarized in **Chapter 9.0, Public and Agency Involvement**) has confirmed that the design assumptions (included as **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports,** and **Appendix G, TCRR Final Conceptual Engineering Plans and Details**) are reasonable, and as such have been included by the FRA within the LOD of this Final EIS. Impacts associated with the anticipated modification of existing electrical transmission lines are discussed throughout **Chapter 3.0, Affected Environment and Environmental Consequences,** while the potential impacts associated with the construction of new electrical transmission lines are included in **Chapter 4.0, Indirect Effects and Cumulative Impacts.**

ES.6.2 Preferred Alternative Design Refinement

After release of the Draft EIS, TCRR continued to refine and optimize the design of the Preferred Alternative, Build Alternative A, in order to address stakeholder input, respond to comments, reduce

[24] City of Lancaster, *Lancaster Regional Airport Master Plan*, accessed May 2020, http://lancaster-tx.com/DocumentCenter/View/2765/Lancaster-Regional-Airport-Master-Plan?bidId=.

and avoid adverse environmental impacts identified during the Draft EIS and improve constructability. Revisions to Build Alternative A are categorized into four main groups and generally described in the following sections, with additional details located in **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports,** and **Appendix G, TCRR Final Conceptual Engineering Plans and Details**.

ES.6.2.1 Alignment and Profile Refinements and Optimizations

Richmond Realignment: The alignment of Segment 3A near the City of Richmond in Navarro County was optimized to minimize impacts to existing county roads and shifted east in response to several thousand public comments about potential natural resources and stakeholder impacts.

Ennis Realignment: The alignment of Segment 2A near the City of Ennis in Ellis County was shifted west to avoid parcels with documented environmental contamination.

Castle Road Realignment: The alignment of Segment 5 was shifted east to reduce impacts to a historic property (Resource ID HA.004a) that is eligible for listing in the National Register of Historic Places (NRHP).

Hempstead Road Revisions: The alignment configuration and profile elevation of Segment 5 adjacent to Hempstead Road in Houston were revised to account for the US 290/Hempstead managed lanes project and planned improvements to Hempstead Road as defined through ongoing coordination with TxDOT and City of Houston.

ES.6.2.2 Station Design Refinements and Optimizations

Houston Northwest Mall Terminal Station Option: Station optimized and refined to align parallel with Hempstead Road and shifted to the northwest to account for the US 290/Hempstead managed lanes project and planned improvements to Hempstead Road.

Dallas Terminal Station: The approach into the Dallas Terminal Station was refined to more closely follow the Union Pacific Railroad (UPRR) freight railroad and to decrease distance to DART's Cedars Station. The Dallas Terminal Station was refined to address the USACE and stakeholder inputs received as part of TCRR's initial Section 408 permission request and coordination with the City of Dallas (i.e., Dallas City Council Resolution No.17-1200,[25] which terminated the planned Trinity Parkway).

ES.6.2.3 General HSR Program Refinements and Optimizations

Houston TMF Relocation: Due to planned developments, land ownership changes, and to account for the raised HSR profile to allow for the Houston Major Thoroughfare and Freeway Plan, the TMF location was shifted north along the Castle Road Realignment.

Houston MOW Facility Relocation: To eliminate conflicts with the proposed TXDOT US 290/Hempstead managed lane project, refinements also included the relocation of the Houston MOW facility.

Systems Relocations: Based on input from utility providers in the Project corridor, several TPSSs were relocated. Refinements also included relocations of smaller facilities (sectioning posts, communication houses, etc.) to coincide with access road and reflect updated design criteria, such as spacing requirements for communication houses.

[25] City of Dallas, Official Action of the Dallas City Council, 17-1200, Item 49, August 9, 2017, accessed May 2020, http://citysecretary2.dallascityhall.com/pdf/CC2017/080917Min.pdf.

Dallas TMF: The Draft EIS identified the Dallas South TMF site as the preferred location; however, following the publication of the Draft EIS the Dallas International Intermodal Terminal and related developments in south Dallas advanced and precluded the development of a TMF at the Dallas South location. Consequently, the Dallas North TMF is the only remaining viable location for the Dallas TMF.

Emergency Access: Design was updated to include emergency response and maintenance staging areas.

ES.6.2.4 LOD Refinements and Optimizations

Reduced Viaduct: Throughout Build Alternative A, the width of viaduct sections was reduced with continued engineering to minimize impacts to environmentally sensitive floodplains and wetlands.

Facility Placement: Throughout Build Alternative A, ancillary facilities such as detention basins, systems facilities, access roads and other Project elements were reconfigured, consolidated or relocated to avoid environmentally sensitive areas or to avoid impacts to multiple parcels.

Road Over Rail: TCRR reduced road over rail crossings that require reconfiguration of existing county roads (and other private roads where practicable).

While refinements occurred to Build Alternative A, all six Build Alternatives (A through F) are assessed in this EIS.

ES.7 No Build Alternative

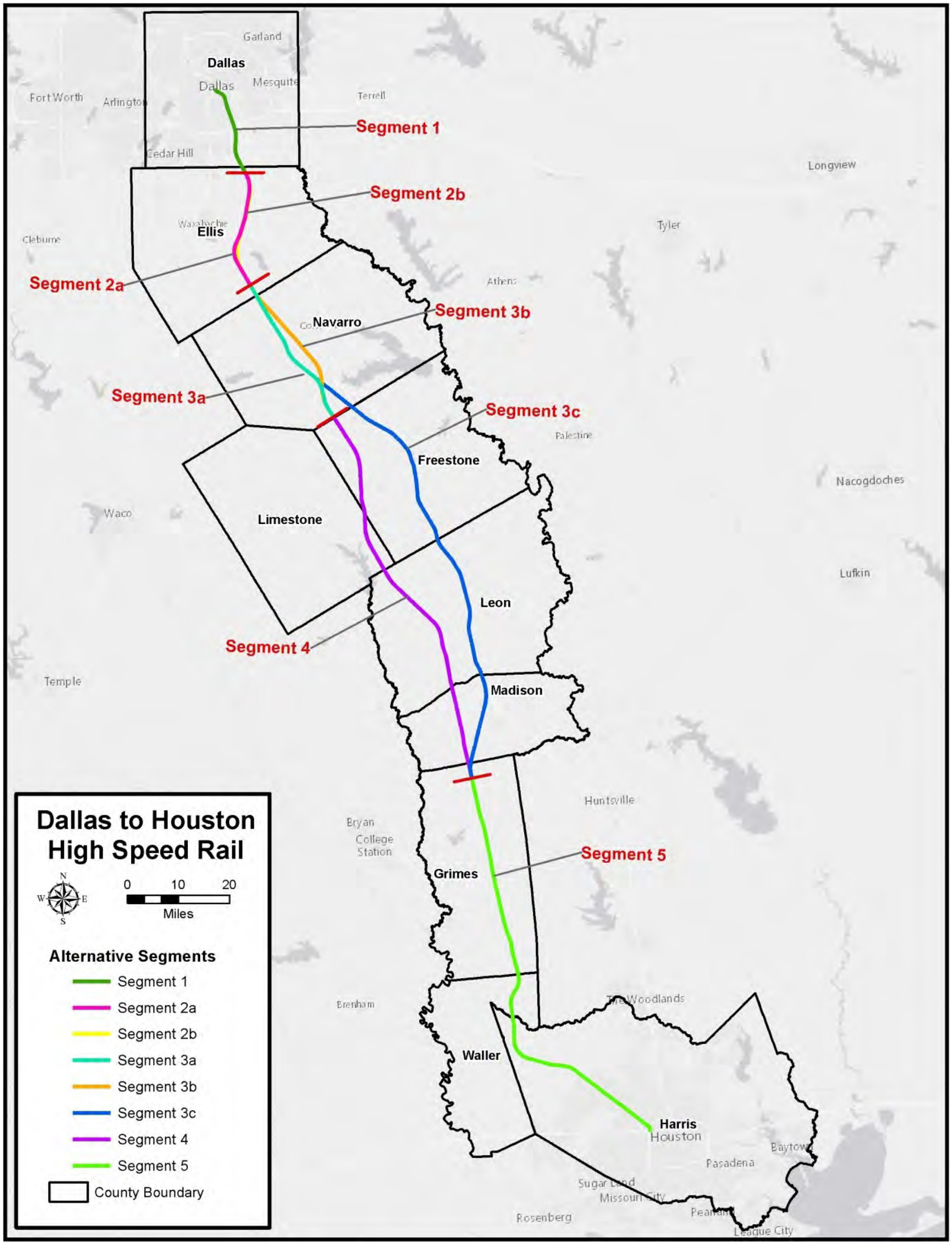
The No Build Alternative is included in this analysis as the baseline for comparison with the Project (Build Alternatives A through F and Houston Terminal Station Options). This is also known as the alternative of no action as required by NEPA. Under the No Build Alternative, FRA would not issue an RPA 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 (Dallas Fort Worth International Airport [DFW], Dallas Love Field Airport [DAL], George Bush Intercontinental Airport [IAH] and William P. Hobby Airport [HOU]) infrastructure. For purposes of describing future transportation conditions in 2040 under the No Build Alternative, planned and programmed projects were included in traffic modeling detailed in **Section 3.11, Transportation**. Additional projects included in the No Build Alternatives are the Integrated Pipeline Project in Navarro and Ellis Counties. The impacts of these projects are discussed in **Section 4.4, Indirect Effects and Cumulative Impacts, Cumulative Impacts**.

The No Build Alternative would not meet the specified Purpose and Need for this Project. The No Build Alternative would not provide congestion relief, improve safety on IH-45 or 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.8 Build Alternatives

The Level II Screening process resulted in the six end-to-end Build Alternatives A through F considered in this EIS. For analytical purposes in this EIS, each alternative is divided into segments, as depicted on **Figure ES-2**. Segment descriptions are included to illustrate the differences between the Build Alternatives. Segment descriptions include identification of more significant facilities such as stations, TMFs, MOW facilities and TPSSs only.

Figure ES-2: Build Alternatives Advanced to EIS, by Segment



Source: AECOM 2019

ES.8.1 Segment 1 (18.3 miles)

Segment 1 is located in Dallas County (**Appendix D, Project Footprint Mapbook, Sheets 1-24**). 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 East 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, North Lancaster/Hutchins Road, East Pleasant Run Road and East Beltline Road. South of East Beltline Road, Segment 1 extends west of Lancaster Airport before turning 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 and a TPSS.

ES.8.2 Segment 2A (23.4 miles)

Segment 2A is located in Ellis County (**Appendix D, Project Footprint Mapbook, Sheets 24-55**). Segment 2A begins approximately 1.5 miles south of the Ellis County line, crossing FM 983 and Wester Road. 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 facility and one TPSS.

ES.8.3 Segment 2B (23.2 miles)

Segment 2B is located in Ellis County (**Appendix D, Project Footprint Mapbook, Sheets 56-87**). 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 facility and one TPSS.

ES.8.4 Segment 3A (30.8 miles)

Segment 3A is located in Ellis and Navarro counties (**Appendix D, Project Footprint Mapbook, Sheets 87-124**). Segment 3A begins 2 miles north of the Navarro County line and deviates from Segment 3b just south of FM 985 before it would cross into Navarro County. Segment 3A continues south towards Barry, passes to the east of Barry and crosses FM 22. The alignment continues southeast, crossing FM 744 and SH 31 west 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 at the Navarro–Freestone County line. Segment 3A includes one siding-off track and two TPSSs.

ES.8.5 Segment 3B (31.1 miles)

Segment 3B is located in Ellis and Navarro counties (**Appendix D, Project Footprint Mapbook, Sheets 125-163**). 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 at the Navarro – Freestone County line. Segment 3B includes one siding off track and one TPSS.

ES.8.6 Segment 3C (113.1 miles)

Segment 3C is located in Navarro, Freestone, Leon, Madison and Grimes counties (**Appendix D, Project Footprint Mapbook, Sheets 164-312**). West 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 six TPSSs.

ES.8.7 Segment 4 (77.9 miles)

Segment 4 is located in Freestone, Limestone, Leon, Madison and Grimes counties (**Appendix D, Project Footprint Mapbook, Sheets 313-415**). Segment 4 begins at the Freestone County line and travels southeast crossing over FM 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 SH 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.

ES.8.8 Segment 5 (84.2 miles)

Segment 5 is located in Grimes, Waller and Harris counties (**Appendix D, Project Footprint Mapbook, Sheets 415-524**). Segment 5 continues south along the utility easement, crossing FM 155 and 39, before crossing SH 30 just west of Roans Prairie, and the proposed Brazos Valley Intermediate 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 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 the Brazos Valley Intermediate Station, one TMF, two MOW facilities, one siding off track and four TPSSs.

ES.8.9 Houston Terminal Station Options

As detailed in **Section 2.5.2.3, Alternatives Considered, Houston Terminal Station Options**, the Houston Terminal Station would be located in northwest Houston within the vicinity of US 290, IH-10 and IH-610. The three terminal station options are the Industrial Site, Northwest Mall and Northwest Transit Center.

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

- **Northwest Mall Terminal Station Option:** The second proposed station option 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 West 18th Street.
- **Northwest Transit Center Terminal Station Option:** The third proposed option 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 METRO Northwest Transit Facility located opposite the station.

ES.8.10 Summary of Build Alternatives

Table ES-2 identifies the segments that create each Build Alternative.

Table ES-2: Build Alternatives A through F

Alternative	Segment
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

ES.9 Summary of Environmental Consequences

The Final EIS considers impacts from the Dallas to Houston HSR Project proposed by TCRR as described in **Section 2.2, Alternatives Considered, Proposed HSR Infrastructure and Operations,** and in the petition for rulemaking submitted by TCRR. The HSR service between Dallas and Houston is the only proposed service or future operating location TCRR has identified to FRA and therefore FRA determined it was appropriate to evaluate the potential project-specific impacts of this proposed service. The potential impacts that would result from implementing this specific Project are identified and discussed in **Chapter 3.0, Affected Environment and Environmental Consequences,** and are summarized below.

Because FRA's proposed rulemaking would enable the safe operation of TCRR's HSR system in other, unidentified locations, in this Final EIS, FRA also considered impacts for application of the technology independent of location. **Section 3.1.2, Introduction, Impacts of the TCRR HSR System Independent of Location,** considers the reasonably foreseeable potential beneficial and adverse environmental impacts of implementing TCRR's HSR service in any location, even though FRA is aware of no proposal to operate such service.

ES.9.1 Air Quality

Detailed in **Section 3.2, Affected Environment and Environmental Consequences, Air Quality**, FRA assessed air quality impacts through an analysis of emissions that would occur during construction and operation of the Project. FRA made quantitative estimates of emissions from construction and operational sources for the Project using standard modeling platforms, emissions data and spreadsheet calculations.

Construction of the Project would temporarily increase local and regional emissions of particulate matter (fugitive dust) and pollutant emissions from fuel combustion (diesel particulate matter, carbon monoxide, carbon dioxide, nitrogen oxides (NO_x), volatile organic compounds (VOCs) and sulfur compounds). 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 sulfur dioxide (SO_2) emissions were quantified 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. 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 43.8 miles would occur within the DFW ozone nonattainment counties, and approximately 46.9 miles would occur within the HGB ozone nonattainment counties. In addition, approximately 32.6 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 for each Build Alternative is not provided. Maximum annual direct (construction-related) NO_x, VOC and SO_2 emissions within the DFW and HGB ozone nonattainment areas and the FRE SO_2 nonattainment area during the 5-year construction period would be less than the respective general conformity *de minimis* level and both short-term and localized. Fugitive dust from construction would be mitigated by using dust suppression techniques such as soil binders or watering, covering or wetting materials during transport, and limiting construction vehicle speeds on non-paved roads. Emissions from fuel consumption could be mitigated by sourcing materials near the construction site and using existing freight rail lines to transport materials.

The Project has a low potential for mobile source air toxics(s) (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 Project would provide another option for intercity travel between Dallas and Houston that would emit air pollutants, including MSATs, into the atmosphere. However, the Project would decrease overall vehicle miles traveled 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.

The lengths of the Build Alternatives vary by no more than approximately 4.69 miles; therefore, the differences in criteria pollutant emissions produced from power consumption to propel trainsets those extra distances would be minimal. Also, the equipment and layout of the Houston Terminal Station Options are similar; therefore, power consumption at these sites would only differ by a minimal amount. In fact, the maximum power consuming Build Alternative and the least consuming Build Alternative vary by approximately 1 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 location areas, 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 trainset 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 trainset 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.

ES.9.2 Water Quality

Detailed in **Section 3.3, Affected Environment and Environmental Consequences, Water Quality,** water in the water quality Study Area generally drains to the southeast towards the Gulf of Mexico and the Project intersects nine watersheds. The Project 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 Project 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 Project 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 result in total suspended solids (TSS) such as rock, soil, and debris fragments entering into downstream water resources. These TSS may also contain bacteria, nutrients, particles and other constituents attached to sediment or carried separately by stormwater that contribute to pollutant loading. Increased pollutant loading in runoff may impact surface water, groundwater quality and water supply. While this could impact all types of waterbodies, threatened or impaired waterbodies and reservoirs or other public water supplies would be more sensitive to construction stormwater runoff.

Potential 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 completed by TCRR prior to the start of construction and in accordance with Texas Commission on Environmental Quality (TCEQ) regulations.

Increased water demand would occur for the duration of construction. Aside from drinking water for construction crews, water would be used for construction activities such as dust suppression and mixing concrete. Potable and non-potable water for construction would be supplied from existing surface or groundwater supply systems, and would be trucked in, as needed. Therefore, water demand during construction would not be anticipated to require construction or expansion of a water treatment facility, or expanded water entitlements. Additional information on water demand during construction and operation is located in **Section 3.9.5.2.1, Utilities and Energy, Utilities**.

Potential operational impacts would result from stormwater runoff and operation activities, such as maintenance of culverts or bridges, fueling and trainset maintenance activities and obtaining water supplies for the operational facilities and trainsets. Operation of the railway would have potential permanent impacts on surface water quality including impaired stream segments. TCRR would implement soil erosion preventive measures, efforts to keep runoff rates similar to existing conditions and measures to prevent collected sediment and contamination from entering water in watersheds (**WQ-MM#6. Total Suspended Solids/Stormwater Runoff Control [Permanent]**) to mitigate potential impacts to water quality.

Surface water in watersheds and groundwater in aquifers are fluid and connected; therefore, the effects on one could impact the larger system and have been combined in evaluating the Study Area for effects to these systems. In general, the potential impacts to surface water quality, groundwater quality and water supply are similar for all Build Alternatives. **Table ES-3** presents the water quality impacts by Build Alternative and Houston Terminal Station Option.

Build Alternatives C and F would not be located near any reservoirs or dams. Build Alternatives A, B, D and E would cross a tributary draining to Lake Limestone Reservoir, a water supply reservoir, resulting in potential temporary indirect water quality impacts to Lake Limestone Reservoir.

The increased demand for water supply would be the same for all Build Alternatives and Houston Terminal Station Option. There would be no notable difference in surface water quality, groundwater quality and water supply as a result of the Project.

Table ES-3: 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 (LF)	344.7	517.4	496	344.7	517.4	496	0	0	0
Impaired Waterbodies with TMDLs (LF)	485.3	485.3	485.3	485.3	485.3	485.3	0	0	0
Impaired Waterbodies Total (LF)	830	1,002.7	981.3	830	1,002.7	981.3	0	0	0
Active Public Water System Wells	1	1	1	1	1	1	0	0	0
Groundwater Wells	9	13	7	9	13	7	0	0	1
Reservoir/Dam Crossings	0	0	0	0	0	0	0	0	0

Source: AECOM, 2019

LF = linear feet

ES.9.3 Noise and Vibration

As discussed in **Section 3.4, Affected Environment and Environmental Consequences, 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 Project. FRA compared these baseline noise measurements against modeled noise levels for both construction and operation of the HSR system.

Operational noise impacts are due primarily from trainsets passing near receivers close to the tracks and low existing noise levels around those receivers. FRA guidance generally projects noise exposure for a trainset passing at a speed of 205 mph to be 90 dBA at a reference distance of 50 feet from the centerline of the track. Sound levels of 90 dBA are considered very loud (louder than a jack hammer at the same distance). According to FRA, the largest screening distance for noise impact is 1,300 feet (new rail corridor in rural area). The distance is based on assumptions for the trainset operations and existing environment and is meant to provide a distance within which any potential impacts from HSR operations would be identified. Beyond this distance, no impacts would occur. Noise mitigation should be applied for severe impacts wherever feasible, as detailed within **Section 3.4.6, Noise and Vibration, Avoidance, Minimization and Mitigation**. In the quietest areas, severe noise impacts would not be expected beyond 350 feet of the centerline of the track. Noise can be mitigated through sound barriers or sound insulation treatments for buildings, such as adding an extra layer of glazing to windows, sealing holes in exterior surfaces that act as sound leaks and providing forced ventilation and air conditioning so that windows do not need to be opened.

Excluding noise impacts from trainset operations, sources of potential operational noise impacts in the vicinity of the Dallas Terminal Station, Brazos Valley Intermediate Station and Houston Terminal Station Options include 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 terminal stations, however, there are no noise-sensitive land uses within these distances. Thus, noise impacts would not occur due to station activities. For the MOW facilities, FTA guidance 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.

As indicated in the tables in **Section 3.4, Affected Environment and Environmental Consequences, Noise and Vibration**, HSR trainset vibration levels would be well below the thresholds for damage to structures, including underground utilities, which are 90 VdB or greater. Therefore, the vibration impact assessment focused on potential annoyance effects.

Estimates detailed within **Section 3.4.5.2.1, Noise and Vibration, Construction Noise and Vibration Impacts,** 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 200 feet from nighttime construction. During construction, some activities may cause perceptible ground-borne vibration, most notably pile driving for structures and vibratory compaction for ground improvements. Potential vibration impacts other than those from pile driving and vibratory compaction within 50 feet of structures would be limited to annoyance effects or interference with the use of sensitive equipment. Estimates detailed within **Section 3.4.5.2.1, Noise and Vibration, Construction Noise and Vibration Impacts**, 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 TMFs that would include pile driving. The noise impacts did not vary substantially by Build Alternative. There would be 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.

Vibration impacts from construction can be mitigated by routing heavily loaded trucks away from residential streets, phasing demolition, earthmoving, and ground-impacting operations so as not to occur in the same time period or avoiding pile-driving in vibration-sensitive area.

Table ES-4 presents the total noise and vibration impacts, without mitigation measures, by Build Alternative.

Table ES-4: 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	10	12	10	9	11	9
	Institutional	0	0	0	0	0	0
Moderate Noise Impact	Residential	280	290	275	285	295	280
	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 2019

As defined in **Section 3.4.3.2.3, Noise and Vibration, Operational Noise Impact Criteria,** moderate noise impacts are changes in the noise level that are noticeable, but the change is not high enough to cause major annoyance or strong, adverse reactions from the community and severe noise impacts are changes in the noise due to the Project would have the potential to be highly annoying and to cause strong, adverse reactions from the community.

ES.9.4 Hazardous Materials and Solid Waste

Discussed in **Section 3.5, Affected Environment and Environmental Consequences, 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. Hazardous materials concerns commonly encountered on a transportation project include industrial sites, Superfund sites, aboveground storage tanks, underground storage tanks, leaking petroleum storage tanks, landfills, structures with asbestos or lead containing materials and contaminated soil and groundwater. Hazardous materials use, handling and storage are regulated by USDOT and by Occupational Safety and Health Act (OSHA). Solid waste and hazardous waste are regulated by the United States Environmental Protection Agency. 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.

Impacts as a result of the construction of the Project 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 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.

Each of the Build Alternatives and Houston Terminal Station Options 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 Build Alternatives A through F and the Houston Terminal Station Options is presented in **Table ES-5**. The high-risk sites would be located in Segments 1 and 5, which are common to all Build Alternatives. Build Alternatives 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. Out of the three station options, the Northwest Mall Terminal Station Option would have the least hazardous materials site impacts.

Table ES-5: 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	297	298	326	297	298	326	4	0	6
Moderate-Risk Sites	155	155	165	155	155	165	3	3	8
High-Risk Sites	4	4	4	3	3	3	2	0	0
Total Impacts	**456**	**457**	**495**	**455**	**456**	**494**	**9**	**3**	**14**

Source: AECOM 2019

Construction of the Project 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, Hazardous Materials and Solid Waste, Mitigation Measures**.

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, Utility Crossings**. Relocation of existing wells and pipelines may be necessary during construction of the Project. 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 Project due to accidental damage, remediation would be conducted prior to continuation of construction activities as detailed in **Section 3.5.6.2, Hazardous Materials and Solid Waste, Mitigation Measures**.

The Project would only provide passenger rail service, and the transportation of hazardous materials in revenue service and joint operations with heavy freight equipment would not be permitted on the trainsets or within the HSR ROW. The operation and maintenance of the Project would involve transporting, using and storing hazardous materials (not in revenue service), and would generate hazardous waste. Hazardous materials could include diesel fuel, lubricants, hydraulic fluids and cleaning products used during the routine maintenance of the ROW, 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.

ES.9.5 Natural Ecological Systems and Protected Species

Section 3.6, Affected Environment and Environmental Consequences, Natural Ecological Systems and Protected Species, frequently referred to as natural resources, includes an analysis of plant and animal species 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. TCRR designed 48 percent of the Build Alternatives adjacent to existing infrastructure, which includes areas that have previously been disturbed by past development.

Construction of the Project could result in the disturbance and potential mortality of wildlife, particularly during vegetation clearing and grading. The removal of vegetation during the breeding bird season, late winter through spring and summer, could result in the loss of active bird nests (i.e., a nest that contains viable eggs and/or chicks) and potentially adult birds. Construction of the Project is not anticipated to have impacts to forage vegetation, species reproduction or species survival of commercially or recreationally important wildlife species occurring within the Study Area. Wildlife, including commercially or recreationally important species, in the immediate area may experience a temporary loss of forage vegetation; however, the prevalence of similar habitats in adjacent areas would minimize the short-term effect of the loss.

Five federally listed endangered species have the potential to occur in the Study Area: Houston toad (*Anaxyrus houstonensis*), interior least tern (*Sterna antillarum)*, whooping crane (*Grus americana)*, Navasota ladies'-tresses (*Spiranthes parksii*) and the large-fruited sand verbena (*Abronia marcocarpa*). In addition, 14 state-listed threatened species, including one federal Candidate species, may be impacted by the construction of each of the Build Alternatives as outlined in **Section 3.6.5.2.2, Natural Ecological Systems and Protected Species**, **Wildlife.** FRA has conducted 3 years of protected species presence/absence surveys in accordance with the USFWS-approved methods for the endangered Houston toad, large-fruited sand verbena and Navasota ladies'-tresses. Surveys have been limited to potential habitat for federally listed target species on properties for which right-of-entry has been obtained. FRA anticipates that the Project may affect, but is not likely to adversely affect, the Houston toad, interior least tern, and whooping crane based on the results of presence/absence species surveys and the implementation of avoidance and mitigation measures described in **Section 3.6.6, Natural Ecological Systems and Protected Species**, **Avoidance, Minimization and Mitigation,** and **NR-CM#4: Section 7 Consultation and Biological Opinion**.

Due to the presence of Navasota ladies'-tresses within the Study Area and the potential for large-fruited sand verbena in unsurveyed areas, FRA initiated formal Section 7 consultation with the USFWS on November 14, 2019, and prepared a Biological Assessment in **Appendix K, Agency Specific Reports, Biological Assessment**, that outlines specific measures to avoid or minimize impacting the species, as discussed in **Section 3.6.5.2.3, Natural Ecological Systems and Protected Species**, **Protected Species,** and **Section 3.6.6, Natural Ecological Systems and Protected Species**, **Avoidance, Minimization and Mitigation**. **Table ES-6** presents acreages of temporary and permanent impacts to potential habitat for three federally listed species with potential to occur in the Study Area (Houston toad, Navasota ladies'-tresses and the large-fruited sand verbena). Impacts to the interior least tern and whooping crane are not presented in **Table ES-6** due to the variability of the species habitat within the Study Area. An assessment of the least tern and whooping crane are included in the Biological Assessment, which can be found in **Appendix K, Agency Specific Reports, Biological Assessment**.

Construction impacts to vegetation and habitat would be minimized and/or avoided by deploying qualified biologists to conduct surveys prior to and during construction activities within or near protected species and their habitat to identify sensitive habitats and ensure implementation of compliance and mitigation measures would help avoid endangered species and their habitats. Qualified biologists would also identify protected species and relocate individuals so that direct mortality would be avoided. Compliance and mitigation measures, including **NR-CM#4: Section 7 Consultation and Biological Opinion,** are described in **Section 3.6.6, Natural Ecological Systems and Protected Species**, **Avoidance, Minimization and Mitigation,** and the Biological Assessment in **Appendix K, Agency Specific Reports, Biological Assessment.**

Table ES-6: Acreage of Protected Species Modeled Suitable Habitat Impacts by Build Alternative

	ALT A		ALT B		ALT C		ALT D		ALT E		ALT F	
	T	P	T	P	T	P	T	P	T	P	T	P
Houston toad/ *Anaxyrus houstonensis*	63	245	63	245	20	237	63	245	63	245	20	237
Large-fruited sand verbena/ *Abronia macrocarpa*	14	112	14	112	12	148	14	112	14	112	12	148
Navasota ladies'-tresses/ *Spiranthes parksii*	251	701	251	701	293	1067	251	701	251	701	293	1,067
Total Protected Species Habitat Impacted	328	1,058	328	1,058	325	1,452	328	1,058	328	1,058	325	1,452

Source: AECOM 2019

Note: T – Temporary, P – Permanent

ES.9.6 Waters of the U.S.

As detailed within **Section 3.7, Affected Environment and Environmental Consequences, Waters of the U.S.**, impacts would occur within waters of the U.S. during the construction and operation of the Project. TCRR, in coordination with the USACE Fort Worth and Galveston Districts, are developing the final design to avoid and minimize impacts to waters of the U.S., as practicable. However, 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. Permanent impacts would occur for the placement of viaduct and bridge support structures and culverts, and within the permanent footprint of access roads, stations, MOW facilities and TMFs and where the Project would be on embankment. All areas where the Project would be on viaduct are being treated as temporary impacts for this Final EIS. Permanent impacts as a result of viaduct support structures would be determined during design development. Temporary 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 waters of the U.S. would require permits and approvals from the USACE (e.g., **WW-CM#4: CWA Section 404, Individual Permit)** and TCEQ (e.g., **WQ-CM#1: Section 401 Water Quality Certification)** that would include permit provisions to avoid, minimize and mitigate impacts as detailed in **Section 3.7.6.1, Waters of the U.S., Compliance Measures and Permitting**.

Qualitative analysis of waters of the U.S. is being conducted by TCRR and will be assessed by the USACE during the permitting process. This analysis will be documented by the USACE separate from this Final EIS. **Table ES-7** provides 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 **Table ES-7**:

- Build Alternative B would impact the greatest amount of streams with 45,631 linear feet of permanent impacts, and Alternative F would impact the least amount of streams with 34,839 linear feet of permanent impacts.

- Build Alternative F would impact the greatest amount of wetlands with 64.4 acres of permanent impacts, and Build Alternative B would impact the least amount of wetlands with 47.4 acres of permanent impacts.
- Build Alternative D would impact the greatest amount of waterbodies with 29.3 acres of permanent impacts, and Build Alternative C would impact the least amount of waterbodies with 21.1 acres permanent impacts.

Overall, Build Alternative B would have the greatest impact on waters of the U.S., while Build Alternative F would have the least impact on waters of the U.S.

All Build Alternatives would impact USACE federally authorized civil works projects (USACE Projects) 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 the USACE Project associated with Lake Bardwell, requiring a Section 408 authorization from the USACE. Impacts to streams, wetlands and waterbodies that occur within the USACE Projects are detailed in **Appendix E, Impacts to USACE Projects Technical Memorandum,** and would be conducted in accordance with **WW-CM#6: Section 408 Permission**.

No stream impacts are anticipated with any of the Houston Terminal Station Options. No waters of the U.S. impacts are anticipated as a result of the Industrial Site Terminal Station or Northwest Mall Terminal Station Options. The Northwest Transit Center Terminal Station Option would temporarily impact 1.6 acres of wetlands and 0.10 acre of waterbodies.

Table ES-7: Impacts to Waters of the U.S. by Build Alternative

	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F
Number of Stream Crossings	641	690	668	664	713	691
Stream Crossings – Temporary (LF)	83,459	83,791	90,942	85,684	86,016	93,167
Stream Crossings – Permanent (LF)	38,898	45,631	35,096	38,640	45,374	34,839
Number of Wetland Crossings	377	387	319	367	377	309
Wetlands – Temporary (acres)	59.5	59.0	44.3	61.1	60.0	45.2
Wetlands – Permanent (acres)	50.0	47.4	63.4	50.3	48.8	64.4
Number of Waterbody Crossings	366	389	306	360	383	300
Waterbodies – Temporary (acres)	33.5	36.3	30.4	30.8	33.8	27.9
Waterbodies – Permanent (acres)	27.5	27.2	21.1	29.3	29.1	22.9

Source: AECOM 2019

LF = linear feet

ES.9.7 Floodplains

As detailed in **Section 3.8, Affected Environment and Environmental Consequences, Floodplains,** during the planning and conceptual engineering of the Project, the Build Alternatives were designed to avoid and minimize crossings of mapped stream channels. However, the Project would still impact regulatory floodplains. During construction, the footprint of the LOD additional workspace area, laydown yards and construction workspace would have a temporary impact to the floodplains. The HSR track and supporting facilities (e.g., permanent roads, parking areas, access/maintenance areas, terminals and non-vegetated embankments) would also result in a permanent impact to the floodplain throughout the operation of the HSR system.

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. Using typical section types, including roadway improvements for grade separations, TCRR calculated impervious cover per linear foot for each Build Alternative. TCRR used this data to estimate increases in peak flow rate and total runoff volume between pre-construction and post-construction conditions per industry-standard hydrologic runoff computation methodologies. TCRR used this analysis to preliminarily design temporary and permanent drainage infrastructure, including detention basins. The design of the Project 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 ES-8 presents impacts to floodplains by Build Alternative. The Houston Northwest Mall Terminal Station Option and Houston Northwest Transit Center Terminal Station Option would not be located within an existing floodplain and would neither require stream crossings nor have permanent or temporary floodplain impacts. The Houston Industrial Site Terminal Station Option would have 0.11 acre of permanent impact located within the 500-year floodplain in Harris County.

Table ES-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	616	557	642	631	572	657
Impacts to 500-Year Floodplain	132	132	133	132	132	133
Total Acres of Intersected Floodplain	**748**	**689**	**775**	**763**	**704**	**790**
Permanent Impacts to 100-Year and 500-Year Floodplains	529	479	579	539	489	589
Temporary Impacts to 100-Year and 500-Year Floodplains	219	210	196	225	215	201
Total Acres of Impacted Floodplain	**748**	**689**	**775**	**764**	**704**	**790**
	Length of Streams with Highly Erodible Soils (linear feet)					
Impacts to Streams	20,574	20,574	20,574	20,574	20,574	20,574
	Number of Crossings					
Bridge/Viaduct Crossings at FEMA Zone AE Crossings	63	63	71	68	68	76
Bridge/Viaduct Crossings at FEMA Zone A Crossings	126	142	137	139	155	150
Bridge/Viaduct Crossings at Non-FEMA Stream Crossings	253	272	311	268	287	326
Total Number of Bridge/Viaduct Crossings	**442**	**477**	**519**	**475**	**510**	**552**
Stream Crossings Having Highly Erodible Soils	73	72	66	73	72	66

Source: AECOM 2019

ES.9.8 Utilities and Energy

As discussed in **Section 3.9, Affected Environment and Environmental Consequences, Utilities and Energy**, the Project would impact utility and energy infrastructure throughout the Study Area. The Project would intersect water and sewer utility lines, as well as energy lines used for electricity, crude oil and natural gas. 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 adherence to federal, state and local regulations would be necessary for appropriate actions to be taken for each crossing occurrence.

The Project would require power for the HSR trainsets, stations, TMFs and MOW facilities. The Project would obtain electricity from the statewide grid, managed by Electric Reliability Council of Texas (ERCOT), resulting in an overall effect on statewide energy use. The total energy (electrical) demand of the Project, at maximum, is estimated to be 531,867 megawatt hours (MWh) per year, or 1,814,804 Million British thermal units (MMBTUs) per year, including power losses from transmission and transformers. Build Alternatives A, C, D, and F would require 13 new electrical transmission line connections to TPSSs to power the Project and Build Alternatives B and E would each require 12 new electrical connections. Because electric utility providers are ultimately responsible for the environmental clearance process for the new electrical transmission lines, the impacts are considered indirect impacts in this Final EIS (see **Section 4.2.1.2, Indirect Effects and Cumulative Effects, New Electrical Transmission Lines.**

Electrical pole adjustments, or raising the existing transmission lines, could be required under all Build Alternatives to accommodate vertical clearances for the HSR ROW. Estimates of pole adjustments range from 74 under Build Alternative C to 89 under Build Alternatives D and E.

Construction of the Project 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 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.

Table ES-9 presents a comparison of utility impacts by Build Alternative.

Table ES-9: Comparison of Utility Impacts by Build Alternative

	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F
New Electric TPSS Connections	13	12	13	13	12	13
Electric Utility Pole Adjustments	85	85	74	89	89	78
Abandoned Oil and Gas Wells	37	37	22	37	37	22

Source: AECOM 2019

Electricity demand during construction of the Project would be limited to power requirements (primarily lighting and power tools) at laydown areas and facility construction sites. Construction power usage would be negligible compared to overall system capacity, and electricity demand during construction is assumed to be the same for all Build Alternatives. Given the linear nature of the Project, 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 3.2.3.2.1, Air Quality, Trainset Operation Emissions**, the energy consumption estimate during construction of the Project would be approximately 58,043 MMBTUs. The fuel consumption savings estimated for the Project by reducing passenger vehicle travel would be approximately 37.4 million gallons of gasoline, or 4,285,420 MMBTUs, annually. This data does not include passengers traveling by air. By comparison, the annual operation of the HSR would consume approximately 1,554,571 MMBTUs, resulting in a net savings in energy of 2,730,849 MMBTUs. Because the Project would save more energy annually (2,730,849 MMBTUs) than it would take to construct the HSR system (58,043 MMBTUs one-time expenditure), the long-term impact on energy consumption would be beneficial.

Operational energy consumption would include the electricity needed to power the HSR trainsets, stations, TMFs and MOW facilities. The Project would obtain electricity from Oncor and CenterPoint, the major electrical service providers in the Study Area. Due to the size and expected electrical demand of the Project, it is likely that statewide electricity reserves and electrical transmission capacity would be affected. The Project 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 3.9.4.2, Utilities and Energy, Energy**. The total energy (electrical) demand of the Project, at maximum, is estimated to be 531,867 MWh per year, or 1,814,804 MMBTUs per year, including power losses from transmission and transformers.

There would be no discernable difference among Build Alternatives A through F, or the Houston Terminal Station Options, for water use and wastewater generation. Additionally, there would be no discernable difference among Build Alternatives A through F, or the Houston Terminal Station Options, for the energy required to operate the HSR system, as well as the anticipated energy saved as a result of the Project.

ES.9.9 Aesthetics and Scenic Resources

Detailed within **Section 3.10, Affected Environment and Environmental Consequences, Aesthetics and Scenic Resources**, aesthetics and scenic resources include the visible natural and cultural landscape features that contribute to a viewer's perception of an area. This Final EIS presents key natural and cultural aesthetic and scenic resources and discusses the existing visual quality of the viewsheds in the Study Area. For the purposes of this analysis, the terms aesthetic and scenic resources are interchangeable with visual resources. 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.

Visual impacts are the combination of changes to existing visual attributes associated with construction and operation of the Project and viewers' responses to those changes. Visual impacts are assessed for visual resources and KVPs, and an overall visual impact is determined for each landscape unit. For each landscape unit, visual impacts are first assigned a degree of impact from low, moderate or high and project impacts can be beneficial, neutral or adverse, as shown in **Table ES-10**. All Build Alternatives would have the same number of beneficial (two) and adverse (two) impacts. Once constructed, the system would have permanent visual impacts by introducing infrastructure (HSR rail, ancillary facilities and stations) and lighting, fencing and an overhead centenary system. Permanent visual impacts would be more adverse in rural areas where the setting and topography are more natural. The system would generally have less of an impact in urban areas where there setting is more compatible with infrastructure. Beneficial impacts would occur in the landscape units (Landscape Units #1 and #13) with station options in Dallas and Houston. There is negligible difference between the impacts of the three options in Houston. All three Houston Terminal Station Options would replace under-utilized or industrial land uses with a modern station and station area improvements. Adverse impacts would occur as a result of the Brazos Valley Intermediate Station in Landscape Unit #8, which is common to all the Build Alternatives. The other adverse impact would occur in Landscape Unit #10, as a result of the MOW facility, TPSS and the HSR system degrading visual quality for a significant number of residents in areas where these facilities and rail system are not compatible.

Table ES-10: Aesthetics and Scenic Resource Impacts by Build Alternative

Landscape Unit	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F
Landscape Unit #1	Moderate/ Beneficial	Moderate/ Beneficial	Moderate/ Beneficial	Moderate/ Beneficial	Moderate/ Beneficial	Moderate/ Beneficial
Landscape Unit #2	Low/ Neutral	Low/ Neutral	Low/ Neutral	Low/ Neutral	Low/ Neutral	Low/ Neutral
Landscape Unit #3	Low/ Neutral	Low/ Neutral	Low/ Neutral	Low/ Neutral	Low/ Neutral	Low/ Neutral
Landscape Unit #4	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral
Landscape Unit #5	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral
Landscape Unit #6	-	-	Moderate/ Neutral	-	-	Moderate/ Neutral
Landscape Unit #7	Moderate/ Neutral	Moderate/ Neutral	-	Moderate/ Neutral	Moderate/ Neutral	-
Landscape Unit #8	High/ Adverse	High/ Adverse	High/ Adverse	High/ Adverse	High/ Adverse	High/ Adverse
Landscape Unit #9	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral
Landscape Unit #10	Moderate/ Adverse	Moderate/ Adverse	Moderate/ Adverse	Moderate/ Adverse	Moderate/ Adverse	Moderate/ Adverse
Landscape Unit #11	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral
Landscape Unit #12	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral
Landscape Unit #13	Moderate/ Beneficial	Moderate/ Beneficial	Moderate/ Beneficial	Moderate/ Beneficial	Moderate/ Beneficial	Moderate/ Beneficial
Total Number of Beneficial	2	2	2	2	2	2
Total Number of Neutral	8	8	8	8	8	8
Total Number of Adverse	2	2	2	2	2	2
Total Number of Adverse Visual Resource Impacts	11	11	10	11	11	10

Source: AECOM 2019

Note: Visual impacts are assessed for visual resources and KVPs and an overall visual impact is determined for each landscape unit. For each landscape unit, visual impacts are first assigned a degree of impact from low, moderate, or high and project impacts can be beneficial, neutral or adverse

- = Build Alternative does not cross the particular landscape unit.

Mitigation measures including vegetation management, lighting and screens would be used to minimize the visual impact of the elevated trainset (on viaduct) at grade embankment or at key station areas. Visual impacts would be mitigated with visual screening such as vegetation (including trees and shrubs), walls, berms or natural looking constructed landforms. Stations and associated structures such as elevators, escalators and walkways would be designed with attractive architectural elements or features that add visual interest to the streetscapes near them.

ES.9.10 Transportation

As discussed in **Section 3.11, Affected Environment and Environmental Consequences, Transportation**, implementation of the Project would result in direct and indirect impacts to the existing transportation network within the Study Area**. Table ES-11** summarizes the impacts for each Build Alternative on rail facilities and operations, roadways, transit services, on-road pedestrian and bicycle facilities and airports.

Implementation of the Project would introduce a direct passenger rail connection between Dallas and Houston that does not currently exist. This would result in a long-term shift in how people travel, particularly between Dallas and Houston. An independent ridership and revenue forecast conducted by TCRR, and summarized in **Appendix J, Ridership Demand Forecasting Methodology Assessment Technical Memorandum**, projected that the HSR system would transport approximately 7.2 million passengers annually by 2040, resulting in a 26 percent mode shift from car to the HSR system and 2 percent mode shift from air to the HSR System.

Regardless of Build Alternative, there would be 27 rail crossings by the HSR system, as shown in **Table ES-11**. All Build Alternatives would cross existing freight railroads and light rail transit lines on viaduct. Impacts to these modes of transportation would be limited to temporary disruption of service during construction. No long-term or permanent operational impact to existing freight rail or transit infrastructure would occur. Where the HSR system would run parallel to freight railroads, crash barriers would be constructed to protect the viaduct support columns.

Roadways would be the primary transportation network impacted by the Project. Each roadway was inventoried for daily traffic volumes, existing travel patterns and geometric conditions. In conjunction with other data, such as surrounding development and transportation plans, environmental and engineering constraints and the availability of alternative routing, TCRR proposed revised configurations of the existing infrastructure relative to the Project (see **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports**). The proposed configurations include:

- **Road Under Railway:** There are two conditions where this configuration would occur: (1) the road would be depressed (below grade) beneath the railway or (2) the road would remain at-grade while the railway would be elevated (viaduct).
- **Road Over Railway:** Either the road would be elevated to go over the railway or the road would remain at-grade and the railway would be depressed.
- **Relocation:** Existing road would be relocated to avoid conflict with the railway.
- **Road Adjustment:** Existing road would be realigned to avoid conflict with the railway
- **Reroute:** Public and private roadways, approaching from one or both sides of the railway, would be rerouted on new access roads (maintained by TCRR) to an alternate, nearby crossing.
- **Closure:** Private roadway on either side of the railway would be closed and traffic would be required to use existing alternate routes.

Approximately 55 percent of the Project would be constructed on viaduct, minimizing permanent impacts to public roads. Approximately 83 percent of the public road crossings would be rail over the roadway or roadway over rail and would not include rerouting of the existing public road. The total number of publicly accessible and private roads permanently modified (i.e., road would experience some type of construction) varies from 102 (Build Alternative C) to 158 (Build Alternative E). Reroutes to existing publicly accessible roads would result in the addition of approximately 16.6 miles (Build Alternative D) to 46.9 miles (Build Alternative C) of public roads. Alternatives B and E would require the acquisition and closure or relocation of the Anxiety Aerodrome in Navarro County.

Table ES-11: Summary of Transportation Impacts by Build Alternative						
	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F
Rail Crossings [a]	27	27	27	27	27	27
Rail Facilities and Operations	There would be no permanent or long-term operational impacts associated with any rail crossings as the Build Alternative would be fully grade separated.					
Road Modifications [b] (*Public and Private*)	138	150	102	145	158	110
Road Modifications [c] (*Public only*)	59	66	79	60	67	80
Length added to Public Roads (miles)	16.8	21.4	46.9	16.6	21.2	46.7
Length removed from Public Roads (miles)	5.1	5.0	27.2	5.2	5.1	27.2
Transit Services	All Build 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 and Bicycle Facilities	None of the segments would permanently impact on-road pedestrian or bicycle facilities.					
Impacts to airports [d]	0	1	0	0	1	0

Source: AECOM 2019

[a] Totals for rail impacts do not include rail at Houston Terminal Station Options. Totals also include DART-owned rail lines in Dallas County

[b] Road modifications reflect the number of reroutes, road adjustments or road over rail constructions that would occur. Some roads are affected by multiple modifications (such as IH-45). Modifications do not reflect total number of roads but total number of road construction sites.

[c] Shared access roads are included in roadway modification lengths. Shared access roads will be developed to provide for maintenance, emergency response access and private property access with a corresponding reduction in the number of new public roads to decrease burden on roadway authorities. Shared access roads would be constructed and maintained by TCRR.

[d] Anxiety Aerodome would be directly impacted by Segment 3B, which is part of Build Alternatives B and E.

Transit services in Dallas and Harris Counties, Operated by DART and METRO, respectively, could see increased ridership due to the Project. Ridership increases would be a beneficial impact.

The Dallas Terminal Station, the Houston Terminal Station, and the Brazos Valley Intermediate Station would impact intersection operations around the stations. Prior to construction and operation, TCRR will perform a full traffic impact analysis (TIA) that complies with the City of Dallas, City of Houston or TxDOT TIA guidelines as applicable. A list of intersections that may need to be improved based on preliminary traffic analysis and design is included in **Section 3.11.5.2, Transportation, Build Alternatives**; however, the actual location and extent of intersection improvements would be subject to the applicable TIA process. TCRR will implement intersection improvements as required by the applicable TIA process.

During construction, there would be a temporary disruption to traffic on roadways, transit services, freight or commuter rail services or pedestrian/bicycle facilities. Construction activities would result in construction traffic on nearby and adjacent roads. Construction activities would also result in traffic delays and temporary road closures on roads crossed by the Project.

As detailed in **Section 3.11.6, Transportation, Avoidance, Minimization and Mitigation**, compliance and mitigation measures would mitigate direct impacts and delays to traffic.

ES.9.11 Elderly and Handicapped

The Build Alternatives and station options would all be designed, constructed and operated in compliance with 49 C.F.R. 37 and 38, and Americans with Disabilities Act of 1990 (ADA), as enforced by the U.S. Department of Justice; therefore, there would be no impacts related to accessibility of the HSR system for the elderly and handicapped as detailed within **Section 3.12, Affected Environment and Environmental Consequences, Elderly and Handicapped**.

ES.9.12 Land Use

As discussed in **Section 3.13, Affected Environment and Environmental Consequences, Land Use,** FRA evaluated and assessed existing land uses to determine land use conversion, structure displacement and land acquisition for the Project. The average acreage of special status farmlands permanently converted to a non-agricultural use of the Build Alternatives would be approximately 3,600 acres. Within the Study Area, there are nearly 2.2 million acres of special status farmlands. The permanent loss of 3,600 acres of special status farmland represents approximately 0.2 percent of all special status farmland within the 10 counties. On average, approximately 1,630 acres of special status farmland, regardless of the Build Alternative, would be temporarily impacted during the construction period.

FRA conducted quantitative analysis of anticipated acquisitions and displaced structures for comparative purposes only. Depending on the Build Alternative, the estimated commercial structure displacement would range from 42 (Build Alternatives A, B, D and E) to 65 (Build Alternatives C and F). The estimated residential structure displacement would range from 235 (Build Alternative A) to 269 (Build Alternative E). Displacement of secondary residential structures, such as sheds and detached garages would range from 37 under Build Alternatives A and C to 52 under Build Alternative E. Displacement of secondary commercial structures would range from 38 under Build Alternatives A, B, D and E to 61 under Build Alternatives C and F.

It is anticipated that total permanent acquisition would range from 1,731 parcels under Build Alternative A to 1,847 parcels under Build Alternative E, while the temporary use of parcels would range from 258 under Build Alternative F to 277 under Build Alternative B.

TCRR would negotiate structure and parcel acquisitions with the property owners on a case-by-case basis during the ROW acquisition. TCRR would communicate its intent to the owners and tenants of affected structures and parcels. TCRR would need to acquire property access before beginning construction on that property. TCRR published *Guiding Principles for Land Acquisition and Landowner Rights* for all property acquisitions, developed in accordance with the Texas Landowner's Bill of Rights.[26,27] No public housing would be impacted by the Project.

The Project would impact a number of businesses, including small family-owned shops, larger chain or franchise businesses, gas stations and industrial sites through parcel acquisition. As shown in **Table ES-12**, depending on the Build Alternative, the estimated total (primary and secondary) structure acquisition of businesses would range from 12 under Build Alternatives A, B, D and E to 18 under Build Alternatives C and F. The Project would also require the acquisition of residential dwelling units (single-family homes on small and large lots, farms/ranches and apartment complexes). Depending on the Build Alternative this estimated structure acquisition of primary and secondary residential structures would range from 49 under Build Alternative A to 54 under Build Alternative F. Both owner-occupied and tenant-occupied residences would be affected. A database search of both commercial properties (industrial, office, retail and land) and residential properties for sale and for lease was conducted to assess the availability of properties to serve as replacement for those displaced by the Project. In each case, replacement properties would be available.[28, 29]

[26] TCRR, " Guiding Principles for Land Acquisition and Landowner Rights," accessed June 2019, https://www.texascentral.com/wp-content/uploads/2015/12/TCPBillofRights.pdf.

[27] Office of the Attorney General of Texas, "The State of Texas Landowner's Bill of Rights," revised February 2012, accessed June 2019, https://www.texasattorneygeneral.gov/sites/default/files/files/divisions/general-oag/LandownersBillofRights.pdf.

.[28] LoopNet, "Commercial Real Estate Search," http://www.loopnet.com/.

[29] Zillow, "Homes for Sale, Homes for Rent and Apartments for Rent Search," http://www.zillow.com/.

Table ES-12: Summary of Land Use Impacts per Build Alternative							
Characteristic		Area of Potential Impacts					
		ALT A	ALT B	ALT A	ALT D	ALT A	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	2,553.4	2,532.9	2,393.2	2,592.4	2,571.9	2,432.3
	Perm	6,619.8	6,814.0	7,295.6	6,610.0	6,804.1	7,285.7
Special-Status Farmland Conversion (acres)	Temp	1,710.8	1,690.4	1,459.8	1,719.4	1,699.0	1,468.5
	Perm	3,534.5	3,764.3	3,573.4	3,483.5	3,713.3	3,522.3
	Indirect	847.5	888.2	697.3	815.6	856.2	779.2
Primary Structure Displacements (within LOD and 50 feet)	Commercial	42	42	65	42	42	65
	Residence	235	255	239	249	269	253
	Community Facilities	2	2	3	2	2	3
Estimated Permanent Parcel Acquisitions		1,731	1,814	1,789	1,764	1,847	1,822
Estimated Temporary Parcel Acquisitions		272	277	259	271	276	258
Estimated Total Structure Acquisitions (Primary and Secondary)	Agriculture	196	223	196	203	230	203
	Commercial	12	12	18	12	12	18
	Community Facilities	0	0	0	0	0	0
	Cultural/Civic Resources	2	2	1	2	2	1
	Oil and Gas	12	12	17	12	12	17
	Residence	49	50	51	52	53	54
	Transportation and Utilities	0	0	1	0	0	1

Source: AECOM 2019

The summary of impacts for the Houston Terminal Station Options is shown separately in **Table ES-13**. While the Houston Northwest Mall Terminal Station Option would have the smallest permanent footprint, it would have the largest displacement of primary business structures (22) and the second highest number of permanent parcel acquisitions (40). The Houston Industrial Site Terminal Station Option would have the largest footprint but would displace the fewest primary business structures (14) and would permanently acquire the fewest number of parcels (25).

Table ES-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	-	27.4	11.8
	Perm	92.2	75.8	88.7
Primary Structure Displacements (Commercial)		14	22	15
Primary Structure Displacements (Community Facilities)		-	-	1
Estimated Permanent Parcel Acquisitions		25	40	43
Estimated Temporary Parcel Acquisitions		2	1	-
Estimated Total Structure Acquisitions (Commercial) [a]		0	1	-

Source: AECOM 2019

Note: There would be no conversions of special-status farmland. Also included in these values are the associated portions of the HSR LOD from the common point just west of the intersection of McAllister and Hempstead Roads.

[a] Includes primary and secondary structures

ES.9.13 Socioeconomics and Community Facilities

As discussed in **Section 3.14, Affected Environment and Environmental Consequences, Socioeconomics and Community Facilities,** FRA assessed impacts of the Project on community character and cohesion, population and employment, the agricultural economy, children's health and safety and community facilities. All impacts related to community character and cohesion would occur on segments common to all Build Alternatives. Economic impacts would provide a direct benefit to the station areas, which are common to all Build Alternatives. The temporary construction employment benefits would be comparable along all the Build Alternatives.

Community characteristics would be altered in four communities within the Study Area –the Le May and Le Forge neighborhood, the Hash Road and Nail Drive community in Dallas County, the Plantation Forest Development in Waller County and the White Oak Falls neighborhood in Harris County. During construction, short-term impacts from increased noise, dust and vehicular congestion resulting from road closures and detours could occur within communities. Of these, the most severe impacts would be anticipated in the Le May and Le Forge neighborhood. Impacts would be unavoidable as the displacements would occur on a common segment of the Project. Therefore as outlined in **Section 3.18.6.2, Socioeconomics and Community Facilities, Mitigation Measures, EJ-MM#1: Le May and Le Forge Neighborhood Mitigation**, TCRR shall relocate the entire neighborhood. Terms of residential displacements and relocations would be subject to one on one negotiation between private owners and TCRR and in accordance with the measures described in **Section 3.14.6, Socioeconomics and Community Facilities, Avoidance, Minimization and Mitigation**

Twelve schools and/or school facilities adjacent to or within 1,000 feet of the LOD would be directly impacted. All school facilities would occur on Build Alternatives A, B, D, E, and all but the one, Leon Independent School District, school would occur for Build Alternatives C and F. All the facilities would experience potential impacts to children's health and safety due to temporary construction. However, these impacts would be mitigated through the use of best management practices and other mitigation measures. No severe or moderate noise impacts are anticipated in proximity to the schools identified; therefore, no potential impacts to children's learning ability while in classrooms would be anticipated.

Three community facilities are located on common segments and would therefore be impacted by all the Build Alternatives: Smith Family Cemetery, Honey Springs Cemetery and the Connection School of Houston. Mount Zion Missionary Baptist Church and Hopewell Church would only be directly impacted and displaced under Build Alternatives C and F. Build Alternatives A, B, D and E would impact one facility, Union Church and Ten Mile Cemetery. One community facility, the Awty International School Early Learning Campus, would be impacted at the Houston Northwest Transit Center Terminal Station Option.

The net increase in HSR jobs was compared to the existing job base in each Economic Analysis Area to determine whether these would be large or small job gains for these economies. The majority of new HSR jobs would be located in Dallas County or Harris County, at the urban stations and TMFs. Direct employment and earnings growth (as a percentage of existing employment and earnings, respectively) would be highest for the Intermediate Counties Economic Analysis Area with 0.2 percent and 2.2 percent growth, respectively. However, all Economic Analysis Areas would experience a growth in earnings. With average taxable expenditures ranging from 35 to 45 percent, these earnings result in approximately $6.3 million annual sales tax revenue for the state, and a combined $1.5 million in sales tax revenue for local jurisdictions. This positive impact on tax revenues would occur annually, as it would create permanent changes to employment and earnings within the regional economy.

TCRR estimates capital costs for the HSR system between $16 billion and $19 billion ($2019). Similarly, detailed cost estimates are not available for each Build Alternative; however, the range of capital costs is sufficient to estimate employment, earnings and tax impacts resulting from TCRR's capital investment. The capital estimate includes construction labor, materials, indirect costs and approximately $2.6 billion for systems and rolling stock. Systems and rolling stock, which would likely be sourced from outside of the state, were excluded from estimates of induced spending within the local economy. ROW acquisition costs offset the loss of existing economic uses and do not create new economic value other than through real estate transaction fees, which are not included in this analysis.

Operation and maintenance of the Project could also lead to development and changes to property values around station areas. Data are less clear regarding the potential effects on property values near rail corridors without nearby station access. Many of the reasons for decreased property values around other transportation projects, such as noise and vibration impacts, would not apply to the electrified HSR design. To the extent that noise or vibration levels could negatively impact specific individual properties, mitigation measures, as described in **Section 3.4.6.2, Noise and Vibration, Mitigation Measures**, would be applied. The potential for negative property value impacts would be limited and would be offset by an equally likely potential for positive station area impacts that would exceed expectations. As a result, no macro-level economic effects are anticipated.

The acquisition of property for construction of the system would impact the available property tax revenue in a variety of ways:

- Agricultural properties or portions of properties that are taxed based on the agricultural productivity would be taxed based on the higher total appraised value once acquired by TCRR, leading to an increase in tax revenue.
- Properties or portions of properties currently receiving homestead, over-65 or disabled homeowner exemptions would not be exempt once acquired by TCRR, leading to an increase in tax revenue.
- Structural improvements displaced by construction of the system would lead to a loss in taxable value.

In addition to impacts from land acquisitions, the improvements constructed under the Project would generate tax revenue for the jurisdictions in which they would be located. The property premium around station areas would also generate property tax revenue, providing an additional benefit to the taxing jurisdictions. The impact to property tax revenue would be beneficial to local jurisdictions and these additional resources would benefit schools, libraries, parks, municipal utilities, hospitals and emergency services that are funded through property taxes.

Table ES-14 summarizes the socioeconomic impacts by Build Alternative.

Table ES-14: Summary of Socioeconomic Impacts by Build Alternative

Resource Area	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F
Communities with Disrupted Character and Cohesion	4	4	4	4	4	4
Economic Impacts [a]	Positive	Positive	Positive	Positive	Positive	Positive
Employment (job years)	317,207	317,207	317,207	317,207	317,207	317,207
Earnings (2019 billions)	$14.5	$14.5	$14.5	$14.5	$14.5	$14.5
Tax Revenue	Positive	Positive	Positive	Positive	Positive	Positive

Table ES-14: Summary of Socioeconomic Impacts by Build Alternative						
Resource Area	**ALT A**	**ALT B**	**ALT C**	**ALT D**	**ALT E**	**ALT F**
Children's Health and Safety [b]	0	0	0	0	0	0
Community Facilities	5	5	5	5	5	5

Sources: AECOM 2019

[a] All economic impacts include the total of one-time construction impacts plus 16 years of operating impacts from 2025 to 2040.

[b] Children's health and safety impacts are the result of temporary construction effects. These impacts will no longer exist once construction has ended.

ES.9.14 Electromagnetic Fields

Section 3.15, Affected Environment and Environmental Consequences, Electromagnetic Fields, discusses electric and magnetic fields referred to as electromagnetic fields (EMFs). EMFs are invisible, non-ionizing radiation. EMFs are commonly produced by both natural and man-made sources. Under extreme conditions, such as a lightning strike, EMF health hazards can include shocks and burns, although such conditions are rare.

During operation, the Project would generate EMF both at 60 Hz and harmonics, as well as at radiofrequencies for HSR signaling and communication equipment. EMF exposure levels within and outside the existing Shinkansen trainsets are reported by Shinkansen to be below International Commission on Non-Ionizing Radiation Protection guidelines;[30] therefore, passengers on the trainset, 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. Additionally, HSR equipment would comply with Federal Communications Commission requirements and not adversely interfere with other electric or electronic equipment.

ES.9.15 Safety and Security

As discussed in **Section 3.16, Affected Environment and Environmental Consequences, Safety and Security,** FRA assessed safety and security issues that could result from natural disasters, safety incidents or criminal acts that would have the potential to affect the HSR system and the ability for emergency services to respond to incidents on or off the HSR system. This Final EIS provides details on safety issues for construction and operation of the Project, including the measures and regulations currently in place, or that would be implemented to protect communities through which the Project would pass. The potential impacts and measures identified to avoid, minimize or mitigate those impacts that are described in **Section 3.16, Affected Environment and Environmental Consequences, Safety and Security**, would apply independent of where TCRR implements the HSR system.

TCRR proposes to implement an HSR system that is based on the Tokaido Shinkansen system, including its design safety elements, systems approach, culture of safety and accident avoidance principles. Accident avoidance principles covering all aspects of system design, operations, inspection, testing and maintenance and training are the foundations for the Tokaido Shinkansen's proven safety record. These key elements of accident avoidance have been monitored and refined over five decades to result in an expert level of understanding of the principles necessary for safe design and operation of an HSR system. These principles led to HSR system operations and design features (detailed as avoidance measures in **Section 3.16.6, Safety and Security, Avoidance, Minimization, and Mitigation**) that would

[30] Central Japan Railway Company, "Environmental Report. 2010," *Global Environmental Committee*, http://jr-central.co.jp.

eliminate or highly mitigate the risk of trainset-to-motor vehicle collisions and high-speed trainset-to-trainset collisions.

Impacts related to collisions would occur if an HSR vehicle were to strike a person, animal, vehicle or other object, either on the HSR track or as a result of an HSR derailment. The potential for derailment would be mitigated through the measures described in **Section 3.16.6, Safety and Security, Avoidance, Minimization, and Mitigation**. To minimize the potential for collisions within the ROW, the system must be built within a dedicated ROW that is completely grade separated from freight, automobile and pedestrian traffic. Additionally, by avoiding bi-directional service on the same track, TCRR would mitigate the risk of head on collisions as trainsets would never need to travel through the same section of track in opposite directions. Further, TCRR's Automatic Train Control system would control trainset movements at all locations, further mitigating the potential for trainset-to-trainset collisions.

Mechanical failure could pose some risk to passengers or employees if confined on a non-operational vehicle and could introduce safety hazards for employees performing emergency maintenance. Additionally, mechanical failure of the doors could impact the safety of boarding or alighting passengers. TCRR's Inspection, Testing and Maintenance Program (see **Section 3.16.6, Safety and Security, Avoidance, Minimization, and Mitigation, SS-CM#3: Inspection, Testing, and Maintenance**) would minimize the occurrence of mechanical failure. TCRR's Emergency Preparedness Plan (see **Section 3.16.6, Safety and Security, Avoidance, Minimization, and Mitigation, SS-CM#1: Emergency Preparedness Plan**) would specify safe evacuation routes and emergency procedures. The HSR trainset design would include emergency exit path markings and signage, emergency lighting, emergency egress and rescue access windows in every car and walkways on both sides of the ROW for both elevated and at-grade sections with vertical access provided in compliance with applicable OSHA, National Fire Protection Association, and ADA standards for emergency access and egress (see **Section 3.16.6, Safety and Security, Avoidance, Minimization, and Mitigation, SS-CM#7: Compliant Facility Design** and **EH-CM#1: Compliance with ADA and TAS).** FRA proposes in the NPRM a requirement that TCRR shall not conduct scheduled ROW maintenance on a section of the ROW prior to that section of the ROW being cleared of revenue service trainsets, and proper action is taken by the general control center staff to protect incursion into established maintenance zones by revenue trainsets. Additionally, the railroad shall not commence revenue service prior to completion of the maintenance activities and that section of the ROW being cleared of MOW equipment. To further mitigate risks associated with emergency maintenance activities and passenger evacuation activities, employees would receive safety training in compliance with **SS-CM#2: System Safety Program**. FRA has proposed in the NPRM a requirement that TCRR shall have station platform attendants on the platform in close proximity to the trainset protection switches and shall have operating rules requiring coordination between on-board crew and station platform attendants to ensure safety during passenger boarding and alighting from trainsets at stations. The N700-Series trainset doors are equipped with interior manual release mechanisms, exterior door indicator lights that can be seen by the platform attendant and a manual door override located on the exterior of each car.

Fire on the HSR trainset or at facilities could represent an impact to the safety of passengers or employees. Impacts related to fire on the trainset would be mitigated through adherence to the guidelines described under **SS-CM#5: Fire Safety**. HSR stations and maintenance facilities would be constructed to include automatic sprinkler systems, alternative automatic extinguishing systems, a fire alarm system, emergency ventilation and emergency power systems, in accordance with National Fire Protection Association standards,[31] as with all major structures in Texas. In compliance with federal

[31] NFPA, Fact Sheet - Codes and Standards, accessed February 2020, www.nfpa.org/codes-and-standards.

OSHA standards and as described under **SS-CM#7: Compliant Facility Design,** station areas would include emergency access and egress plans designed to increase the effectiveness and timeliness of emergency response. TCRR's Emergency Preparedness Plan (see **SS-CM#1: Emergency Preparedness Plan**) would specify safe evacuation routes and emergency procedures.

The Project 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.

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 trainset could quickly arrive at to allow emergency response teams to access the HSR ROW and trainset. 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 trainsets. The HSR system's design features work to minimize potential operational safety impacts.

As described in **SS-CM#4**: **Perform Hazard Analysis**, TCRR would be required establish a risk-based hazard management program and conduct hazard analyses. Any natural hazards identified through this process would be addressed with appropriate hazard controls and procedures. TCRR's operating plan would specify the conditions under which the system would be suspended, such as during or in preparation for extreme weather events. Procedures for communication and responding during an emergency situation, including communication protocols, would be detailed through TCRR's Emergency Preparedness Plan (see **SS-CM#1: Emergency Preparedness Plan**).

The HSR system's intrusion detection system, embedded throughout the HSR rail corridor, would detect debris that breaks through the barrier and would suspend HSR service until the tracks could be inspected and cleared. FRA proposes in the NPRM regulation requiring TCRR to conduct special inspections of the track and ROW in the event of fire, flood, severe storm, temperature extremes or other conditions that may damage track infrastructure. Sweeper vehicles, which inspect the ROW for obstacles, could be deployed following any service disruption or severe weather event. Given the system technology that would be implemented and the ability of TCRR to suspend service in the event of severe weather or infrastructure damage, it is unlikely that the Project would impact passenger safety beyond the No Build condition.

The impacts to safety and security would be applicable to all Build Alternatives. The primary difference amongst the Build Alternatives is the number of emergency responders potentially affected by construction, permanent road changes and the level of coordination necessary to avoid impacts. The total number of permanent road modifications resulting in 1 minute or more in travel time impact and the number of fire and EMS jurisdictions with high or localized construction activity are summarized by Build Alternative in **Table ES-15**.

Table ES-15: Summary of Impacts by Build Alternatives						
Impact	**ALT A**	**ALT B**	**ALT C**	**ALT D**	**ALT E**	**ALT F**
Permanent Road Modifications resulting in 1 minute or more in additional through travel time	12	13	9	11	12	8
Permanent Road Modifications reducing through travel time by 1 minute or more	0	0	0	1	1	1
Total fire and EMS service areas bisected by construction	56	57	51	56	57	51
Fire and EMS providers with high potential for construction effects	3	4	5	3	4	5
Fire and EMS providers with localized potential for construction effects	8	7	6	8	7	6

Source: AECOM 2019

ES.9.16 Recreational Facilities

Recreational facilities are defined as parklands, off-street trails and other recreational facilities that may serve a public use and are discussed in **Section 3.17, Affected Environment and Environmental Consequences, Recreational Facilities**. Operational impacts would be long-term and permanent. These would represent direct changes that would permanently alter the use, character or setting of the recreational facility. This would include full or partial acquisition of any public recreational facility and changes in use, access or visual quality or noise impacts to recreational facilities or parklands.

Of the 43 recreational facilities identified within the Study Area, three would be located in (or immediately adjacent to) the LOD and impacted by the Project: Honey Springs Cemetery (all Build Alternatives), Lake Bardwell (Build Alternatives D, E and F) and Fort Boggy State Park (Build Alternatives C and F). The other 40 facilities are within the Study Area but outside of the LOD and would not be directly or indirectly impacted by the Project.

Honey Springs Cemetery is an NRHP-eligible historic property also designated as a special-use park by the City of Dallas. Honey Springs Cemetery is located west and adjacent to the LOD. At the entrance of the cemetery is a memorial wall. The Project would be constructed nearby on private property immediately adjacent to the cemetery traveling on viaduct. During construction, potential temporary impacts could include short-term noise and vibration impacts due to the operation of heavy equipment and localized air quality impacts due to dust and emissions caused by the movement of earth and heavy equipment. Additionally, proximity of the resource adjacent to the LOD could result in temporary restrictions in access to the facility.

Build Alternatives D, E and F would be on viaduct when crossing Lake Bardwell, a USACE-owned and managed property, and would directly impact approximately 25.9 acres of Lake Bardwell's 2,917 acres (0.88 percent). Build Alternatives D, E and F would permanently impact fee owned land within Lake Bardwell. Temporary impacts related to the construction of Build Alternatives D, E and F could result in noise impacts and localized air quality impacts. However, no severe or moderate impacts were identified in this area. Construction and maintenance of the ROW would include the clearing of trees and brush. As the area is used for seasonal hunting (September 1 to March 31), these construction activities could serve as a deterrent to wildlife, reducing availability of small game and feral hogs in the area. Additionally, the multi-use trails located within the Lake Bardwell area could be temporarily impacted (temporary access reroute or closure) during construction.

Segment 3C would intersect parklands on the west side of Fort Boggy State Park primarily on viaduct and would require the acquisition of approximately 67 acres. Build Alternatives C and F would be constructed adjacent to the west side of IH-45 ROW and include reconstruction of the frontage road. This portion of the Fort Boggy State Park is undeveloped and not routinely accessible to park users due to locked gates. FRA was informed by the Texas Parks and Wildlife Department (TPWD) that park property on the west side of IH-45 is accessible on an "…as-needed-basis, such as during public hunting events that only occur during legal hunting seasons."[32] TPWD also informed FRA that potential plans for further development and use of this western property of Fort Boggy are dependent on securing funding; therefore, nothing has been planned or programmed in the Study Area.

Temporary impacts related to the construction of Build Alternatives A, B and C in Segment 2, or Build Alternatives D, E and F in Segment 2B could result in noise impacts, localized air quality impacts and visual impacts. However, no severe or moderate impacts were identified in this area. Also, the Fort Boggy State Park recreational areas and facilities are primarily located on the east side of IH-45, more than a quarter-mile from the Project and are therefore outside of the LOD and the Study Area. No potential impacts would be anticipated to recreational facilities east of IH-45 in Fort Boggy State Park.

Table ES-16 provides a summary of permanent impacts to recreational facilities by Build Alternative. The Houston Terminal Station Options would not impact any recreational facilities.

Table ES-16: 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	1	1	1	2
Trails	0	0	0	0	0	0
Total	**0**	**0**	**1**	**1**	**1**	**2**

Source: AECOM 2019

ES.9.17 Environmental Justice

As detailed in **Section 3.18, Affected Environment and Environmental Consequences, Environmental Justice**, all Build Alternatives would cross communities defined as minority or low-income populations per U.S. Census Bureau 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 by a federal action and to provide opportunities for meaningful participation throughout Project development.

FRA developed an outreach plan to connect with potentially impacted minority and low-income communities in Dallas, Harris, and Waller Counties.[33] FRA scheduled and hosted listening sessions in coordination with pre-existing community meetings where possible in order to better engage individuals potentially impacted by the Project.

There are 126 total block groups that intersect the Study Area. Of these block groups, 87 have been identified as minority and/or low-income block groups.

Construction impacts common to all Build Alternatives include increases in light levels and visual nuisances from construction equipment, vehicles and structures. Adverse temporary impacts and visual degradation due to construction activities would not be permanent and would not substantially alter the existing view quality. Overall, temporary construction laydown areas within rural areas would impact fewer people in terms of overall viewers or people who would see the laydown area during construction, and where practical, would be adjacent to major roadways and freight lines to reduce

[32] August 16, 2018, E-mail correspondence with TPWD staff informed the Project team that hunting was allowed on undeveloped portions of Fort Boggy State Park west of IH-45 during designated seasons.

[33] No minority and/or low-income communities were identified within the Study Area of other counties.

visual and traffic impacts from lighting and screening. Temporary aesthetic impacts due to construction would be common to all communities throughout the Project and would not represent a disproportionately high and adverse visual impact to minority and/or low-income block groups.

Five neighborhoods or communities identified in minority and/or low-income block groups would be potentially impacted by the Project: Downtown Dallas, Le May and Le Forge Neighborhood, Hash Road and Nail Drive, Plantation Forest and the Houston Terminal Station Option area (including Spring Branch Super Neighborhood). Two other communities not identified in minority and/or low-income block groups are discussed in **Section 3.14, Affected Environment and Environmental Consequences, Socioeconomics and Community Facilities**. All identified locations would be on Segment 1 and Segment 5, common to all Build Alternatives. After implementation of the mitigation measures discussed in **Section 3.18.6, Environmental Justice, Avoidance, Minimization and Mitigation**, there would be no notable disproportionately high and adverse impacts to minority and/or low-income populations as a result of the Build Alternatives and Houston Terminal Station Options.

ES.9.18 Cultural Resources

Discussed in **Section 3.19, Affected Environment and Environmental Consequences, Cultural Resources**, as defined by NEPA, cultural resources is an inclusive term that encompasses a broad range of resources consisting of physical evidence of past human activity. The term includes any prehistoric or historic structures, buildings, objects, sites, districts (a collection of related structures, buildings, objects and/or sites), landscapes, natural features, traditional cultural properties (TCPs) and cemeteries.

Not all resources that are cultural are considered significant under applicable cultural resources laws. Cultural resources must meet specific criteria and possess sufficient historic integrity to qualify the resource as a *historic property*, as defined by the National Historic Preservation Act (NHPA). NHPA is the cornerstone of federal historic preservation law. Section 106 of NHPA and its implementing regulations,[34] require that prior to issuing federal funding, partial funding, permitting, licensing, approval or taking other action, federal agencies must 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.[35] In the State of Texas, cultural resources may also merit designation as a Recorded Texas Historic Landmark and may also be designated as a State Antiquities Landmark.

In addition to historic properties considered under Section 106, the Project has 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, Section 2, Chapter 22 of the TAC) and in Section 28.03(f) of the Penal Code of Texas. The Health and Safety Code prohibits use of cemetery property for non-cemetery purposes. As determined in consultation between FRA and the Texas Historical Commission (THC), the State Historic Preservation Office for the State of Texas, cemeteries considered to be exposed to potential adverse impacts under NEPA, regardless of any designation or NRHP eligibility determination under Section 106, are those wholly or partially within the LOD or those with boundaries within 150 feet of the LOD.

Potential impacts to cultural resources include multiple Study Areas and would be coordinated with the THC, 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

[34] Protection of Historic Properties [36 C.F.R. 800].
[35] 54 U.S.C. 306108.

Build Alternatives in a suburban setting and 1,300 feet beyond the LOD of the Build Alternatives in a rural setting. The Project in Dallas and Harris Counties traverses urban, suburban and rural settings, which are reflected in the historic resources APE limits applied in those two counties. The Project in the remaining eight counties traverses only rural settings, and the historic resources APE applied in those counties was 1,300 feet beyond the LOD.

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

To ensure the appropriate measures to minimize harm for potential impacts, FRA, in consultation with THC, determined it is appropriate to develop and implement a Programmatic Agreement (PA) for the Project because FRA will not be able to fully determine effects to historic properties prior to approving the undertaking.[36] The PA establishes the process that governs FRA's compliance with Section 106 after approval of the undertaking. FRA developed the draft PA in consultation with the THC, ACHP, USACE, TCRR and other consulting parties. FRA provided consulting parties with an opportunity to review and comment on the draft PA prior to the release of the Final EIS and is providing the public an opportunity to review the draft PA by appending the draft PA to the Final EIS.

All Build Alternatives would have adverse impacts on historic properties and cemeteries within the LOD or within 150 feet of the LOD, as shown in **Table ES-17**. Of the six Build Alternatives, Build Alternatives A and B would have the greatest impact to cultural resources and Build Alternative F would have the least impact to cultural resources. The Houston Industrial Site Terminal Station Option in Harris County would have an adverse impact on a historic property (Site HA.208: Tex-Tube Complex). The remaining two Terminal Station Options in Harris County would have no impact on historic properties. Although, under the Texas Health and Safety Code, the Houston Northwest Transit Center Terminal Station Option, if chosen, could have an adverse impact on a historic cemetery with no NRHP designation (Site HA.212: Beth Yeshurun-Post Oak Cemetery/Beth Cemetery). To date, no archeological sites within the Project LOD have been listed or determined eligible for listing in the NRHP.

Table ES-17: Cultural Resources (Historic Properties and Cemeteries) Impacts by Build Alternative and Houston Terminal Station Option

	Build Alternatives						Houston Terminal Station Option		
	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F	Industrial Site	Northwest Mall	Northwest Transit Center
Adverse Impacts	14	14	13	12	12	11	1	0	1

Source: AECOM 2019

ES.9.19 Soils and Geology

FRA evaluated in **Section 3.20, Affected Environment and Environmental Consequences, Soils and Geology,** the existing soil and geological conditions along the Project to determine whether 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

[36] 36 C.F.R. 800.14 (b)(1)(ii)-(iii).

walls, noise walls, fences and utilities. In addition, some portions of the Project would require the construction of embankments, which includes cutting, excavation and grading into existing subsurface materials at varying depths, as well as vegetation removal. Potential impacts to soil and geological conditions from the Project would be avoided, minimized and mitigated with the implementation of standard engineering design measures.

Table ES-18 presents soil characteristics and area of potential impacts by Build Alternative. The three Houston Terminal Station Options would be comprised of the same two soil classifications; therefore, the soil composition is not a differentiating factor between the Houston Terminal Station Options.

Table ES-18: 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		9,173.4	9,347.1	9,689.0	9,202.8	9,376.4	9,718.4
Shrink-Swell Potential	Low	2,593.6	2,585.8	2,848.3	2,593.6	2,585.8	2,848.3
	Moderate	1,458.4	1,465.1	1,485.0	1,456.9	1,463.7	1,483.6
	High	2,284.0	2,477.1	2,471.2	2,289.2	2,482.4	2,476.4
	Very High	2,727.9	2,697.5	2,781.8	2,752.8	2,722.4	2,806.7
Erosion Potential	Low	1,611.6	1,591.3	1,914.1	1,679.3	1,659.1	1,981.9
	Moderate	4,511.2	4,619.9	4,786.6	4,472.1	4,580.9	4,747.6
	High	2,963.5	3,036.8	2,907.9	2,963.5	3,036.8	2,907.9
Corrosion Potential	Low	55.3	71.8	81.4	55.3	71.8	81.4
	Moderate	2,204.8	2,182.0	2,761.1	2,204.8	2,182.0	2,761.1
	High	6,824.5	6,992.5	6,764.5	6,853.2	7,021.2	6,793.2
Prime Farmland Soils		5,245.3	5,454.7	5,033.2	5,202.9	5,412.3	4,990.8
Surface Mines		0 [a]	0 [a]	0 [a]	0	0	0

Source: NRCS 2016

[a] The Midlothian Quarry and Plant in Ellis County was identified at approximately 1/2-mile west of Segment 2A. Exact limits would need to be field-verified (once survey access is granted) to confirm or discount presence in the Study Area.

ES.9.20 Greenhouse Gas Emissions

Section 3.21, Affected Environment and Environmental Consequences, Greenhouse Gas Emissions, identifies potential climate change impacts resulting from construction and operation of the Project. Resilience of the Project to potential climate change impacts is also discussed. The assessment found that construction emissions would represent 0.02 percent of total annual greenhouse gas (GHG) emissions statewide, representing a negligible impact.

Long-term induced activities that would contribute to GHG emissions for the Project would be vehicle and bus travel on roadways, air travel between Dallas and Houston and power generation for the electricity consumed by the HSR trainsets, 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 by those passengers using electric trainsets instead of cars and buses to travel between Dallas and Houston. The magnitude of GHG emissions reduced by this change in mode of travel would be expected to be greater than that generated by the trainset and station power consumption and passenger travel to and from stations.

Power plant GHG emission factors reflect current and historical data, and not future year emissions that account for more stringent standards and improvements in emissions controls, as vehicle emissions reduction modeling would; therefore, the emission factors were adjusted. Future year power plant emissions factors were projected using trends in the historical eGRID data that indicated downward trends in the emission rates of pollutants, including GHG, and historical U.S. Energy Information Administration data indicating an increasing percentage of power generated by non-combustion sources in Texas. The same data sources and procedures described in **Section 3.2.3.2**, **Air Quality, Operational Emissions Methodology, Future Year Trainset Emissions Adjustment**, were used to project the future year GHG emissions factor. The future year GHG emissions factor and power consumption were used to calculate annual GHG emissions in the year 2040, the year of the highest rate of HSR operation. Total vehicle miles traveled reductions and 2040 GHG vehicle emissions factor were used to calculate vehicle emissions reductions of GHG for the year 2040.

Besides these modes of travel, HSR use between Dallas and Houston would also be expected to replace some air travel between the two cities. A life cycle environmental assessment of U.S. passenger transit systems estimated that on a per passenger-mile traveled (PMT) basis, mid-size aircraft travel produced more GHG operationally than the California HSR system.[37] Under a 90 percent occupancy scenario, the 737 midsize aircraft (the most common model in Dallas-Houston routes) was estimated to produce approximately 125 grams (gm) CO_2e/PMT, while the California HSR system was estimated to produce approximately 60 gm CO_2e/PMT. Under a 10 percent occupancy scenario, midsize aircraft was estimated to produce approximately 250 gm CO_2e/PMT, while the California HSR system was estimated to produce approximately 275 gm CO_2e/PMT. However, for the median occupancy case, midsize aircraft was estimated to produce approximately 175 gm CO_2e/PMT, while the California HSR system was estimated to produce approximately 90 gm CO_2e/PMT. On average, this would be 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 Project due to the minor percentage (9 percent) of the existing mode share for aircraft between Dallas and Houston, according to the travel mode share data discussed in **Section 3.2.3.2, Air Quality, Operational Emissions Methodology, Vehicle Emissions Reductions**.

The Project operation emissions would result in a long-term net reduction of GHG that would offset the construction emissions within 3.6 years at full operation and continue to achieve net reduction of GHG for the life of the HSR system. Considering the net reduction and offset, the long-term impact of the Project would be beneficial and not adverse.

All the Build Alternatives would extend from Dallas to Houston and cross features subject to the long-term potentially adverse effects of climate change, as discussed in **Section 3.21.4, Greenhouse Gas Emissions, Affected Environment**. The Build Alternatives would not appreciably differ in terms of the amount of area potentially subjected to higher average annual precipitation, an increased risk of wildfire or higher ambient temperatures. Resilience to climate change impacts would be similar among the Build Alternatives. The design, construction, maintenance and inspection actions proposed for the HSR system would manage risks introduced from climate change.

ES.9.21 Section 4(f)/Section 6(f) Evaluation

Section 4(f) of the USDOT Act of 1966 prohibits USDOT agencies from using land from publicly owned parks, recreation areas (including recreational trails), wildlife and waterfowl refuges, or public and private historic properties, unless there is no feasible and prudent alternative to that use and the action includes all possible planning to minimize harm to the property resulting from such a use.

Within **Chapter 7.0, Section 4(f) and Section 6(f) Evaluation**, FRA examined six Build Alternatives, A through F, and three Houston Terminal Station Options for the Project. Each of the six Build Alternatives,

[37] Mikhail V. Chester, *Life-cycle Environmental Inventory of Passenger Transportation in the United States*, Dissertation, Berkeley, CA: Institute of Transportation Studies, University of California, Berkeley, 2008.

including the Preferred Alternative, would use three properties protected by Section 4(f) because the properties are on segments that are common to each Build Alternative:

- DA.023 (Cadiz Street Underpass and Overpass), Dallas
- DA.076a (Guiberson Corporation), Dallas
- DA.110b (Linfield Elementary School)

FRA determined that Build Alternatives C and F, not the Preferred Alternative, would require the use of an additional Section 4(f) property, Fort Boggy State Park. Among the Houston Terminal Station Options, the Houston Industrial Site Terminal Station Option, not the Preferred Alternative, would require the use of one Section 4(f) property (HA.208 Tex-Tube Complex).

None of the Build Alternatives would avoid a use of Section 4(f) properties (**Section 7.8, Section 4(f) and Section 6(f) Evaluation, Avoidance Alternatives**). In this task, FRA examined location alternatives, alternative actions, alignment shifts and design changes, and determined that there is no feasible and prudent avoidance alternative as defined by Section 4(f). As a result, the Section 4(f) evaluation considers all six Build Alternatives.

FRA has consulted with THC and TPWD, the officials with jurisdiction over the Section 4(f) properties in this evaluation. Consultation has enabled FRA to understand the purpose and significance of each property and the concerns of officials with jurisdiction regarding Project impacts on each property. More importantly, consultation with officials with jurisdiction has enabled the Project design to be refined to reduce or eliminate use of Section 4(f) properties where reasonably feasible (**Section 7.9, Section 4(f) and Section 6(f) Evaluation, All Possible Planning to Minimize Harm**). Ongoing consultation activities will include identifying and making commitments to specific minimization and mitigation measures and concurring with FRA's determinations of effect and least overall harm in the Final Section 4(f) Evaluation (**Section 7.10, Section 4(f) and Section 6(f) Evaluation, Coordination**).

In the Section 4(f) Evaluation, FRA identified Build Alternative A and the Houston Northwest Mall Terminal Station Option as the alternative with the least overall harm to Section 4(f) properties (**Section 7.11.2, Section 4(f) and Section 6(f) Evaluation, Analysis and Results**). This is based on Build Alternative A having the same or fewer uses of Section 4(f) properties compared to the other Build Alternatives but having fewer impacts to other resources that are not protected by Section 4(f). The Houston Northwest Mall Terminal Station Option would not use Section 4(f) properties.

The Section 4(f) Evaluation will be subject to review and comment by the Department of the Interior (DOI). Concurrent with the DOI's review will be continuing consultation under Section 106 to finalize the PA. FRA will consider DOI's comments, Section 106 consultation activities and TPWD coordination outcomes prior to making final Section 4(f) determinations and preparing a Final Section 4(f) Evaluation, which will be included in the ROD for the Project.

Section 6(f) of the Land and Water Conservation Fund (LWCF) Act prohibits property acquired and improved with LWCF assistance from being converted to uses other than public outdoor recreation without the approval of NPS. Therefore, the Study Area for Section 6(f)-protected resources is limited to the LOD.

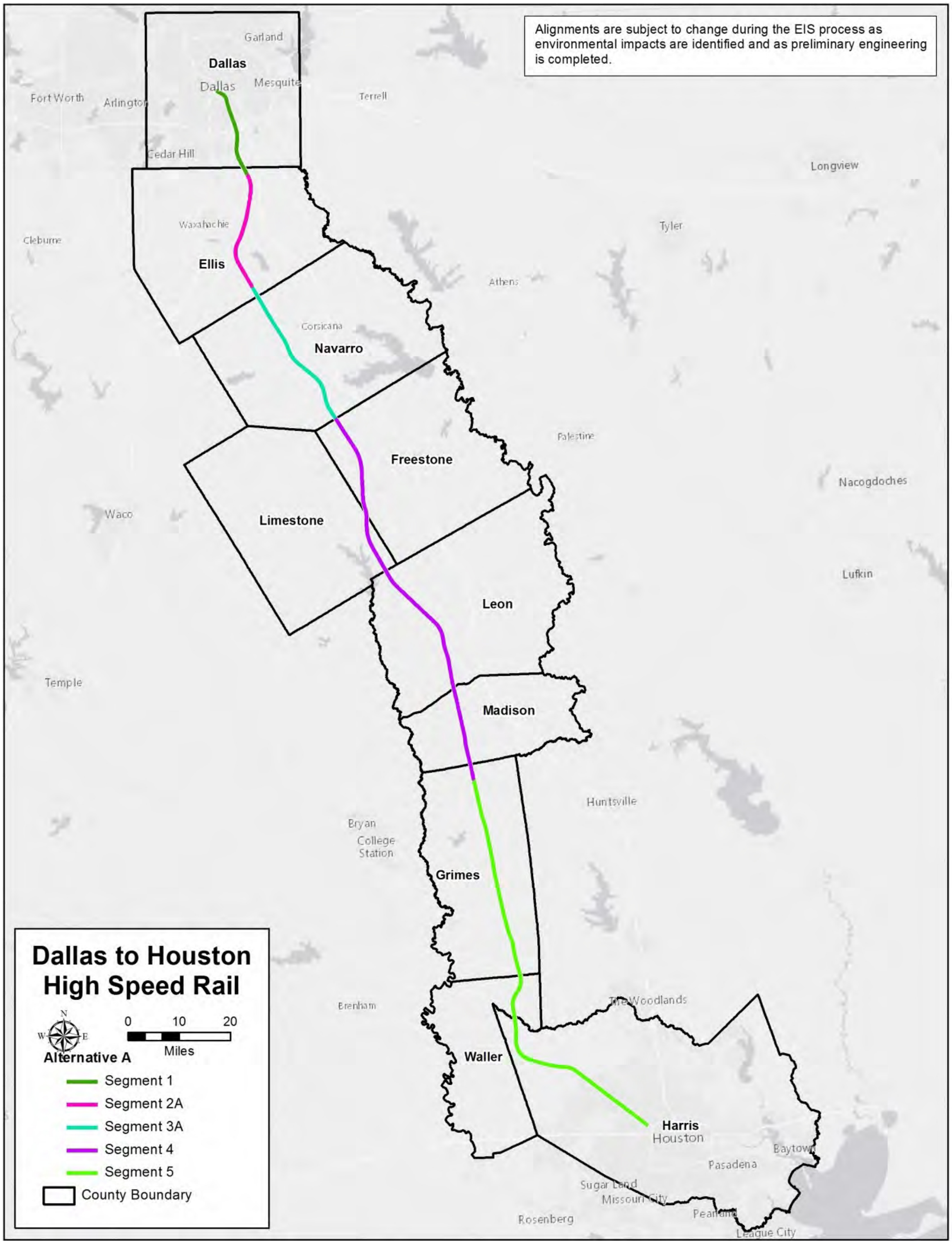
No resources within the Section 6(f) Study Area are protected under Section 6(f). Therefore, no conversion of Section 6(f) properties would occur as a result of implementation of the Project.

ES.10 FRA's Preferred Alternative

FRA, as the lead federal agency, after considering the comparative analysis of the No Build Alternative, the Build Alternatives, and Houston Terminal Station Options presented in this Final EIS and the potential impacts of the Build Alternatives, identifies Build Alternative A and the Houston Northwest Mall Terminal Station Option as the Preferred Alternative. FRA identified Build Alternative A as the Preferred Alternative in the Draft EIS published December 22, 2017. In identifying the preferred alternative in this Final EIS, FRA has considered environmental, technical, public comments on the Draft EIS and other factors, including the alternative that would best meet the cooperating agencies' defined plans, policies and regulations.

Build Alternative A (see **Figure ES-3**) is comprised of Segment 1 (including the Dallas Terminal Station and a TMF), Segment 2A (including a MOW), Segment 3A, Segment 4 (including two MOW facilities) and Segment 5 (including two MOW facilities, a TMF, and the Brazos Valley Intermediate Station). 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 East 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, North Lancaster/Hutchins Road (TMF facility), East Pleasant Run Road and West Beltline Road. South of West Beltline Road, the alignment extends west of Lancaster Airport before turning southwest to enter Ellis County and cross 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. The alignment 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 west 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, FM 27 (MOW facility) and FM 1366. As the alignment 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 US 79 (MOW facility). It continues south crossing FM 391 as it travels towards Concord and crosses SH 7 and veers south to parallel the utility easement. It crosses into Madison County northeast of Normangee and continues south crossing FM 2289, FM 978 and FM 1452 before crossing SH 190 west of Cottonwood. The alignment crosses FM 1372 and crosses into Grimes County just north of FM 1696. Build Alternative A continues south along the utility easement, crossing FM 155 and FM 39, before crossing SH 30 just west of Roans Prairie (Brazos Valley Intermediate 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. Approximately 129 miles of the Preferred Alternative, Build Alternative A, is constructed on viaduct, 27 miles by cut construction and 79 miles on embankment.

Figure ES-3: EIS End-to-End Build Alternative A



Source: AECOM 2019

While the Draft EIS did not identify a preferred option for the Houston Terminal Station in Harris County, this Final EIS identifies the Houston Northwest Mall Terminal Station Option as the preferred terminal station location.

Although FRA is identifying a Preferred Alternative in this Final EIS, FRA analyzed all Build Alternatives and the Houston Terminal Station Options in this Final EIS.

ES.10.1 Statutory Considerations

Important regulatory requirements that must be addressed in the identification of a preferred alternative for this Project are Section 404 of the Clean Water Act[38], Section 14 of the Rivers and Harbors Act,[39] and provisions of Section 4(f) of the USDOT Act.[40]

Under Section 404 and 408 requirements, the USACE 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 the USACE federally authorized civil works projects (USACE Projects) 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 the USACE Project associated with Lake Bardwell, requiring a Section 408 authorization from the USACE. Impacts to streams, wetlands and waterbodies that occur within the USACE Projects are detailed in **Appendix E, Impacts to USACE Projects Technical Memorandum**.

Segment 1 is common to all Build Alternatives—proceeding south from the Dallas Terminal Station all Build Alternatives must cross the Trinity River. Either Segment 2A or 2B, located in Ellis County, would be a component of 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 the USACE determined that per the USACE National Non-Recreation Outgrant Policy,[41] 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 described in **Chapter 7.0, Section 4(f) and Section 6(f) Evaluation**, Section 4(f) prohibits the use of a Section 4(f) property unless there is no feasible or prudent alternative to such use and the project includes all possible planning to minimize harm to the property resulting from such use; or a project as a whole, including any measure(s) to minimize harm, has a *de minimis*, or minimal, impact on the Section 4(f) property. Segments 1 and 5, common to all Build Alternatives, would impact three Section 4(f) resources along common segments in Dallas and Harris Counties. Additionally, Segment 3C (on Build Alternative C) would use an additional property, Fort Boggy State Park. The Houston Industrial Site Terminal Station Option would require the use of a Section 4(f) protected resource. The Houston Northwest Mall and Houston Northwest Transit Center Terminal Station Options would not impact Section 4(f) resources.

[38] 33 U.S.C. 1344 (Section 404).
[39] 33 U.S.C. 408 (Section 408).
[40] 49 U.S.C. 303 (Section 4(f)).
[41] USACE, ER 1130-2-550 Chapter 17, September 30, 2013, accessed May 2020, https://www.saw.usace.army.mil/Portals/59/docs/recreation/Land%20Use/USACE%20Non-Recreation%20Outgrant%20Policy%20ER1130-5-550%20Ch.%2017%20.pdf.

ES.10.2 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
- Elderly and Handicapped
- Socioeconomics and Community Facilities
- Electromagnetic Fields
- Environmental Justice
- Greenhouse Gas Emissions

Environmental resources that differentiate Build Alternatives A, B and C are presented in **Table ES-19**. These resources are not weighted, meaning that no one criterion is more meaningful than another. The highlighted cells show the least potentially impactful site for each criterion.

Table ES-19: Comparison of Build Alternatives A, B and C

Evaluation Criteria	Measure	Alt A	Alt B	Alt C
Water Quality (Section 3.3)				
Impaired Waterbodies – 303(d) List	Feet	344.7	517.4	496
Impaired Waterbodies Total	Feet	830.0	1,002.7	981.3
Groundwater Wells	Count	9	13	7
Noise and Vibration (Section 3.4)				
Severe Noise Impact Residential	Count	10	12	10
Moderate Noise Impact Residential	Count	280	290	275
Hazardous Materials and Solid Waste (Section 3.5)				
Low-Risk Hazardous Material Sites	Count	297	298	326
Moderate-Risk Hazardous Material Sites	Count	155	155	165
Natural Ecological Systems and Protected Species (Section 3.6) [a]				
Protected Species Modeled Habitat - Temporary	Acres	328	328	325
Protected Species Modeled Habitat - Permanent	Acres	1,058	1,058	1,452
Waters of the U.S. (Section 3.7)				
Stream Crossings – Temporary	Feet	83,459	83,791	90,942
Stream Crossings – Permanent	Feet	38,898	45,631	35,096
Wetlands – Temporary	Acres	59.5	59.0	44.3
Wetlands – Permanent	Acres	50.0	47.4	63.4
Waterbodies – Temporary	Acres	33.5	36.3	30.4
Waterbodies – Permanent	Acres	27.6	27.2	21.1
Floodplains (Section 3.8)				
Impacts to 100-Year Floodplain	Acres	616	557	642
Impacts to 500-Year Floodplain	Acres	132	132	133
Permanent Impacts to 100-Year and 500-Year Floodplains	Acres	529	479	579
Temporary Impacts to 100-Year and 500-Year Floodplains	Acres	219	210	196
Total Acres of Impacted Floodplain	Acres	748	689	775

Table ES-19: Comparison of Build Alternatives A, B and C				
Evaluation Criteria	**Measure**	**Alt A**	**Alt B**	**Alt C**
Total Number of Bridge/Viaduct Crossings of FEMA Zone AE	Count	63	63	71
Total Number of Bridge/Viaduct Crossings of FEMA Zone A	Count	126	142	137
Utilities and Energy (Section 3.9)				
New Electric TPSS Connections	Count	13	12	13
Electric Utility Pole Adjustments	Count	85	85	74
Total Electric Connections and Adjustment	Count	98	97	87
Abandoned Oil and Gas Wells	Count	37	37	22
Aesthetics and Scenic Resources (Section 3.10)				
Total Number of Adverse Visual Resource Impacts	Count	11	11	10
Transportation (Section 3.11)				
Road Modifications [b] (*Public and Private*)	Count	138	150	102
Road Modifications [c] (*Public only*)	Count	59	66	79
Length added to Public Roads (miles)	Miles	16.8	21.4	46.9
Length removed from Public Roads (miles)	Miles	5.1	5.0	27.2
Impacts to airports [d]	Count	0	1	0
Land Use (Section 3.13)				
LU Conversion – Temporary	Acres	2,553.4	2,532.9	2,393.2
LU Conversion – Permanent	Acres	6,619.8	6,814.0	7,295.6
Special Status Farmland – Temporary	Acres	1,710.8	1,690.4	1,459.8
Special Status Farmland – Permanent	Acres	3,534.5	3,764.3	3,573.4
Special Status Farmland – Indirect [e]	Acres	847.5	888.2	697.3
Displacement – Commercial (primary)	Count	42	42	65
Displacement – Residence (primary)	Count	235	255	239
Displacement – Community Facilities (primary)	Count	2	2	3
Estimated Permanent Parcel Acquisitions	Count	1,731	1,814	1,789
Estimated Temporary Parcel Acquisitions	Count	272	277	259
Estimated Structure Acquisitions – Agriculture	Count	196	223	196
Estimated Structure Acquisitions – Commercial	Count	12	12	18
Estimated Structure Acquisitions – Cultural/Civic Resources	Count	2	2	1
Estimated Structure Acquisitions – Oil and Gas	Count	12	12	17
Estimated Structure Acquisitions – Residence	Count	49	50	51
Estimated Structure Acquisitions – Transportation and Utilities	Count	0	0	1
Safety and Security (Section 3.16)				
Permanent Road Modifications resulting in 1 minute or more in additional through travel time	Count	12	13	9
Total fire and EMS service areas bisected by construction	Count	56	57	51
Fire and EMS providers with high potential for construction effects	Count	3	4	5
Fire and EMS providers with localized potential for construction effects	Count	8	7	6
Recreational Facilities (Section 3.17)				
Parks	Count	0	0	1
Environmental Justice (Section 3.18)				
Number of Minority and/or Low-Income block groups intersected by the Study Area	Count	80	80	81
Number of all block groups intersected by the Study Area	Count	118	118	119
Cultural Resources (Section 3.19)				
Adverse Impacts to Historic Properties	Count	14	14	13

Table ES-19: Comparison of Build Alternatives A, B and C				
Evaluation Criteria	**Measure**	**Alt A**	**Alt B**	**Alt C**
Soils and Geology (Section 3.20)				
LOD Area	Acres	9,173.4	9,347.1	9,689.0
Shrink-Swell Potential – Low	Acres	2,593.6	2,585.8	2,848.3
Shrink-Swell Potential – Moderate	Acres	1,458.4	1,465.1	1,485.0
Shrink-Swell Potential – High	Acres	2,284.0	2,477.1	2,471.2
Shrink-Swell Potential – Very High	Acres	2,727.9	2,697.5	2,781.8
Erosion Potential – Low	Acres	1,611.6	1,591.3	1,914.1
Erosion Potential – Moderate	Acres	4,511.2	4,619.9	4,786.6
Erosion Potential – High	Acres	2,963.5	3,036.8	2,907.9
Corrosion Potential – Low	Acres	55.3	71.8	81.4
Corrosion Potential – Moderate	Acres	2,204.8	2,182.0	2,761.1
Corrosion Potential – High	Acres	6,824.5	6,992.5	6,764.5
Prime Farmland Soils	Acres	5,245.3	5,454.7	5,033.2

Source: AECOM 2019

Note: Specific impacts are not included in this comparison table if they are equal across Build Alternatives A, B and C.

[a] Threatened and endangered species acreages include habitat for species with mapped habitat that may be impacted, including Houston toad, large-fruited sand verbena and Navasota ladies'-tresses. Threatened and endangered species in the Study Area that may be impacted but that do not have mapped habitat include the interior least tern and the whooping crane.

[b] Road modifications reflect the number of reroutes, road adjustments or road over rail constructions that would occur. Some roads are affected by multiple modifications (such as IH-45). Modifications do not reflect total number of roads but total number of road construction sites.

[c] Shared access roads are included in roadway modification lengths. Shared access roads will be developed to provide for maintenance, emergency response access and private property access with a corresponding reduction in the number of new public roads to decrease burden on roadway authorities. Shared access roads would be constructed and maintained by TCRR.

[d] Anxiety Aerodrome would be directly impacted by Segment 3B, which are part of Build Alternatives B and E.

[e] Indirect impacts to special status farmland in **Section 3.13, Land Use,** are defined as a 25-foot setback added to the LOD to account for indirect loss of productive farmland to accommodate the use of farm and ranch equipment or impacts such as induced wind and changes in irrigation.

All three Build Alternatives would result in impacts to impaired waterbodies and groundwater wells, with Build Alternative B having the most at approximately 1,003 feet of impaired waterbodies and 13 groundwater wells.

All three Build Alternatives would result in severe and moderate noise and vibration impacts to several residences. Alternative B would have the most noise impacts at 12 severe and 290 moderate noise impacts to residences.

Build Alternatives A and B would have an impact on the same number of moderate-risk hazardous materials sites (155), while Build Alternative C would impact the most moderate-risk hazardous materials sites (165). Build Alternative C has the potential to impact 29 more low-risk hazardous materials sites compared to Build Alternatives A.

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 394 additional acres of protected species habitat compared to Build Alternatives A and B.

Determinations related to waters of the U.S. require USACE consideration. Temporary impacts to wetlands and waterbodies would be comparable across Build Alternatives A, B and C. Temporary stream crossings would be 7,483 feet less for Build Alternative A than Build Alternative C. Permanent stream impacts under Build Alternative B would be approximately 6,733 feet greater compared to Build Alternative A and approximately 10,535 feet greater compared to Build Alternative C. Permanent impacts to wetlands across all three Build Alternative would range from 48 to 64 acres with Build Alternative B having the potential to permanently impact the fewest acres of wetlands. Permanent impacts to waterbodies would range from 21 to 28 acres with Build Alternative A having the potential to impact the most waterbodies. FRA has taken a conservative approach regarding jurisdictional determinations. The waterbodies data have not been revised to note USACE jurisdiction, which means that all waterbodies are assumed jurisdictional at this time. The USACE site assessments are ongoing and the identification of non-jurisdictional features by the USACE as part of the Section 404 Individual Permits (**WW-CM#4: CWA Section 404, Individual Permit**) will refine the evaluation of impacts to waterbodies, potentially resulting in the identification of different impacts to waterbodies than those described in **Tables ES-7, ES-19, ES-20** and **ES-21**.

Build Alternatives A, B and C would impact 557 to 642 acres of floodplains. Build Alternative B would intersect 85 acres less than Build Alternative C and 59 acres less than Build Alternative A.

All three Build Alternatives would have approximately the same amount of electrical connections and adjustments of existing infrastructure. Build Alternative C has the potential to permanently impact 15 fewer abandoned oil and gas wells compared to Build Alternatives A and B.

Transportation impacts would be mitigated through reroutes and regrading roadways. Build Alternative A would have the fewest modifications to existing public roads (59). Build Alternative C would result in the greatest length of public roadways removed (27 miles), as well as miles added (47 miles). Build Alternative A would result in the least length of roadway removed (5 miles) and least length added (17 miles). Additionally, Build Alternative C would require the realignment of the frontage road along IH-45 for a length of approximately 48 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 B would be the only alternative with a permanent impact to an airport.

Build Alternative A has the potential to permanently convert approximately 194 acres less of land use compared to Build Alternative B and 676 acres less compared to Build Alternative C. For special status farmland, Build Alternative C would permanently impact approximately 362 acres less than Build Alternative A and 612 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. As detailed in **Section 3.13, Land Use**, primary displacements include structures located directly within the proposed LOD or within 50 feet of the LOD. Build Alternatives A and B would result in fewer displacements of businesses (commercial structures) compared to Build Alternative C, and while Build Alternatives A and C would have similar residential displacement, Build Alternative B would result in the displacement of several more homes. Build Alternative B would require the largest number of land parcels, while Build Alternative A would require the least (88 less than Build Alternative B). Build Alternatives A and B would require the acquisition of fewer commercial structures (6 less) compared to Build Alternative C. Build Alternatives A and C would also result in the acquisition of fewer agricultural structures (barns/sheds) compared to Build Alternative B (27 more). All three Build Alternatives would result in a similar number of homes additionally acquired (in addition to those displaced discussed above) by the Project; therefore, overall Build Alternative A would displace or acquire the most residences (26 more than Build Alternative B).

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. As the identification and evaluation of historic properties is ongoing, the evaluation of, and assessment of effects to, cultural resources on the Preferred Alternative will continue in a phased approach as provided for in 36 C.F.R. 800.4(b)(2) and 36 C.F.R. 800.5(a)(3) and the Section 106 PA.

Build Alternatives A, B and C would use three properties along common segments in Dallas and Harris Counties protected by Section 4(f). Additionally, Build Alternative C would use an additional property, Fort Boggy State Park.

When the environmental impacts of these Build Alternatives A, B and C are compared, Build Alternative A would have the fewest permanent impacts to the socioeconomic, natural, physical and cultural resources environment as noted in **Table ES-19** and described in the preceding text. Therefore, FRA identified Build Alternative A as the Preferred Alternative in both the Draft and this Final EIS.

ES.10.3 Comparison of Houston Terminal Station Option Alternatives

Chapter 3.0, Affected Environment and Environmental Consequences, describes the socioeconomic, natural, physical and cultural resources evaluation criteria used to compare all Houston Terminal Station Options. For most resource areas, there are no distinguishable differences among the Houston Terminal Station Options. Environmental resources that have a negligible difference in the identification of a preferred alternative include:

- Air Quality
- Water Quality
- Noise and Vibration
- Natural Ecological Systems and Protected Species
- Floodplains
- Utilities and Energy
- Aesthetics and Scenic Resources
- Elderly and Handicapped
- Electromagnetic Fields
- Safety and Security
- Recreational Facilities
- Environmental Justice
- Soils and Geology
- Greenhouse Gas Emissions

As discussed above, and detailed in **Chapter 7.0, Section 4(f) and Section 6(f) Evaluation,** the Houston Industrial Site Terminal Station Options would require the use of a Section 4(f) protected resource. Because there are feasible and prudent alternatives that would avoid the use of the Houston Industrial Site Terminal Station Option, FRA eliminated it from consideration as the preferred station option. Environmental resources that differentiate between the Houston Northwest Mall and Northwest Transit Center Terminal Station Options are presented in **Table ES-20**. These resources are not weighted, meaning that no one criterion is more significant than another. The highlighted cells show the least potentially impactful site for each criterion.

Table ES-20: Comparison of Houston Terminal Station Options Northwest Transit Center and Northwest Mall

Evaluation Criteria	Measure	Northwest Transit Center	Northwest Mall
Hazardous Materials and Solid Waste (Section 3.5)			
Low-Risk Hazardous Material Sites	Count	6	0
Moderate-Risk Hazardous Material Sites	Count	8	3
High-Risk Hazardous Material Sites	Count	0	0
Waters of the U.S. (Section 3.7)			
Wetlands – Temporary	Acres	1.6	0.0
Waterbodies – Temporary	Acres	0.10	0.0
Transportation (Section 3.11)			
Intersections at LOS E or F	Count	22	24
Land Use (Section 3.13)			
LU Conversion – Temporary	Acres	11.8	27.4
LU Conversion – Permanent	Acres	88.7	75.8
Displacement – Commercial (primary)	Count	15	22
Displacement – Community Facility (primary)	Count	1	0
Estimated Permanent Parcel Acquisitions	Count	43	40
Estimated Temporary Parcel Acquisitions	Count	0	1
Estimated Structure Acquisitions – Commercial	Count	0	1
Socioeconomics and Community Facilities (Section 3.14)			
Community Facility	Count	1	0
Cultural Resources (Section 3.19)			
Adverse Impacts to Historic Properties	Count	1	0

Source: AECOM 2019

The Houston Northwest Transit Center Terminal Station Option would impact more moderate-risk (5 more) and low-risk (6 more) hazardous materials sites than the Houston Northwest Mall Terminal Station Option.

While permanent impacts to wetlands across the terminal options are similar (0 acres, not shown in **Table ES-20**), overall temporary impacts to wetlands and other waterbodies would be 1.7 acres more at the Houston Northwest Transit Center Terminal Station Option. All waterbodies are assumed to be within USACE jurisdiction at this time. The 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 differing impacts to waterbodies than those described in **Tables ES-7, ES-19, ES-20** and **ES-21**.

Both terminal station options would impact similar numbers of intersections.

The Houston Northwest Mall Terminal Station Option has the potential to permanently convert approximately 13 fewer acres of land compared to the Houston Northwest Transit Center Terminal Station Option. The Houston Northwest Mall Terminal Station Option would permanently acquire three fewer parcels than the Houston Northwest Transit Center Terminal Station Option. The Houston Northwest Transit Center Terminal Station Option would impact one cultural resource and one community facility (Awty International School Annex), while the Houston Northwest Mall Terminal Station Option would impact no cultural resources or community facilities but would displace more commercial businesses.

When the environmental impacts of each station option are compared, the Houston Northwest Mall Terminal Station Option would have fewer permanent impacts to the socioeconomic, natural, physical and cultural resources environment as noted in **Table ES-20** and described in the preceding text. Therefore, FRA is identifying the Houston Northwest Mall Terminal Station Option as the preferred Houston terminal station alternative in this Final EIS.

ES.10.4 Preferred Alternative Impacts

Overall impacts of the Preferred Alternative, Build Alternative A and Houston Northwest Mall Terminal Station Option, are summarized in **Table ES-21**. Direct impacts of the Preferred Alternative, and Build Alternatives A through F and the three Houston Terminal Station Options, are detailed in **Chapter 3.0, Affected Environment and Environmental Consequences**, while indirect and cumulative impacts are addressed in **Chapter 4.0, Indirect Effects and Cumulative Impacts**.

ES.11 Next Steps in the Environmental Process

CEQ regulations require FRA to wait a minimum of 30 days after the Final EIS is made available before releasing a ROD.[42] The ROD documents FRA's decision, the alternatives considered in the EIS, the environmentally preferable alternative, and a summary of the required mitigation measures

[42] 40 C.F.R. 1506.10.

Table ES-21: Summary of Preferred Alternative Direct Impacts

Evaluation Criteria		Measure	Build Alternative A	Houston Northwest Mall Terminal Station Option	Total
Air Quality (Section 3.2)					
Air Quality Impacts		N/A	Net emissions benefit for permanent operations, temporary construction impacts.		
Water Quality (Section 3.3)					
Impaired Waterbodies – 303(d) List		Feet	344.7	0	344.7
Impaired Waterbodies with TMDLs		Feet	485.3	0	485.3
Impaired Waterbodies Total		Feet	830	0	830
Active Public Water System Wells		Count	1	0	1
Groundwater Wells		Count	9	0	9
Reservoir/Dam Crossings		Count	0	0	0
Noise and Vibration (Section 3.4)					
Severe Noise Impact	Residential	Count	10	0	10
	Institutional	Count	0	0	0
Moderate Noise Impact	Residential	Count	280	0	280
	Institutional	Count	1	0	1
Vibration Impact	Residential	Count	0	0	0
	Institutional	Count	0	0	0
Hazardous Materials and Solid Waste (Section 3.5)					
Low-Risk Hazardous Material Sites		Count	297	0	297
Moderate-Risk Hazardous Material Sites		Count	155	3	158
High-Risk Hazardous Material Sites		Count	4	0	4
Natural Ecological Systems and Protected Species (Section 3.6) [a]					
Protected Species Modeled Habitat – Temporary		Acres	328	0	328
Protected Species Modeled Habitat – Permanent		Acres	1,058	0	1,058

Source: AECOM 2019

[a] Threatened and Endangered Species acreages include habitat for species with modeled habitat (as detailed in **Section 3.6**) that may be impacted, including Houston toad, large-fruited sand verbena and Navasota ladies'-tresses. Threatened and endangered species in the Study Area that may be impacted but that do not have modeled habitat include the interior least tern and the whooping crane.

[b] A single landscape unit is shared between Segment 5 and the Houston Terminal Station Options; therefore, the total number of beneficial landscape units is the same as Build Alternative A.

[c] Totals for rail impacts do not include rail at Houston Terminal Stations. Totals also include DART-owned rail lines in Dallas County

[d] Road modifications reflect the number of reroutes, road adjustments, or road over rail constructions that would occur. Some roads are affected by multiple modifications (such as IH-45). Modifications do not reflect total number of roads but total number of road construction sites.

[e] Shared access roads are included in roadway modification lengths. Shared access roads will be developed to provide for maintenance, emergency response access and private property access with a corresponding reduction in the number of new public roads to decrease burden on roadway authorities. Shared access roads would be constructed and maintained by TCRR.

[f] Anxiety Aerodrome would be directly impacted by Segment 3B, which are part of Alternatives B and E

[g] Indirect impacts to special status farmland in **Section 3.13, Land Use** are defined as a 25-foot setback added to the LOD to account for indirect loss of productive farmland to accommodate the use of farm and ranch equipment or impacts such as induced wind and changes in irrigation.

[h] The "Community Facilities" category in **Section 3.14, Socioeconomics and Community Facilities**, encompasses categories of affected structures and facilities that are broken down into more defined categories within **Section 3.13, Land Use**, therefore values between the two sections are not identical. Refer to the Section for a complete definition of each category.

[i] Children's health and safety impacts are the result of temporary construction effects. These impacts will no longer exist once construction has ended.

[j] The Midlothian Quarry and Plant in Ellis County was identified at approximately one-half-mile west of Segment 2A. Exact limits would need to be field-verified to confirm or discount presence in the Study Area.

Table ES-21: Summary of Preferred Alternative Direct Impacts				
Evaluation Criteria	**Measure**	**Build Alternative A**	**Houston Northwest Mall Terminal Station Option**	**Total**
Waters of the U.S. (Section 3.7)				
Stream Crossings – Temporary	Feet	83,459	0	83,459
Stream Crossings – Permanent	Feet	38,898	0	38,898
Wetlands – Temporary	Acres	59.5	0	59.5
Wetlands – Permanent	Acres	50.0	0	50.0
Waterbodies – Temporary	Acres	33.5	0	33.5
Waterbodies – Permanent	Acres	27.6	0	27.6
Floodplains (Section 3.8)				
Impacts to 100-Year Floodplain	Acres	616	0	616
Impacts to 500-Year Floodplain	Acres	132	0	132
Permanent Impacts to 100-Year and 500-Year Floodplains	Acres	529	0	529
Temporary Impacts to 100-Year and 500-Year Floodplains	Acres	219	0	219
Total Acres of Impacted Floodplain	Acres	748	0	748
Total Number of Bridge/Viaduct Crossings of FEMA Zone AE	Count	63	NA	63
Total Number of Bridge/Viaduct Crossings of FEMA Zone A	Count	126	NA	126
Utilities and Energy (Section 3.9)				
New Electric TPSS Connections	Count	13	0	13
Electric Utility Pole Adjustments	Count	85	0	85
Total Electric Connections and Adjustment	Count	98	0	98
Abandoned Oil and Gas Wells	Count	37	0	37

Source: AECOM 2019

[a] Threatened and Endangered Species acreages include habitat for species with modeled habitat (as detailed in **Section 3.6**) that may be impacted, including Houston toad, large-fruited sand verbena and Navasota ladies'-tresses. Threatened and endangered species in the Study Area that may be impacted but that do not have modeled habitat include the interior least tern and the whooping crane.

[b] A single landscape unit is shared between Segment 5 and the Houston Terminal Station Options; therefore, the total number of beneficial landscape units is the same as Build Alternative A.

[c] Totals for rail impacts do not include rail at Houston Terminal Stations. Totals also include DART-owned rail lines in Dallas County

[d] Road modifications reflect the number of reroutes, road adjustments, or road over rail constructions that would occur. Some roads are affected by multiple modifications (such as IH-45). Modifications do not reflect total number of roads but total number of road construction sites.

[e] Shared access roads are included in roadway modification lengths. Shared access roads will be developed to provide for maintenance, emergency response access and private property access with a corresponding reduction in the number of new public roads to decrease burden on roadway authorities. Shared access roads would be constructed and maintained by TCRR.

[f] Anxiety Aerodrome would be directly impacted by Segment 3B, which are part of Alternatives B and E

[g] Indirect impacts to special status farmland in **Section 3.13, Land Use** are defined as a 25-foot setback added to the LOD to account for indirect loss of productive farmland to accommodate the use of farm and ranch equipment or impacts such as induced wind and changes in irrigation.

[h] The "Community Facilities" category in **Section 3.14, Socioeconomics and Community Facilities**, encompasses categories of affected structures and facilities that are broken down into more defined categories within **Section 3.13, Land Use**, therefore values between the two sections are not identical. Refer to the Section for a complete definition of each category.

[i] Children's health and safety impacts are the result of temporary construction effects. These impacts will no longer exist once construction has ended.

[j] The Midlothian Quarry and Plant in Ellis County was identified at approximately one-half-mile west of Segment 2A. Exact limits would need to be field-verified to confirm or discount presence in the Study Area.

Table ES-21: Summary of Preferred Alternative Direct Impacts				
Evaluation Criteria	**Measure**	**Build Alternative A**	**Houston Northwest Mall Terminal Station Option**	**Total**
Aesthetics and Scenic Resources (Section 3.10)				
Total Number of Beneficial [b]	Count	2	1	2
Total Number of Neutral	Count	8	0	8
Total Number of Adverse	Count	2	0	2
Total Number of Adverse Visual Resource Impacts	Count	11	0	11
Transportation (Section 3.11)				
Rail Crossings [c]	Count	27	0	27
Road Modifications [d] (*Public and Private*)	Count	138	0	138
Road Modifications [e] (*Public only*)	Count	59	0	59
Length added to Public Roads (miles)	Miles	16.8	0	16.8
Length removed from Public Roads (miles)	Miles	5.1	0	5.1
Impacts to airports [f]	Count	0	0	0
Number of Intersections at LOS E or F	Count	NA	24	24
Elderly and Handicapped (Section 3.12)				
Elderly and Handicapped Impacts	NA	Project would be designed, constructed and operated in compliance with ADA; therefore, there would be no impacts related to accessibility of the HSR system for the elderly and handicapped.		
Land Use (Section 3.13)				
Existing Land Use Conversion – Temporary	Acres	2,553.4	27.4	2,580.8
Existing Land Use Conversion – Permanent	Acres	6,619.8	75.8	6,695.6
Special Status Farmland – Temporary	Acres	1,710.8	0.0	1,710.8
Special Status Farmland – Permanent	Acres	3,534.5	0.0	3,534.5
Special Status Farmland – Indirect [g]	Acres	847.5	0	847.5
Displacement – Commercial (primary)	Count	42	22	64

Source: AECOM 2019

[a] Threatened and Endangered Species acreages include habitat for species with modeled habitat (as detailed in **Section 3.6**) that may be impacted, including Houston toad, large-fruited sand verbena and Navasota ladies'-tresses. Threatened and endangered species in the Study Area that may be impacted but that do not have modeled habitat include the interior least tern and the whooping crane.

[b] A single landscape unit is shared between Segment 5 and the Houston Terminal Station Options; therefore, the total number of beneficial landscape units is the same as Build Alternative A.

[c] Totals for rail impacts do not include rail at Houston Terminal Stations. Totals also include DART-owned rail lines in Dallas County

[d] Road modifications reflect the number of reroutes, road adjustments, or road over rail constructions that would occur. Some roads are affected by multiple modifications (such as IH-45). Modifications do not reflect total number of roads but total number of road construction sites.

[e] Shared access roads are included in roadway modification lengths. Shared access roads will be developed to provide for maintenance, emergency response access and private property access with a corresponding reduction in the number of new public roads to decrease burden on roadway authorities. Shared access roads would be constructed and maintained by TCRR.

[f] Anxiety Aerodrome would be directly impacted by Segment 3B, which are part of Alternatives B and E

[g] Indirect impacts to special status farmland in **Section 3.13, Land Use** are defined as a 25-foot setback added to the LOD to account for indirect loss of productive farmland to accommodate the use of farm and ranch equipment or impacts such as induced wind and changes in irrigation.

[h] The "Community Facilities" category in **Section 3.14, Socioeconomics and Community Facilities**, encompasses categories of affected structures and facilities that are broken down into more defined categories within **Section 3.13, Land Use**, therefore values between the two sections are not identical. Refer to the Section for a complete definition of each category.

[i] Children's health and safety impacts are the result of temporary construction effects. These impacts will no longer exist once construction has ended.

[j] The Midlothian Quarry and Plant in Ellis County was identified at approximately one-half-mile west of Segment 2A. Exact limits would need to be field-verified to confirm or discount presence in the Study Area.

Table ES-21: Summary of Preferred Alternative Direct Impacts				
Evaluation Criteria	**Measure**	**Build Alternative A**	**Houston Northwest Mall Terminal Station Option**	**Total**
Displacement – Residence (primary)	Count	235	0	235
Displacement – Community Facilities (primary) [h]	Count	2	0	2
Estimated Permanent Parcel Acquisitions	Count	1,731	40	1,771
Estimated Temporary Parcel Acquisitions	Count	272	1	273
Estimated Structure Acquisitions – Agriculture	Count	196	0	196
Estimated Structure Acquisitions – Commercial	Count	12	1	13
Estimated Structure Acquisitions – Community Facilities	Count	0	0	0
Estimated Structure Acquisitions – Cultural/Civic Resources	Count	2	0	2
Estimated Structure Acquisitions – Oil and Gas	Count	12	0	12
Estimated Structure Acquisitions – Residence	Count	49	0	49
Estimated Structure Acquisitions – Transportation and Utilities	Count	0	0	0
Socioeconomics and Community Facilities (Section 3.14)				
Communities with Disrupted Character and Cohesion	Count	4	0	4
Economic Impacts	NA	Positive		
Employment	Job Years	317,207		
Earnings	2019 billions	$14.50		
Tax Revenue	NA	Positive		
Children's Health and Safety [i]	Count	0	0	0
Community Facilities [h]	Count	5	0	5
Electromagnetic Fields (Section 3.15)				
EMF Impacts	NA	No electromagnetic interference (EMI) or adverse EMF exposure would occur from the Project.		

Source: AECOM 2019

[a] Threatened and Endangered Species acreages include habitat for species with modeled habitat (as detailed in **Section 3.6**) that may be impacted, including Houston toad, large-fruited sand verbena and Navasota ladies'-tresses. Threatened and endangered species in the Study Area that may be impacted but that do not have modeled habitat include the interior least tern and the whooping crane.

[b] A single landscape unit is shared between Segment 5 and the Houston Terminal Station Options; therefore, the total number of beneficial landscape units is the same as Build Alternative A.

[c] Totals for rail impacts do not include rail at Houston Terminal Stations. Totals also include DART-owned rail lines in Dallas County

[d] Road modifications reflect the number of reroutes, road adjustments, or road over rail constructions that would occur. Some roads are affected by multiple modifications (such as IH-45). Modifications do not reflect total number of roads but total number of road construction sites.

[e] Shared access roads are included in roadway modification lengths. Shared access roads will be developed to provide for maintenance, emergency response access and private property access with a corresponding reduction in the number of new public roads to decrease burden on roadway authorities. Shared access roads would be constructed and maintained by TCRR.

[f] Anxiety Aerodrome would be directly impacted by Segment 3B, which are part of Alternatives B and E

[g] Indirect impacts to special status farmland in **Section 3.13, Land Use** are defined as a 25-foot setback added to the LOD to account for indirect loss of productive farmland to accommodate the use of farm and ranch equipment or impacts such as induced wind and changes in irrigation.

[h] The "Community Facilities" category in **Section 3.14, Socioeconomics and Community Facilities**, encompasses categories of affected structures and facilities that are broken down into more defined categories within **Section 3.13, Land Use**, therefore values between the two sections are not identical. Refer to the Section for a complete definition of each category.

[i] Children's health and safety impacts are the result of temporary construction effects. These impacts will no longer exist once construction has ended.

[j] The Midlothian Quarry and Plant in Ellis County was identified at approximately one-half-mile west of Segment 2A. Exact limits would need to be field-verified to confirm or discount presence in the Study Area.

Table ES-21: Summary of Preferred Alternative Direct Impacts				
Evaluation Criteria	**Measure**	**Build Alternative A**	**Houston Northwest Mall Terminal Station Option**	**Total**
Safety and Security (Section 3.16)				
Permanent Road Modifications resulting in 1 minute or more in additional through travel time	Count	12	0	12
Permanent Road Modifications reducing through travel time by 1 minute or more	Count	0	0	0
Total fire and EMS service areas bisected by construction	Count	56	0	56
Fire and EMS providers with high potential for construction effects	Count	3	0	3
Fire and EMS providers with localized potential for construction effects	Count	8	0	8
Recreational Facilities (Section 3.17)				
Parks	Count	0	0	0
Environmental Justice (Section 3.18)				
Number of Minority and/or Low-Income block groups intersected by the Study Area	Count	80	7	87
Number of all block groups intersected by the Study Area	Count	118	11	129
Identified Minority and/or Low-Income Communities	Count	5	1	5
Disproportionately High and Adverse Impact to Minority and/or Low-Income Communities	NA	No	No	No
Cultural Resources (Section 3-19)				
Adverse Impacts to Historic Properties	Count	14	0	14

Source: AECOM 2019

[a] Threatened and Endangered Species acreages include habitat for species with modeled habitat (as detailed in **Section 3.6**) that may be impacted, including Houston toad, large-fruited sand verbena and Navasota ladies'-tresses. Threatened and endangered species in the Study Area that may be impacted but that do not have modeled habitat include the interior least tern and the whooping crane.

[b] A single landscape unit is shared between Segment 5 and the Houston Terminal Station Options; therefore, the total number of beneficial landscape units is the same as Build Alternative A.

[c] Totals for rail impacts do not include rail at Houston Terminal Stations. Totals also include DART-owned rail lines in Dallas County

[d] Road modifications reflect the number of reroutes, road adjustments, or road over rail constructions that would occur. Some roads are affected by multiple modifications (such as IH-45). Modifications do not reflect total number of roads but total number of road construction sites.

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[f] Anxiety Aerodrome would be directly impacted by Segment 3B, which are part of Alternatives B and E

[g] Indirect impacts to special status farmland in **Section 3.13, Land Use** are defined as a 25-foot setback added to the LOD to account for indirect loss of productive farmland to accommodate the use of farm and ranch equipment or impacts such as induced wind and changes in irrigation.

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[i] Children's health and safety impacts are the result of temporary construction effects. These impacts will no longer exist once construction has ended.

[j] The Midlothian Quarry and Plant in Ellis County was identified at approximately one-half-mile west of Segment 2A. Exact limits would need to be field-verified to confirm or discount presence in the Study Area.

Table ES-21: Summary of Preferred Alternative Direct Impacts

Evaluation Criteria	Measure	Build Alternative A	Houston Northwest Mall Terminal Station Option	Total
Soils and Geology (Section 3.20)				
LOD Area	Acres	9,173.4	103.9	9,277.3
Shrink-Swell Potential – Low	Acres	2,593.6	0	2,594.6
Shrink-Swell Potential – Moderate	Acres	1,458.4	19.2	1,477.6
Shrink-Swell Potential – High	Acres	2,284.0	0	2,284.0
Shrink-Swell Potential – Very High	Acres	2,727.9	0	2,728.9
Erosion Potential – Low	Acres	1,611.6	0	1,612.6
Erosion Potential – Moderate	Acres	4,511.2	3.2	4,514.4
Erosion Potential – High	Acres	2,963.5	16.2	2,979.7
Corrosion Potential – Low	Acres	55.3	0	55.3
Corrosion Potential – Moderate	Acres	2,204.8	0	2,205.8
Corrosion Potential – High	Acres	6,824.5	19.4	6,844.9
Prime Farmland Soils	Acres	5,245.3	0	5,245.3
Surface Mines[j]	Count	0 [a]	0	0 [a]
Green House Gas Emissions (Section 3.21)				
GHG Emissions	NA	No long-term increases in GHG emissions, the Project would likely reduce GHG emissions by shifting the modes of travel		

Source: AECOM 2019

[a] Threatened and Endangered Species acreages include habitat for species with modeled habitat (as detailed in **Section 3.6**) that may be impacted, including Houston toad, large-fruited sand verbena and Navasota ladies'-tresses. Threatened and endangered species in the Study Area that may be impacted but that do not have modeled habitat include the interior least tern and the whooping crane.

[b] A single landscape unit is shared between Segment 5 and the Houston Terminal Station Options; therefore, the total number of beneficial landscape units is the same as Build Alternative A.

[c] Totals for rail impacts do not include rail at Houston Terminal Stations. Totals also include DART-owned rail lines in Dallas County

[d] Road modifications reflect the number of reroutes, road adjustments, or road over rail constructions that would occur. Some roads are affected by multiple modifications (such as IH-45). Modifications do not reflect total number of roads but total number of road construction sites.

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[g] Indirect impacts to special status farmland in **Section 3.13, Land Use** are defined as a 25-foot setback added to the LOD to account for indirect loss of productive farmland to accommodate the use of farm and ranch equipment or impacts such as induced wind and changes in irrigation.

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[j] The Midlothian Quarry and Plant in Ellis County was identified at approximately one-half-mile west of Segment 2A. Exact limits would need to be field-verified to confirm or discount presence in the Study Area.

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Dallas to Houston High-Speed Rail
Final Environmental Impact Statement

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Appendices

List of Tables

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List of Acronyms

$\mu g/m^3$	micrograms per cubic meter
µT	microTesla
AAI	All Appropriate Inquiries
AASHTO	American Association of State Highway and Transportation Officials
ACHP	Advisory Council of Historic Preservation
ACS	American Community Survey
ADA	Americans with Disabilities Act of 1990
AEP	Annual Exceedance Probability
AIS	Aquatic Invasive Species
AMSL	Above Mean Sea Level
ANSI	American National Standards Institute
APE	Area of Potential Effect
APTA	American Public Transportation Association
ARB	Air Resources Board
ARPA	Archeological Resources Protection Act
ARRA	American Reinvestment and Recovery Act of 2009
AST	Aboveground Storage Tank
ATC	Automatic Train Control
ATF	Bureau of Alcohol, Tobacco, Firearms, and Explosives
ATP	Auto Transformer Post
AU ID	Assessment Unit Identification
AU	Assessment unit
BA	Bardwell
BA	Biological Assessment
BCC	Bridge Class Culvert
BEA	United States Bureau of Economic Analysis
BLS	Bureau of Labor Statistics
BMP	Best Management Practice
BO	Biological Opinion
BOEM	Bureau of Ocean Energy Management
BTU	British Thermal Unit
BVCOG	Brazos Valley Council of Governments
C.F.R.	Code of Federal Regulations
CAFE	Corporate Average Fuel Economy
CCN	Certificate of Convenience and Necessity
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CH	Communication House
CH_4	Methane
CM	Compliance Measure
CNN	Certificate of Convenience and Necessity
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalents
CR	County Road
CSA	Combined Statistical Area

CTS	Community Transit Service, Inc.
CWA	Clean Water Act
DA	Department of the Army
DAL	Dallas Love Field
DART	Dallas Area Rapid Transit
dB	decibels
dBA	A-weighting system
DDI	Downtown Dallas, Inc.
DEA	Drug Enforcement Administration
DEM	Digital Elevation Model
DFIRM	Digital Flood Insurance Rate Map
DFW	Dallas/Fort Worth
DFW	Dallas-Fort Worth International Airport
DH	Downtown Houston
DNPL	Delisted National Priorities List
DO	Dissolved Oxygen
DOI	United States Department of Interior
ECOS	Environmental Conservation Online System
EF	Emission Factor
EIA	United States Energy Information Administration
EIS	Environmental Impact Statement
EJ	Environmental Justice
EM	Electromagnetic
EMF	Electromagnetic Field
EMI	Electromagnetic Interference
EMP	Emergency Management Plan
EMS	Emergency Medical Services
EMST	Ecological Mapping Systems of Texas
EMU	Evaluation Mapping Unit
EO	Executive Order
EOR	Elements of Occurrence
EPA	United States Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ERCOT	Electric Reliability Council of Texas
ERMSA	Emergency Response and Maintenance Staging Area
ESA	Environmental Site Assessment
F	Fahrenheit
FAA	Federal Aviation Administration
FBI	Federal Bureau of Investigation
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FM	Farm to Market
FRA	Federal Railroad Administration
FRE	Freestone County
FTA	Federal Transit Administration

GC	General Conformity
GCD	Groundwater Conservation District
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GHz	gigahertz
GIS	Geographic Information System
GLO	Texas General Land Office
gm	grams
GMR	Global Medical Response
GWP	Global Warming Potential
HABS	Historic American Building Survey
HAER	Historic American Engineering Record
HALS	Historic American Landscapes Survey
HAZMAP	Hazard Mitigation Action Plan
HC	Hockley
HCFC	Hydrochlorinated Fluorocarbon
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
HOTCOG	Heart of Texas Council of Governments
HOTRTD	Heart of Texas Rural Transit District
HOU	Houston Hobby Airport
HOV	High-Occupancy Vehicle
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
IAH	Houston George Bush Intercontinental Airport
ICE	Immigrations and Customs Enforcement
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IEEE	Institute of Electrical and Electronics Engineers
IF	Isolated Find
IH	Interstate Highway
IHW	Industrial Hazardous Waste
IPaC	Information for Planning and Conservation
ISA	Initial Site Assessment
ISD	Independent School District
ISH	Intermediate Signal House
ITL	Integrated Texas Logistics, Inc.
JRC	Central Japan Railway Company
KBHCCD	Kay Bailey Hutchison Convention Center Dallas
kHz	kilohertz
km/h	kilometers per hour

kV	kilovolt
KVP	Key Viewpoint
Ldn	Day-Night Sound Level
LEDPA	Least Environmentally Damaging Practicable Alternative
LEED	Leadership in Energy and Environmental Design
LEP	Limited English Proficiency
Leq	"equivalent" sound level
LID	Low Impact Development
LOD	Limit of Disturbance
LOS	Level of Service
LPST	Leaking Petroleum Storage Tank
LWCF	Land and Water Conservation Fund
MAP ID	Map Identification Number
MBTA	Migratory Bird Treaty Act of 1918
MD	Middle
METRO	Houston Metro
mG	milligauss
mg/L	milligrams per liter
mg/m^3	milligrams per cubic meter
mgd	million gallons per day
MHz	megahertz
MM	Mitigation Measure
MMBtu	Million British thermal unit
MMI	Modified Mercalli Intensity
MOA	Memorandum of Agreement
MOVES	Motor Vehicle Emission Simulator
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 Designation
MSH	Main Signal House
MTFP	Houston Major Thoroughfare and Freeway Plan
MTP	Metropolitan Transportation Plan
MUTCD	Manual on Uniform Traffic Control Devices
MW	megawatts
mW/cm^2	milliwatts per square centimeter
MWh	megawatt hours
N_2O	Nitrous Oxide
NAA	Nonattainment Area
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NCHRP	National Cooperative Highway Research Program
NCTCOG	North Central Texas Council of Governments
NDMS	National Disaster Medical System
NEPA	National Environmental Policy Act

NFPA	National Fire Protection Association
NGA	National Gas Act
NHD	National Hydrography Dataset
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NLCD	National Land Cover Dataset
NO_2	Nitrogen Dioxide
NOA	Notice of Availability
NOAA	National Oceanic Atmospheric Association
NOI	Notice of Intent
NOV	Notice of Violation
NO_x	Nitrogen Oxide
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPRM	Notice of Proposed Rulemaking
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NTIS	National Technical Information Service
NWI	National Wetlands Inventory
O_3	Ozone
OCS	Overhead Catenary System
OH	Overhead
OSHA	Occupational Safety and Health Administration
OTHM	Official Texas Historic Marker
PA	Programmatic Agreement
Pb	lead
PCB	Polychlorinated Biphenyl
PFC	Perfluorinated Compound
PHMSA	Pipeline and Hazardous Materials Safety Administration
PM	Particulate Matter
PMT	Passenger-Mile Traveled
ppb	parts per billion
ppm	parts per million
PPV	Peak Particle Velocity
PRIIA	Passenger Rail Investment and Improvement Act
PST	Petroleum Storage Tank
PTC	Positive Train Control
PTCEI	Positive Train Control Enforcement and Implementation
PUCT	Public Utilities Commission of Texas
RCRA	Resource Conservation and Recovery Act
RFQ	Request for Qualifications
RIMSII	Regional Input-Output Modeling System
RNT	Rail Neutral Temperature
ROD	Record of Decision
ROW	Right-of-Way
RPA	Rule of Particular Applicability
RPZ	Runway Protection Zone

RRIF	Railroad Rehabilitation and Improvement Financing
RSIA	Rail Safety Improvement Act
RTEST	Rare, Threatened and Endangered Species of Texas
RTHL	Recorded Texas Historic Landmark
RTP	Regional Transportation Plan
SAL	State Antiquities Landmark
SEL	Sound Exposure Level
SFHA	Special Flood Hazard Areas
SGCN	Species of Greatest Conservation Need
SH OSR	State Highway – Old San Antonio Road
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SO_2	Sulfur Dioxide
SP	Sectioning Post
SPCC	Spill Prevention, Control, and Countermeasure
SSH	Sub-signal House
SSP	Sub-Sectioning Post
SSURGO	Soil Survey Spatial and Tabular Data
ST	Short-Term Noise Monitoring Site
START	Study of Terrorism and Responses to Terrorism
STATSGO2	U.S. General Soil Map by State
STB	Surface Transportation Board
SUD	Special Utility District
SVOC	Semi Volatile Organic Compound
SWA	Southwest Airlines
SWPPP	Storm Water Pollution Prevention Plan
TAC	Texas Administrative Code
TARL	Texas Archeological Research Laboratory
TAS	Texas Accessibility Standards
TASA	Texas Archeological Sites Atlas
TCEQ	Texas Commission on Environmental Quality
TCP	Texas Central Partners, LLC
TCP	Traditional Cultural Property
TCR	Texas Central High-Speed Railway, LLC
TCRH	Texas Central Rail Holdings, LLC
TCRI	Texas Central Railroad & Infrastructure, Inc.
TCRR	Texas Central Railroad, LLC
TDEM	Texas Division of Emergency Management
TDS	Total Dissolved Solids
TERP	Texas Emissions Reduction Plan
TEXU	Texas Utilities General Company
THC	Texas Historical Commission
THPO	Tribal Historic Preservation Office
THSRA	Texas High Speed Rail Authority
TIA	Traffic Impact Analysis
TIFIA	Transportation Infrastructure Finance and Improvement Act
TIP	Transportation Improvement Plan
TMDL	Total Maximum Daily Load

TMF	Trainset Maintenance Facility
TOD	Transit Oriented Development
TOPRS	Texas-Oklahoma Passenger Rail Study
TPDES	Texas Pollutant Discharge Elimination System
TPSS	Traction Power Substation
TPWD	Texas Parks and Wildlife Department
TRE	Trinity Railway Express
TSA	Transportation Security Administration
TSHA	Texas State Historical Association
TSS	Total Suspended Solids
TUEX	TU Electric Big Brown Steam Electric Station Rail
TWDB	Texas Water Development Board
TxDOT	Texas Department of Transportation
TxLED	Texas Low Emission Diesel Fuel
TXNDD	Texas Natural Diversity Database
TxWRAP	Texas A&M Wildlife Risk Assessment Portal
U.S.	United States Highway
U.S.C.	United States Code
UG	Underground
UPRR	Union Pacific Railroad
USACE	United States Army Corps of Engineers
USBM	United States Bureau of Mines
USCB	United States Census Bureau
USDA	United States Department of Agriculture
USDOT	United States Department of Transportation
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UST	Underground Storage Tank
V/m	volts per meters
VdB	vibration decibels
VFD	Volunteer Fire Department
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Compound
WMA	Wildlife Management Area
WPA	Works Progress Administration
WWTP	Wastewater Treatment Plant

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1.0 INTRODUCTION

The United States Department of Transportation's (USDOT) Federal Railroad Administration (FRA) prepared this Environmental Impact Statement (EIS) in compliance with the National Environmental Policy Act of 1969 (NEPA).[1] This EIS assesses the potential beneficial and adverse environmental impacts of FRA's proposed rulemaking to enable effective safety oversight of the operation of a high-speed passenger rail (HSR) system based on the Japanese N700-Series Tokaido Shinkansen technology that is described in a Petition for Rulemaking for a Rule of Particular Applicability (RPA) submitted by Texas Central Railroad, LLC (TCRR). TCRR's petition for rulemaking contains TCRR's proposal to construct and operate an approximately 240-mile, for-profit HSR system connecting Dallas and Houston based on the Japanese N700-Series Tokaido Shinkansen technology (the Project). In addition to the purpose of and need for the Project, this chapter discusses the Project background and history, and outlines the organization of this EIS.

This EIS evaluates and documents the potential environmental impacts of FRA's proposed action as required by NEPA, Council on Environmental Quality (CEQ) NEPA regulations[2] and FRA's *Procedures for Considering Environmental Impacts*.[3] FRA is the lead agency for the preparation of this EIS, in cooperation with the United States Environmental Protection Agency (EPA), the Federal Highway Administration (FHWA), the Federal Transit Administration (FTA), the Surface Transportation Board (STB), the United States Army Corps of Engineers (USACE) and the 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 entities that were identified and coordinated with during the EIS process, as detailed in **Chapter 9.0, Public and Agency Involvement**.

FRA has broad authority to prescribe regulations and issue orders, as necessary, for every area of railroad safety.[5] FRA's existing regulations do not adequately address the safety concerns and operational characteristics of the HSR system proposed by TCRR. Therefore, FRA has proposed minimum federal safety standards through an RPA (regulations that apply to a specific railroad or a specific type of operation) to ensure the TCRR's proposed system is operated safely. This regulatory action constitutes a major federal action and triggers the environmental review under NEPA.[6]

Passenger Rail Categories[4]

Up to 125 miles per hour (mph) – Tier I trains are those operating in shared rights of way (ROW) at speeds not exceeding 125 mph.

Between 125 and 160 mph – Tier II trains are those operating at higher speed than 125 mph but not exceeding 160 mph.

Up to 220 mph – Tier III trains are those operating at high speed in exclusive ROW without grade crossings. Tier III trains may utilize existing infrastructure at speeds not exceeding 125 mph.

Additionally, TCRR (including its affiliated companies) may pursue financial assistance from USDOT, including, but not limited to, a direct loan under the Railroad

[1] 42 United States Code (U.S.C.) 4321 et seq.
[2] 40 Code of Federal Regulations (C.F.R.) 1500-1508.
[3] 64 Federal Register 28545 (May 26, 1999) as updated in 78 Federal Register 2713 (January 14, 2013).
[4] 49 C.F.R. 238.5.
[5] 49 U.S.C. 20101 et seq.; 49 C.F.R. 1.89, Parts 200-299.
[6] A major federal action, as defined by 40 C.F.R. 1508.18, includes actions with effects that may be major and that are potentially subject to federal control and responsibility.

Rehabilitation and Improvement Financing (RRIF) Loan Program,[7] credit assistance under the Transportation Infrastructure Finance and Improvement Act of 1998 (TIFIA)[8] or other federal assistance to finance a portion of the Project. Should USDOT provide credit or other financial assistance, such activity would also constitute a major federal action.

Texas Central Partners, LLC (TCP) and its affiliated/subsidiary entities, as detailed in **Table 1-1**, are collectively referred to as “Texas Central.” Together, they are responsible for Project development and implementation (i.e., design, construction, financing and operation). TCRR is a private Texas-based company and a wholly owned subsidiary of Texas Central Rail Holdings, LLC (TCRH), which, in turn, is a wholly owned subsidiary of TCP, a Delaware limited liability company. Other wholly owned subsidiaries of TCRH include Texas Central Railroad & Infrastructure, Inc. (TCRI) and Integrated Texas Logistics, Inc. (ITL).

TCRR submitted a petition for an RPA to FRA (discussed further in **Section 1.1.2.1, Rule of Particular Applicability**). As the entity responsible for the petition for an RPA, TCRR is specifically identified as the Project Proponent throughout this EIS. The Project Proponent (or applicant) is the entity proposing a major federal action subject to NEPA and seeking federal regulatory approvals for the Project. TCRR is assisting with the planning and coordinating with FRA for the NEPA compliance for the Project, which would include a Record of Decision (ROD) for the EIS, and related permits.

Table 1-1: Texas Central and Affiliates/Subsidiaries [a]

Company		Role
Texas Central Partners, LLC	TCP	Parent company and a Delaware limited liability company
Texas Central Rail Holdings, Inc.	TCRH	Wholly owned subsidiary of TCP with overall responsibility for the Project’s development and implementation
Texas Central Railroad, LLC [b]	TCRR	• Project Proponent as defined by NEPA • Wholly owned subsidiary of TCRH • Submitted petition for the Rule of Particular Applicability to FRA • Submitted petitions jointly with TCRI to the STB • Submitted permit applications to USACE • Will be the entity with TCRI responsible for operation and maintenance of the railroad after placement into revenue service • Incorporated as a railroad and registered as such with the Texas Comptroller of Public Accounts
Texas Central Railroad & Infrastructure, Inc.	TCRI	• Wholly owned subsidiary of TCRH • Submitted petitions jointly with TCRR to the STB • Responsible for acquisitions of land and property required to comprise the limits of disturbance (LOD) and support TCRH in delivery of the Project • Will be the entity with TCRR responsible for operation and maintenance of the railroad after placement into revenue service • Incorporated as a railroad and registered as such with the Texas Comptroller of Public Accounts
Integrated Texas Logistics, Inc.	ITL	• Wholly owned subsidiary of TCRH • Responsible to support TCRH in delivery of the Project • Acting as signatory to agreement with project management consultant • Incorporated as a railroad and registered as such with the Texas Comptroller of Public Accounts

[7] 45 U.S.C. 821 et seq.
[8] 23 U.S.C. 601-609.

Table 1-1: Texas Central and Affiliates/Subsidiaries [a]		
Company		**Role**
Texas Central Infrastructure, LLC	TCI	• Wholly-owned subsidiary of TCRH • Will be signatory to main design-build contracts used to deliver Project and services contract(s) for operation and maintenance of railroad after placement into revenue service

[a] Responsible for Project development and implementation (i.e., design, construction, financing and operation).

[b] Texas Central High-Speed Railway, LLC (TCR) initially promoted the development of the Project. The roles and responsibilities of TCR have been assumed by TCRR.

1.1 Project History and Federal Involvement

1.1.1 Project History

The U.S.-Japan High-Speed Rail, LLC, a transportation service company, 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. JRC's investment corridor analysis, completed in 2009, evaluated 97 city pairs nationwide to determine an optimal location within the United States for implementation of the N700-Series Tokaido Shinkansen HSR system with minimal modifications. JRC's privately funded analysis identified Dallas to Houston as the most viable HSR city pair in the United States. 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, Texas Central was formed to promote the development and operation of a private, for-profit, reliable HSR system connecting Dallas to Houston. Texas Central developed preliminary engineering reports and other studies to evaluate technical challenges, practicability and the extent of any environmental "fatal flaws." Based on this analysis, Texas Central determined the Project was viable and initiated preparatory work 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 Dallas-Fort Worth (DFW) Metroplex and Houston. Prior to initiating the work, Texas Central 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.[9]

1.1.2 U.S. Department of Transportation

FRA, a USDOT operating administration, is the lead agency for the preparation of this EIS for the Project. This EIS may be used by FRA, USDOT, or other USDOT operating administrations to satisfy those entities' obligations to comply with NEPA, should they take action with regard to this Project. This EIS may also

[9] Refer to FRA's website for the current status of the Dallas to Fort Worth Core Express-Passenger Service project at https://www.permits.performance.gov/permitting-projects/dallas-fort-worth-core-express-service.

be used by other federal agencies to satisfy those entities' obligations to comply with NEPA, should they take action with regard to this Project.

1.1.2.1 Rule of Particular Applicability

As stated previously, FRA's existing regulations do not adequately address the safety concerns presented by the Project's proposed system. Therefore, TCRR cannot operate the system without FRA regulatory action.[10] Generally, during its rulemaking process, including for an RPA, 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, or in response to a rulemaking petition).
2. Developing the proposed rule.
3. Publishing the Notice of Proposed Rulemaking (NPRM) in the Federal Register and soliciting public comment.
4. Evaluating written comments from the public and, if a public hearing is convened, comments made during a public hearing on the NPRM.
5. Developing the Final Rule.
6. Publishing the Final Rule in the Federal Register.

Information on FRA's rulemaking process can be found online at https://railroads.dot.gov/legislation-regulations/regulations-rulemaking/regulations-rulemaking.

To establish minimum safety requirements for the Project, on April 15, 2016, after extensive consultation with FRA's Office of Railroad Safety, TCRR submitted a rulemaking petition to FRA for an RPA, a regulation that applies to its specific railroad operation. TCRR updated its petition in subsequent submittals on August 12 and 16, 2016, with updated vehicle track interaction information. On September 27, 2017, TCRR provided an updated petition, combining previous supplementals and superseding all previous submittals (see Docket Number FRA-2019-0068).[11] FRA granted TCRR's rulemaking petition on August 30, 2019. On March 10, 2020, FRA published an NPRM proposing a set of minimum federal safety standards to enable effective safety oversight of the operation of TCRR's HSR system within the United States (see 85 Federal Register 14036 [March 10, 2020]).[12]

On March 10, 2020, FRA published the NPRM in the Federal Register opening the comment period for the public to provide comments on the proposed technical safety requirements. In addition, FRA held three telephonic public hearings on Monday, May 4 through Wednesday, May 6, 2020. Each meeting offered telephone attendees the opportunity to provide oral comments on the NPRM. As of the execution of this Final EIS on May 15, 2020, oral comments made during the public hearings and written comments submitted to the Docket[13] have raised no new substantive issues relevant to environmental concerns from those received during the public comment period of the Draft EIS (discussed in **Section 9.6.2, Public and Agency Involvement, Draft EIS Comment Period** and **Appendix H, Response to Draft EIS Comments**) or on topics not already covered within this Final EIS. FRA will continue to evaluate comments received during the comment period for the Proposed Rulemaking. FRA will address comments on technical safety requirements proposed in the NPRM in the Final Rule, which will be published in the Federal Register.

[10] TCRR will need to demonstrate compliance with the requirements of the RPA and other applicable FRA requirements in order to operate the system.

[11] Available at https://www.regulations.gov/docket?D=FRA-2019-0068.

[12] TCRR's rulemaking petition was for a rule for the Dallas to Houston FRA's proposed rule.

[13] As of May 15, 2020, 221 comments were submitted within the public comment period for the Proposed Rule Making to https://www.regulations.gov/docketBrowser?rpp=25&so=DESC&sb=commentDueDate&po=0&D=FRA-2019-0068

1.1.2.2 USDOT Credit or Financial Assistance

As previously noted, TCRR (including its affiliated companies) may pursue financial assistance from the USDOT, including, but not limited to, a direct loan through the RRIF or TIFIA programs to finance a portion of the Project. These are the two primary credit programs maintained by USDOT and are overseen by the Build America Bureau (the Bureau). Should USDOT provide credit or financial assistance to the Project, this activity would constitute a major federal action. Should TCRR receive financial assistance from USDOT, additional federal requirements attached to the provision of federal funds or financial assistance, including domestic buying preferences, prevailing wage laws, employee protections, and property acquisition standards, may apply to the Project.

Through the TIFIA program, USDOT 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, USDOT 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, USDOT has authority to allocate private activity bonds for qualified surface transportation projects. A USDOT private activity bond allocation provides private developers and operators with access to tax-exempt interest rates for bonds issued for these types of projects.

1.1.3 Roles of Cooperating Agencies

The following are cooperating agencies in accordance with 40 C.F.R. 1501.6: USACE, EPA, USFWS, FHWA, FTA, and STB. More information about the permitting roles of cooperating and other agencies can be found in **Chapter 8.0, Applicable Federal, State and Local Permits and Approvals**.

1.1.3.1 U.S. Army Corps of Engineers

USACE is not a proponent or opponent of the Project. As a cooperating agency and as part of its permitting process, USACE intends to use this EIS to the maximum extent practicable to address the USACE's evaluation of Department of the Army (DA) permits and decisions regarding impacts to wetlands and waters of the U.S. in accordance with Section 404 of the Clean Water Act (CWA)[14] and Section 10 of the Rivers and Harbors Act of 1899.[15] In addition to its public interest evaluation and determination, USACE is required to conclude whether the applicant's proposal is the least environmentally damaging practicable alternative (LEDPA) in association with CWA Section 404(b)(1) guidelines. USACE shall use this EIS and its appendices as a base document for its review and supplemental analysis of USACE impacts. Additionally, 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 USACE's permitting role on the Project. TCRR submitted permit applications under Section 404 and Section 10 as applicable to USACE for review on October 16, 2017. TCRR submitted a request for permission to alter, occupy or use

[14] 33 U.S.C. 1344.
[15] 33 U.S.C. 403.

the Dallas Floodway, a federally authorized civil works project, under Section 408 on February 2, 2018. The USACE federal actions are separate from FRA's issuance of an RPA and any other federal action for the Project. USACE will complete additional analyses to support its review of TCRR's permit applications and request independently of this EIS. This includes the preparation of any supplemental environmental analysis for compliance with NEPA and consultation with the FRA under Section 106 of the National Historic Preservation Act of 1966 (NHPA)[16].

Additional USACE analyses and associated environmental documentation will be completed in conjunction with FRA's NEPA review. The public notices for USACE's review of TCRR's permit applications were initially issued on December 22, 2017, and are available for review at https://www.swf.usace.army.mil/Media/Public-Notices/Article/1402533/swf-2011-00483-dallas-to-houston-high-speed-rail/ and https://www.swg.usace.army.mil/Media/Public-Notices/Article/1403447/swg-2014-00412-texas-central-railroad-llc-various-wetlands-and-waterbodies-wall/. Subsequent public notices were released by the Fort Worth and Galveston Districts on March 31, 2020, and are available for review at https://www.swf.usace.army.mil/Media/Public-Notices/Article/2130238/dallas-to-houston-high-speed-rail-project/ and https://www.swg.usace.army.mil/Media/Public-Notices/Article/2131827/swg-2014-00412-texas-central-railroad-llc-various-wetlands-and-waterbodies-wall/.

1.1.3.2 Surface Transportation Board

STB regulates and resolves disputes involving railroad rates, railroad mergers or sales, new rail line construction, abandonments, and certain other transportation matters involving interstate rail operations. STB also has certain regulatory authority over Amtrak passenger rail.[17] The agency has discretion to tailor its regulatory approach to meet changing transportation needs.

In April 2016, TCRI and TCRR, affiliates of Texas Central as shown in **Table 1-1**, 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 its deliberation of Texas Central's petitions, STB accepted FRA's invitation to serve as a cooperating agency.

On July 18, 2016, STB dismissed Texas Central's proceedings for lack of jurisdiction, "as [the Project] would be constructed and operated entirely within the State of Texas and would not be part of the interstate rail network."[18] On May 4, 2018, TCRI and TCRR submitted a petition to STB to reopen the proceedings based on updated agreements between Texas Central and Amtrak. These agreements and anticipated related operations are discussed further in **Section 2.2.5, Alternatives Considered, Proposed HSR Operations**. On June 20, 2019, STB issued a decision directing TCRR to provide additional information for consideration to reopen the petition.[19] TCRI and TCRR responded to STB's request on August 21, 2019.

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[16] 16 U.S.C. 470.

[17] STB, *FY 2017 Annual Report*, February 2018, https://prod.stb.gov/wp-content/uploads/files/docs/annualReports/Annual%20Report%202017.pdf.

[18] STB, "Surface Transportation Board Decision Document," July 18, 2016, https://www.stb.gov/decisions/readingroom.nsf/WEBUNID/33B41339BCCF056B85257FF4006D67E0?OpenDocument.

[19] STB, "Surface Transportation Board Decision Document," June 20, 2019, https://www.stb.gov/decisions/readingroom.nsf/9855c1fb354da09b85257f1f000b5f79/4dc7af731266efdf8525841f0069ff47?OpenDocument.

As of this EIS, STB has not issued a ruling on TCRI and TCRR's petition to reopen. STB's most recent decision[20] and the current status of the proceedings can be found online at www.stb.gov under docket number FD_36025_0. STB may use this EIS to support its compliance with NEPA should it undertake a major federal action relating to the Project.

1.1.3.3 Other Cooperating Agencies

EPA has special expertise in regard to the CWA,[21] the Rivers and Harbors Act of 1899[22] and the Clean Air Act of 1970.[23]

FHWA has an approval role related to certain road crossings or construction within federal ROW. This would include the Project's proposed rail-over-road crossings of six highways (IH-20, US 79, US 287, US 84, US 190 and US 290) and potential impacts associated with IH-45 frontage roads and access ramps. In Texas, FHWA has assigned its NEPA-related responsibilities to TxDOT under the Surface Transportation Project Delivery Program, commonly known as "NEPA Assignment".[24] As stated previously, TxDOT provided technical assistance to FRA in an advisory capacity throughout the preparation of the EIS, based on the agency's experience in conducting environmental reviews of transportation projects in Texas.

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

USFWS has an approval role related to protected and endangered species and suitable habitat under the Endangered Species Act of 1973 as amended,[25] the Migratory Bird Treaty Act of 1918[26] and the Bald and Golden Eagle Protection Act of 1972.[27] On November 14, 2019, FRA submitted a Biological Assessment (BA) to USFWS as part of formal consultation under Section 7(a)(2) of the Endangered Species Act of 1973. USFWS is currently reviewing the BA and will be issuing a Biological Opinion (BO) for the Project.

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

The following sections describe the purpose of 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, Alternatives Considered**) and Houston Terminal Station options, and is one of the factors considered in identifying a Preferred Alternative. The purpose and need also provides the basis for identifying, evaluating and comparing the Build and No Build Alternatives and Houston Terminal Station options.

[20] STB, "Surface Transportation Board Decision Document," July 15, 2019, https://www.stb.gov/decisions/readingroom.nsf/9855c1fb354da09b85257f1f000b5f79/fdb1065215902ff985258435005a6b72?OpenDocument.

[21] 33 U.S.C. 1251 et seq..

[22] 33 U.S.C. 403.

[23] 42 U.S.C. 7401.

[24] 23 U.S.C. 327.

[25] 16 U.S.C. 1531 et seq.

[26] 16 U.S.C. 703-712; 50 C.F.R. Chapter 1.

[27] 16 U.S.C. 668.

1.2.1 Purpose

The purpose of the privately proposed Project is to provide the public with reliable and safe HSR transportation between Dallas and Houston.[28]

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 for the Project 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) 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

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 and constructible and connects two of the largest urban centers in the country. To achieve TCRR's financial and ridership objectives, TCRR identified the following functional criteria for the Project:

- **Technological**: vehicle and operating procedures based on the N700-Series Tokaido Shinkansen system
- **Operational**: approximate 90-minute travel time between Dallas and Houston, with achievable speeds not exceeding 205 mph in a "closed system" corridor[29]
- **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.[30] 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 (60 to 75 minutes); however, the overall trip duration when considering pre-arrival time more than doubles. Pre-arrival time refers to the time recommended by airlines (approximately 1 to

[28] 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.

[29] A "closed system" corridor means the corridor is not interconnected with any other railroad system, operations would be independent and separated from existing roadways and other infrastructure. There are no at-grade crossings, which means a car would not have to wait for a trainset to pass and then drive over the tracks to the other side of the system.

[30] TCRR estimated in 2017 that 94 percent of the traveling public uses private automobiles to travel between Dallas and Houston; 6 percent use air or bus. See **Appendix J, Ridership Demand Forecasting Methodology Assessment Technical Memorandum.**

2 hours)[31,32,33] to arrive at the airport to allow for parking, checking in, checking luggage and passing through Transportation Security Administration security checkpoints. Additionally, flights are more sensitive to inclement weather such as severe rain and snowstorms or other delay-causing events from inside and outside of Texas,[34] while HSR may be affected only by extreme weather events such as tornados or straight-line winds between Dallas and Houston as described in **Section 2.2.1, Alternatives Considered, Technology,** and **Section 3.16.5.2, Safety and Security, Build Alternatives**.

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 planning studies, population growth, commuting population, congestion of the state transportation system, reliability, safety and limitations of existing modes of travel. Each of these factors is described in detail below.

1.2.2.1 Planning Studies and Legislative Efforts

Previous studies completed by FRA and TxDOT,[35, 36] 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 Turnpike Authority to study the feasibility of developing an HSR system in the Texas Triangle, an area bound by the cities of Dallas, Houston and San Antonio as depicted on **Figure 1-1**. The Texas Turnpike Authority reported to the legislature in 1989 that an HSR system (with speeds over 150 mph) would be feasible.[37]

In 1990, the Texas Legislature authorized the creation of the Texas High Speed Rail Authority (THSRA). The THSRA determined the pursuit of HSR was in the public's interest and in 1991 the THSRA 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 THSRA. Hearings opened on March 25, 1991, and it was determined that HSR was in the public interest and that Texas TGV, a consortium of HSR operators and financial institutions known as the Texas High Speed Rail Corporation, was the most qualified. They were awarded the franchise in June 1991.[38]

[31] Delta Air Lines, Inc., "Check-in Times at U.S. Airports," accessed November 2019, https://www.delta.com/us/en/check-in-security/check-in-time-requirements/domestic-check-in.

[32] American Airlines, "Check-in and arrival," accessed November 2019, https://www.aa.com/i18n/travel-info/check-in-and-arrival.jsp.

[33] United Airlines, Inc., "Check-in and airport processing times," accessed November 2019, https://www.united.com/ual/en/us/fly/travel/airport/process.html?irgwc=1&clickid=Rj9TON0CDxyORS2wUx0Mo3cjUkn1g12mtXwu3Y0.

[34] The Federal Aviation Administration (FAA) reports that approximately 70 percent of flight traffic delays (with times greater than 15 minutes) are due to inclement weather (seasonal storms, rain thunderstorms, low visibility and winds), and that delays in high-volume areas (such as New York) can ripple throughout the country. FAA, "FAQ: Weather Delay," August 29, 2017, accessed November 2019, https://www.faa.gov/nextgen/programs/weather/faq/.

[35] TxDOT, *2016 Texas Rail Plan Update*, May 2016, accessed November 2019, https://ftp.dot.state.tx.us/pub/txdot-info/rail/2016-rail-plan/chapter-1.pdf.

[36] USDOT, FRA, "Vision for High-Speed Rail in America," April 1, 2009, accessed November 2019, http://www.fra.dot.gov/eLib/Details/L02833.

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

[38] Ibid.

Figure 1-1: Texas Triangle

Source: AECOM 2016

In 1992, the THSRA governing board 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 THSRA. Ultimately, the Project was cancelled in 1994 when the State of Texas withdrew the franchise.[39]

In 2008, Congress passed the Passenger Rail Investment and Improvement Act (PRIIA), which established the framework for developing HSR corridors. Building on this framework, in the American Reinvestment and Recovery Act of 2009 (ARRA), Congress 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 USDOT High-Speed Rail Strategic Plan, *Vision for High-Speed Rail in America*,[40] which reintroduced the potential for development of HSR across the United States, including in Texas.

Early Texas planning efforts also identified potential HSR corridors, including the Dallas to Houston corridor. In 2010, TxDOT issued the *Texas Rail Plan*[41] 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 Texas Rail Plan also included the potential implementation of

[39] Ibid.
[40] FRA, *Vision for High-Speed Rail in America*, U.S. Department of Transportation, April 1, 2009.
[41] TxDOT, *2016 Texas Rail Plan Update*, May 2016, accessed November 2019, https://ftp.dot.state.tx.us/pub/txdot-info/rail/2016-rail-plan/chapter-1.pdf.

HSR within the Dallas to Houston corridor. In October 2019, TxDOT released a Draft 2019 Texas Rail Plan for review with an update of the high-speed passenger rail system between Dallas and Houston.[42] 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 its 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*,[43] which identified intercity "mega-regions" as having the highest potential for HSR service in the United States based on ridership potential. The Dallas to Houston corridor was the highest-ranking Texas-based corridor identified for prioritizing investment in HSR.

In November 2017, FRA and TxDOT also concluded the Texas-Oklahoma Passenger Rail Study (TOPRS) evaluating a range of passenger rail service options (conventional rail, higher speed rail and high-speed rail) in an 850-mile corridor from Oklahoma City to South Texas. The 2017 Tier I Record of Decision[44] (ROD) formally selected seven alternatives to serve as the framework for future investment in new and improved conventional and HSR service in three regions between Oklahoma City and South Texas. The ROD did not grant approval for construction, but selected service-level alternatives for specific geographic sections along the corridor, to be carried forward into a more detailed, Project-Level EIS in the future. A Dallas to Houston geographic region was not assessed by TOPRS.

These planning efforts identified potential HSR 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.[45]

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 11 million people in the next approximately 20 years, increasing the population of Texas to 40.7 million.[46] 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 on **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 7.5 million in 2019[47] to more than 10.7 million people by

[42] Ibid.

[43] Petra Todorovich and Yoav Hagler, *High Speed Rail in America*, 2011.

[44] FRA, *Texas-Oklahoma Passenger Rail Study Service-Level FEIS/ROD*, November 3, 2017, https://cdxnodengn.epa.gov/cdx-enepa-II/public/action/eis/details?eisId=241034.

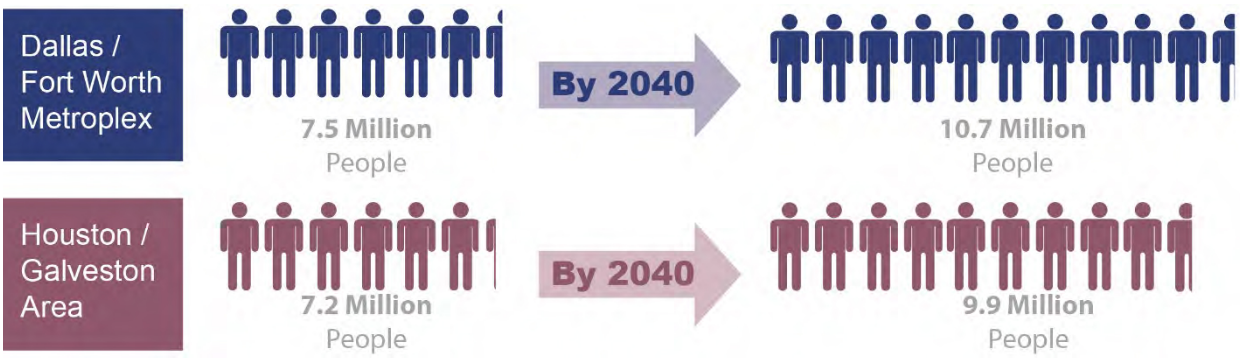
[45] According to TCRR's 2040 ridership forecast, HSR would account for 21 percent of the traveling public market share between Dallas and Houston. This HSR market share would derive from a 16 percent decrease in vehicular traffic market share and a 6 percent decrease in air travel market share (numbers rounded).

[46] Texas Demographic Center, 2018 Texas Population Projections Data Tool, accessed May 2019, https://demographics.texas.gov/Data/TPEPP/Projections/Tool.aspx?fid=BB3FC422219B483881B61221F9E31B1A.

[47] NCTCOG Regional Data Center, 2019 NCTCOG Population Estimates (County), 4/26/2019, http://data-nctcoggis.opendata.arcgis.com/datasets/2019-nctcog-population-estimates-county.

2040.[48] The Houston-Galveston Area Council (H-GAC), MPO for this region, presents a similar population forecast, rising from more than 7.2 million in 2020 to 9.9 million people by 2040.[49]

Figure 1-2: Population Forecasts



Source: AECOM 2020

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.[50] Currently 49 Fortune 500 companies are headquartered in Texas,[51] of which the DFW Metroplex is home to 24[52] and Houston is home to 22.[53] 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 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 (72 percent increase).[54] Similarly, H-GAC forecasts more than 4.5 million people will be employed by 2040, which is 1.3 million more people than in 2015 (41 percent increase).[55]

1.2.2.3 Commuting Population

In addition to continued population growth, a growing workforce trend is the increasing prevalence of the "super-commuter." In its 2012 publication, "The Emergence of the Super-Commuter," the New York University Rudin Center for Transportation defines super-commuters as individuals who live beyond the census-defined combined statistical area (CSA) of their workplace.[56] 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

[48] NCTCOG Regional Data Center, 2040 NCTCOG Demographic Forecast (District), 5/20/2015,accessed February 2020, http://data-nctcoggis.opendata.arcgis.com/datasets/2040-nctcog-demographic-forecast-district?selectedAttribute=HH40.
[49] H-GAC, 2018 Annual Regional Growth Forecast: Counties, accessed February 2020, https://datalab.h-gac.com/rgf2018/.
[50] Bill Hethcock, "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.
[51] Fortune Media IP Limited, "Fortune 500 Rankings, Headquarters State: Texas" 2019, accessed February 2020, https://fortune.com/fortune500/2019/search/?hqstate=TX.
[52] Dom DiFurio, "Number of Dallas-Fort Worth companies on the Fortune 500 list grows in 2019," *The Dallas Morning news*, May 16, 2019, https://www.dallasnews.com/business/2019/05/16/number-of-dallas-fort-worth-companies-on-the-fortune-500-list-grows-in-2019.
[53] Greater Houston Partnership, "Fortune 500 Companies," August 29, 2019, https://www.houston.org/houston-data/fortune-500-companies.
[54] NCTCOG Regional Data Center, 2040 NCTCOG Demographic Forecast (District), 5/20/2015, accessed February 2020, http://data-nctcoggis.opendata.arcgis.com/datasets/2040-nctcog-demographic-forecast-district?selectedAttribute=HH40.
[55] H-GAC. 2018 Annual Regional Growth Forecast, , accessed February 2020, https://datalab.h-gac.com/rgf2018/.
[56] 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.

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.[57, 58] A study spanning 2009 to 2017 found that Harris and Dallas Counties have the largest population of super-commuters (43,632 and 21,679, respectively) while surrounding counties, including Fort Bend, Austin (both within the greater Houston Area), Kaufman and Parker (both within DFW Metroplex), have seen significant increases in super-commuters, ranging from approximately 72 to 102 percent increases over the 6 year timeframe.[59] Super-commuters 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 would be anticipated to also increase, placing an even greater demand on the existing travel infrastructure.

1.2.2.4 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, while HSR operations would not be affected by mild inclement weather. 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 127 percent by 2035, resulting in average speeds decreasing from 59 to 39 mph.[60] 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,[61] which would also decrease traffic speeds, making highway travel increasingly less reliable.

TxDOT has identified its top 100 congested segments of roadway across the state for 2018, which include roadways in the DFW Metroplex, Houston, Austin, San Antonio, Laredo, Brownsville, Corpus Christi, El Paso and their surrounding areas.[62] Five segments of IH-45 are on the list, four of which are in Harris County and one in Dallas County. According to TxDOT, the average delay for those five segments is 1.67 times the expected travel time at optimum conditions, which means that an average 30-minute trip in light traffic would take more than 50 minutes to complete in heavier traffic. Additionally, the average planning time index for these five segments, which takes into account the time differentials between peak and non-peak traffic, is 2.35 times greater than under optimum conditions, which means that a driver may need to allot more than an hour to make the same 30-minute trip. These same five segments account for 2.7 million hours in delayed travel and $360.2 million in congestion costs, which is the economic cost in lost time and wasted fuel.

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[57] Ibid.

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

[59] Dallas Business Journal, "Texas Counties with the highest percent increase in super commuters," October 11, 2019, accessed November 2019, https://www.bizjournals.com/dallas/gallery/460362.

[60] 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.

[61] Per TxDOT 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.

[62] TxDOT, "100 Congested Roadways," last updated November 12, 2018, http://www.txdot.gov/inside-txdot/projects/100-congested-roadways.html.

On Texas highways, freight travel accounts for 12 percent of annual vehicle miles traveled (VMT), further adding to congestion. As of 2016, approximately 1.2 billion tons, or 54 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 (8th: IH-45 at US 59, 11th: IH-10 at IH-45, 25th: IH-45 at IH-610 North**,** depicted on **Figure 1-3**) and Dallas (12th: IH-45 at IH-30). By 2045, congestion on the Texas highway system, particularly within the Texas Triangle (Dallas-Houston-San Antonio), is anticipated to further increase as tonnage transported by truck is projected to increase by 108 percent. This increase in tonnage would lead to additional daily truck trips and truck VMT, which, in turn, would further limit reliable interstate travel.[63]

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

Source: AECOM, 2018 (Southbound IH-45 at East Parker Road, June 27, 2018, 12:41 PM)

As detailed in **Section 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.[64] Lists of planned transportation capacity improvement projects by county within the Transportation Study Area are detailed in **Section 3.11.4, Transportation, Affected Environment**. 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

63 TxDOT, *Texas Freight Mobility Plan 2017*, accessed May 2019, http://ftp.dot.state.tx.us/pub/txdot/move-texas-freight/studies/freight-mobility/2017/plan.pdf.

64 NTCOG, Mobility 2045, Regional Performance, accessed November 2019, https://www.nctcog.org/nctcg/media/Transportation/DocsMaps/Plan/MTP/G-Regional-Performance.pdf.

IH-45 corridor.[65,66] In addition, adding highway capacity would not allow for a 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.

1.2.2.5 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.[67] As detailed in **Table 1-2**, the average annual number of fatalities on national highways from 2008 to 2017 was 34,663, which is more than 45 times higher than travel by air, rail and transit.[68] 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).[69] 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 reported accident rates between 2010 and 2017. Between 2010 and 2017 total crashes increased over 115 percent, while fatal crashes increased over 125 percent during the seven year period.[70]

Table 1-2: National Transportation Fatalities by Mode

Mode	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	AVG.
Highway	37,423	33,883	32,999	32,479	33,782	32,893	32,744	35,484	37,806	37,133	34,663
Railroad	804	695	735	681	669	702	768	749	760	824	739
Air Travel	568	548	477	499	450	429	443	406	413	346	458
Transit	192	233	222	226	265	273	236	254	257	241	240

Sources: USDOT, National Transportation Statistics, Transportation Fatalities by Mode, 2017

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 1-3**).[71]

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65 U.S. PIRG Education Fund, Highway Boondoggles 5, June 18, 2019, accessed November 2019, https://uspirg.org/reports/usp/highway-boondoggles-5.

66 Benjamin Schneider, "CityLab University: Induced Demand," September 6, 2018, accessed November 2019, https://www.citylab.com/transportation/2018/09/citylab-university-induced-demand/569455/.

67 Per FRA, 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.

68 USDOT, Bureau of Transportation Statistics, "Transportation Fatalities by Mode," 2017, accessed May 2019, https://www.bts.gov/content/transportation-fatalities-mode.

69 USDOT, Bureau of Transportation Statistics, *Transportation Statistics Annual Report 2018*, Washington, DC, 2014, accessed May 2018, https://www.bts.dot.gov/sites/bts.dot.gov/files/docs/browse-statistical-products-and-data/transportation-statistics-annual-reports/TSAR-2018-Web-Final.pdf.

70 TxDOT, "Reportable Motor Vehicle Traffic Crashes On IH 45, Between Greens Road in Houston, Texas and Interstate 20 in Dallas, Texas (Dallas, Ellis, Freestone, Harris, Leon, Madison, Montgomery, Navarro, and Walker Counties), 2010-2017," Received via email June 27, 2019.

71 TxDOT, *Texas Rail Plan*, May 2016, accessed November 2019, https://ftp.dot.state.tx.us/pub/txdot-info/rail/2016-rail-plan/chapter-1.pdf.

Table 1-3: National Railroad Fatalities by Accident Type											
Accident Type	**2008**	**2009**	**2010**	**2011**	**2012**	**2013***	**2014**	**2015**	**2016**	**2017**	**AVG.**
Train Accidents	27	4	8	6	9	11	5	11	7	6	9
Other Accident	30	27	25	30	24	32	31	51	31	34	32
Highway - Railroad Crossing	290	248	261	246	231	232	262	237	255	271	253
Trespassers	457	416	441	399	405	427	470	450	467	513	445
RAILROAD TOTAL	804	695	735	681	669	702	768	749	760	824	739
ADJUSTED RAILROAD	**57**	**31**	**33**	**36**	**33**	**43**	**36**	**62**	**38**	**40**	**41**

Sources: USDOT, National Transportation Statistics, Transportation Fatalities by Mode, 2017

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 are adjusted to remove trespassers and highway-rail crossing fatalities (as depicted in Adjusted Railroad values in **Table 1-3**), 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.[72]

1.2.2.6 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,[73] more than 380 public and private use airports[74] and 10,469 miles of railroad.[75] Direct passenger rail service between Dallas and Houston has not existed since the mid-1950s. As shown on **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

Figure 1-4: Amtrak Rail Map

Source: Amtrak 2011

[72] USDOT, FRA, "Highway-Rail Grade Crossings Overview," accessed November 2019, https://www.fra.dot.gov/Page/P0156.
[73] TxDOT Transportation Planning and Programming Division, Standard Reports, "Mileage by Highway Status by Highway System," September 25, 2014.
[74] Texas Transportation Commission Aviation Division, "2015 Texas Airport Directory," December 2015, accessed May 2019, http://www.txdot.gov/inside-txdot/division/aviation/airport-directory-list.html.
[75] TxDOT, *Texas Rail Plan*, May 2016, accessed November 2019, https://ftp.dot.state.tx.us/pub/txdot-info/rail/2016-rail-plan/chapter-1.pdf.

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.[76] Lastly, the most common cause for delays of passenger trains (such as the *Texas Eagle*) that share rail lines owned by freight rail is interference with freight trains.[77] 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.[78]

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 4 hours.[79] Additionally, Megabus, a bus service within the corridor, transports riders via 12 routes with an estimated travel time of approximately 4 hours. Vonlane, a luxury bus company, transports riders between Dallas and Houston via four routes with an average travel time of 3.5 hours.[80] 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. Four commercial airports are 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 USDOT Bureau of Transportation Statistics, 2018 air ridership (1.0 billion systemwide [domestic and international] 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.[81]

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, and offers 19 weekday roundtrips between DAL and HOU.[82] The Dallas to Houston market was once the most travelled route for SWA, but in 2013 the SWA CEO reported a 50 percent decrease in that route as they move to more versatility with long-haul flights.[83] 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

[76] Amtrak, "Train Schedules & Timetables," January 25, 2015, accessed November 2019, https://www.amtrak.com/train-schedules-timetables.
[77] Amtrak, "On-Time Performance Testimony to the STB," *Amtrak Ink: A Monthly Publication for and by AMTRAK Employees*, October 2014.
[78] Amtrak, 2015, "A Message from AMTRAK Regarding On-time Performance," *All Aboard: The Official Blog of Amtrak*, accessed November 2019, http://blog.amtrak.com/2015/02/message-amtrak-regarding-time-performance/.
[79] Travel times for Greyhound are based on the published and ticketed travel times between their respective Dallas and Houston stations. This information can be found at https://www.greyhound.com/en/ecommerce/schedule.
[80] Travel times for Vonlane bus services are based on the published and ticketed travel times between their respective Dallas and Houston stations. This information can be found at https://www.vonlane.com/user/booking/index/.
[81] USDOT, "2018 Traffic Data for U.S Airlines and Foreign Airlines U.S. Flights," March 2019, accessed November 2019, https://www.bts.dot.gov/newsroom/2018-traffic-data-us-airlines-and-foreign-airlines-us-flights.
[82] Southwest Airlines Co, "ANNUAL REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934," 2017, accessed May 2019, http://investors.southwest.com/~/media/Files/S/Southwest-IR/2017%2010-K%20Final%20Filed%20879.pdf.
[83] Lynn Brezosky, "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.

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 in 2014 continued to decline by more than 35 percent since 2000.[84] 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.[85] In addition to expanding long-haul services, SWA ended 2017 with international service to 14 destinations, including from Houston and Dallas,[86] and has announced plans to continue expanding international service (anticipated 15 international destinations in 2020).[87] Due to the steady decline in short-haul routes over the past 6 years, and the focus on international expansion over the past 2 years, an increase in short-haul routes between Dallas and Houston is not expected.

The City of Dallas completed a renovation of DAL in 2014, 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.[88] 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 FRA's proposed action. This includes implementing TCRR's proposed HSR service between Dallas and Houston as described in the petition for rulemaking submitted by TCRR, which is the only future operating location TCRR has identified to FRA. Because FRA's proposed rulemaking would enable the safe operations of the HSR system proposed by TCRR independent of location, in **Section 3.1.2, Introduction, Impacts of the TCRR HSR System Independent of Location**, this EIS also evaluates and documents the reasonably foreseeable potential impacts of implementing TCRR's HSR service in any other location. FRA's identification and evaluation of potential impacts that could occur anywhere TCRR's service is implemented is informed by the evaluation of potential impacts between Dallas and Houston. TCRR has not proposed to operate in any other location and therefore any discussion of location-specific impacts, other than the service proposed in TCRR's petition for rulemaking and conceptual engineering (included as **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports,** and **Appendix G, TCRR Final Conceptual Engineering Plans and Details**), would be speculative.

[84] ibid.

[85] Southwest Airlines Co, "Southwest Airlines One Report," 2014, accessed November 2019, https://southwestonereport.com/about-the-one-report.

[86] Southwest Airlines Co, "ANNUAL REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934," 2017, accessed May 2019, http://investors.southwest.com/~/media/Files/S/Southwest-IR/2017%2010-K%20Final%20Filed%20879.pdf.

[87] Southwest Airlines, 2019 International Travel Map, accessed November 2019, https://www.southwest.com/html/air/intl/?clk=GFOOTER-FLY-INTL.

[88] Southwest Airlines Co, "Southwest Airlines One Report," 2014, accessed November 2019, https://southwestonereport.com/about-the-one-report/.

The subsequent chapters contain the following information:

- **Chapter 2.0**: Describes the alternatives analysis, proposed technology, Project Build Alternatives, Houston Terminal Station options and No Build Alternative
- **Chapter 3.0**: Establishes the environmental baseline (affected environment) and environmental consequences and outlines mitigation strategies for FRA's proposed action
- **Chapter 4.0**: Analyzes and describes indirect and cumulative effects of the Project
- **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**: Analyzes 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
- **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.

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2.0 ALTERNATIVES CONSIDERED

2.1 Introduction

As a private company, TCRR 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 Terminal Station Options) and the No Build Alternative for the Project were identified and screened. Chapter 2.0 provides a detailed description of the alternatives evaluated in this Final EIS. Lastly, this chapter identifies the Preferred Alternative based on the analysis contained in this Final EIS.

Each alternative carried forward from the screening process is further assessed for environmental impacts in **Chapter 3.0, Affected Environment and Environmental Consequences. Chapter 3.0, Affected Environment and Environmental Consequences,** also begins with a detailed discussion of the Project footprint, or limits of disturbance (LOD) in **Section 3.1, Environmental Consequences, Introduction**.

2.2 Proposed HSR Infrastructure and Operations

TCRR is proposing to construct and operate a high-speed passenger rail system between Dallas and Houston. TCRR is proposing to replicate the Tokaido Shinkansen HSR system in the U.S. with minimal modifications. TCRR is proposing to build a new railway consisting of an approximately 240-mile route from Dallas to Houston with terminal stations in each city and an intermediate station in Brazos Valley. The Project is a double main-track railway, powered by a 25 kilovolt (kV) overhead catenary system (OCS). As detailed in **Section 2.2.5, Proposed HSR Operations**, TCRR intends to operate the railway 18 hours per day, 7 days per week with the remaining 6 hours per day allocated to a maintenance window. The HSR system proposed by TCRR is based on the Tokaido Shinkansen HSR system, and is the only proposed HSR infrastructure evaluated in this Final EIS as described in further detail below.

2.2.1 Technology

The Project includes the deployment of an electric-powered HSR passenger rail system based on JRC's Tokaido Shinkansen system. Accident statistics are not available for systems operating technology comparable to the Project; however Japan's Tokaido Shinkansen HSR, which operates a similar technology, has had no passenger fatalities resulting from a trainset accident, such as a derailment or collision, since the service began over 50 years ago.[1, 2] The technology has a proven safety record with only one earthquake-related derailment since the service began, which resulted in no passenger injuries. The HSR system would suspend operations in the event of environmental factors (e.g., extreme weather

[1] The only injuries and/or fatalities reported in association with the Tokaido Shinkansen HSR system was a single passenger suicide by self-immolation on June 30, 2015. This instance is unrelated to the design, operation and overall safety of the system. BBC News Online, "Japan bullet train passenger 'self-immolation' fire kills two," June 30, 2015, accessed November 2019, https://www.bbc.com/news/world-asia-33322794.

[2] JRC, "About the Shinkansen," FY 2016, accessed November 2019, https://global.jr-central.co.jp/en/company/about_shinkansen/.

events such as tornados or straight-line winds) farther down the rail line.[3] Even with natural disasters, average delay times of only 0.4 minute are reported for the Shinkansen HSR system.[4] Additionally, the Project would run a daily sweeper vehicle and visual inspections of the ROW down the extent of the rail line to inspect the track and equipment for operational issues.[5]

The trainset technology would be adapted to meet the regulatory requirements, as established by an FRA RPA, to ensure the system is operated safely. To minimize risk and enhance passenger safety, the alignment is proposed to be a "closed system." A "closed system" is one that is not interconnected with any other railroad system, and the HSR trainset operations are independent and separated from existing roadways and other infrastructure (i.e., no at-grade crossings). Operating a "closed system" contributes to the HSR trainset ability to safely achieve speeds not to exceed 205 mph, and to attain an approximate 90-minute travel time between Dallas and Houston. Additionally, TCRR would only provide passenger rail service. Hazardous materials and other conventional heavy freight would not be transported on the trains or within the HSR ROW.

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 Final Conceptual Engineering Design and Constructability Reports,** and **Appendix G, TCRR Final Conceptual Engineering Plans and Details**) completed as of July 1, 2019 (including memorandum listing Final Conceptual Engineering Report Clarifications and Corrections dated May 6, 2020) 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 on **Figure 2-1** through **Figure 2-5**. The HSR ROW would vary in width with an average width of 328 feet and a minimum ROW of 100 feet that would include the track, OCS, access road and security fencing. Based on existing infrastructure (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/embankment (**Figures 2-1** and **2-2**), retained fill (**Figure 2-3**), retained cut (**Figure 2-4**) and bridge-like structure, called viaduct (**Figure 2-5**). Approximately 55 percent of the HSR line would be constructed on viaduct.

A typical trainset would consist of eight 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 eight-car trainset would carry up to 400 seated passengers.

Power would be distributed to the trainset via the OCS, which is the electrical wiring that runs above each track and provides electricity from the traction power substation (TPSS) to the trainset, as depicted on **Figures 2-1, 2-2, 2-3, 2-4** and **2-5**. The HSR system would be monitored and controlled from a system-wide Operations Control Center located at the trainset maintenance facility (TMF) in Dallas.

[3] Inclement weather (i.e., rain, wind or fog) is not anticipated to impact the operation of the N700-Series Tokaido Shinkansen HSR system. Additionally, as discussed further in **Section 3.16.5.2, Safety and Security, Build Alternatives**, the likelihood of extreme weather events (hurricanes or tropical storms) adversely impacting the active operations on the Build Alternatives is low.

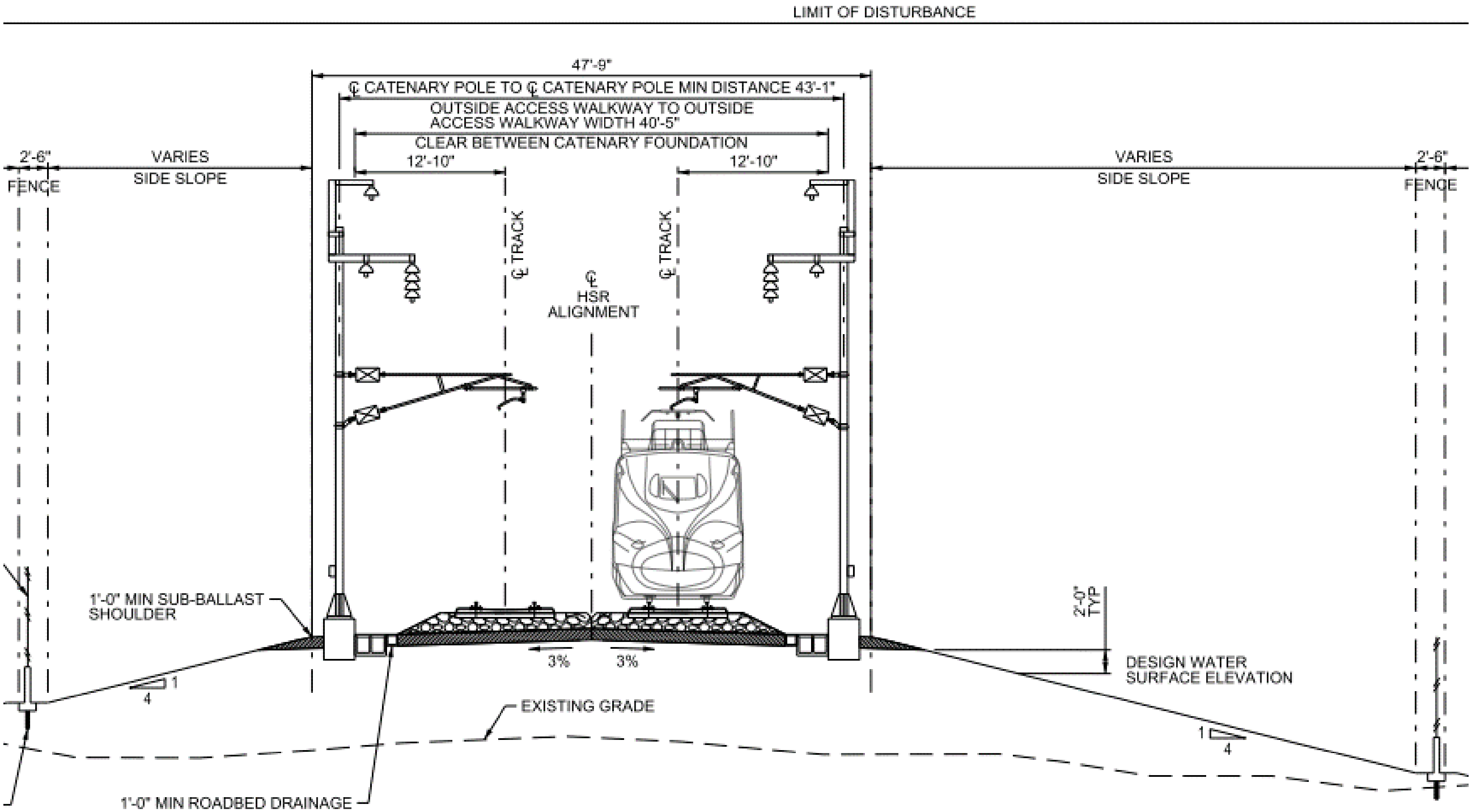
[4] JRC, "About the Shinkansen," FY 2016, accessed November 2019, https://global.jr-central.co.jp/en/company/about_shinkansen/.

[5] International High-Speed Rail Association, *SHINKANSEN Fact Book*, October 22, 2014, accessed November 2019, http://www.ihra-hsr.org/_pdf/factbook_en_1018.pdf.

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

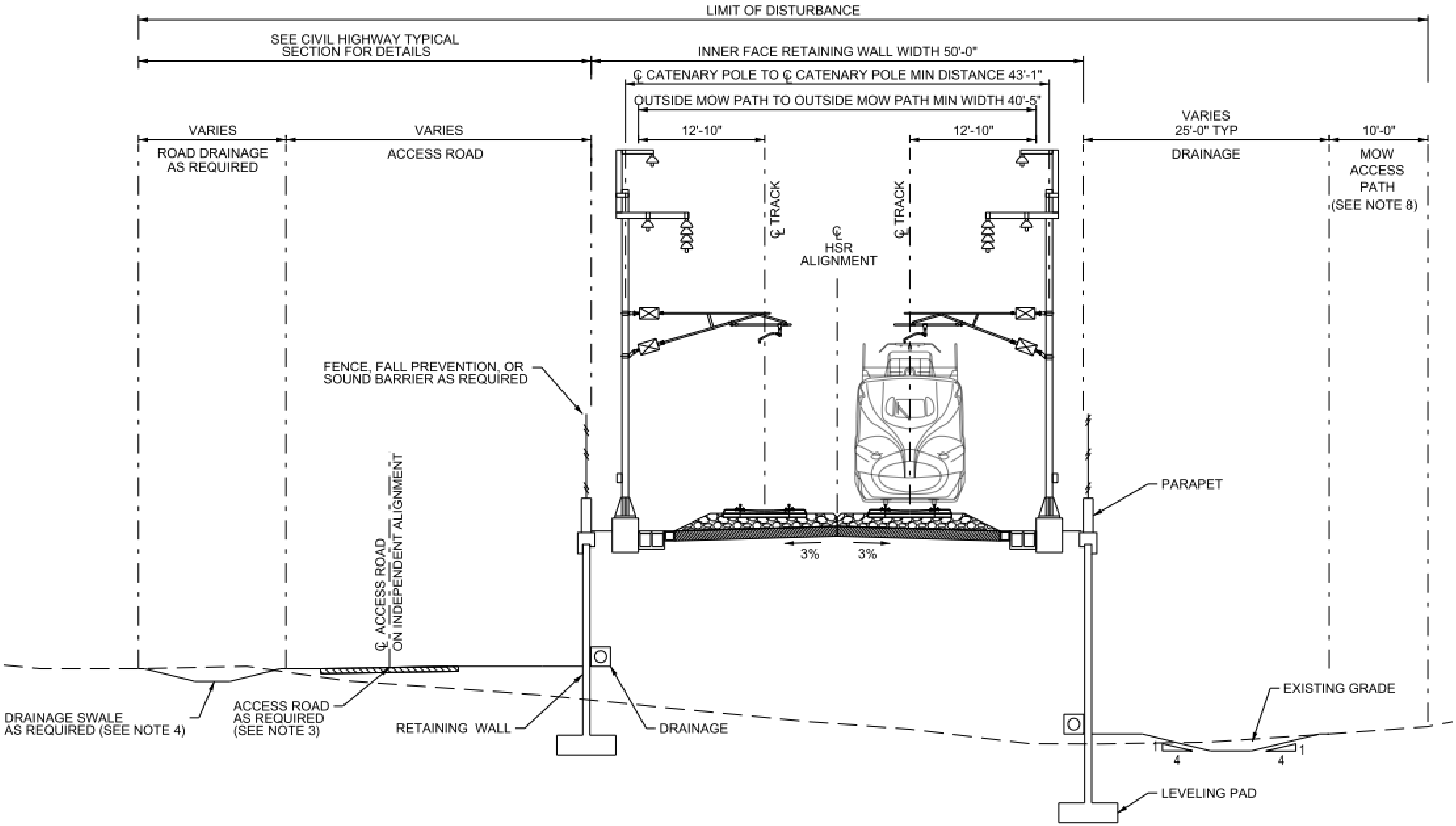
Source: TCRR 2014

Figure 2-2: Embankment Typical Section



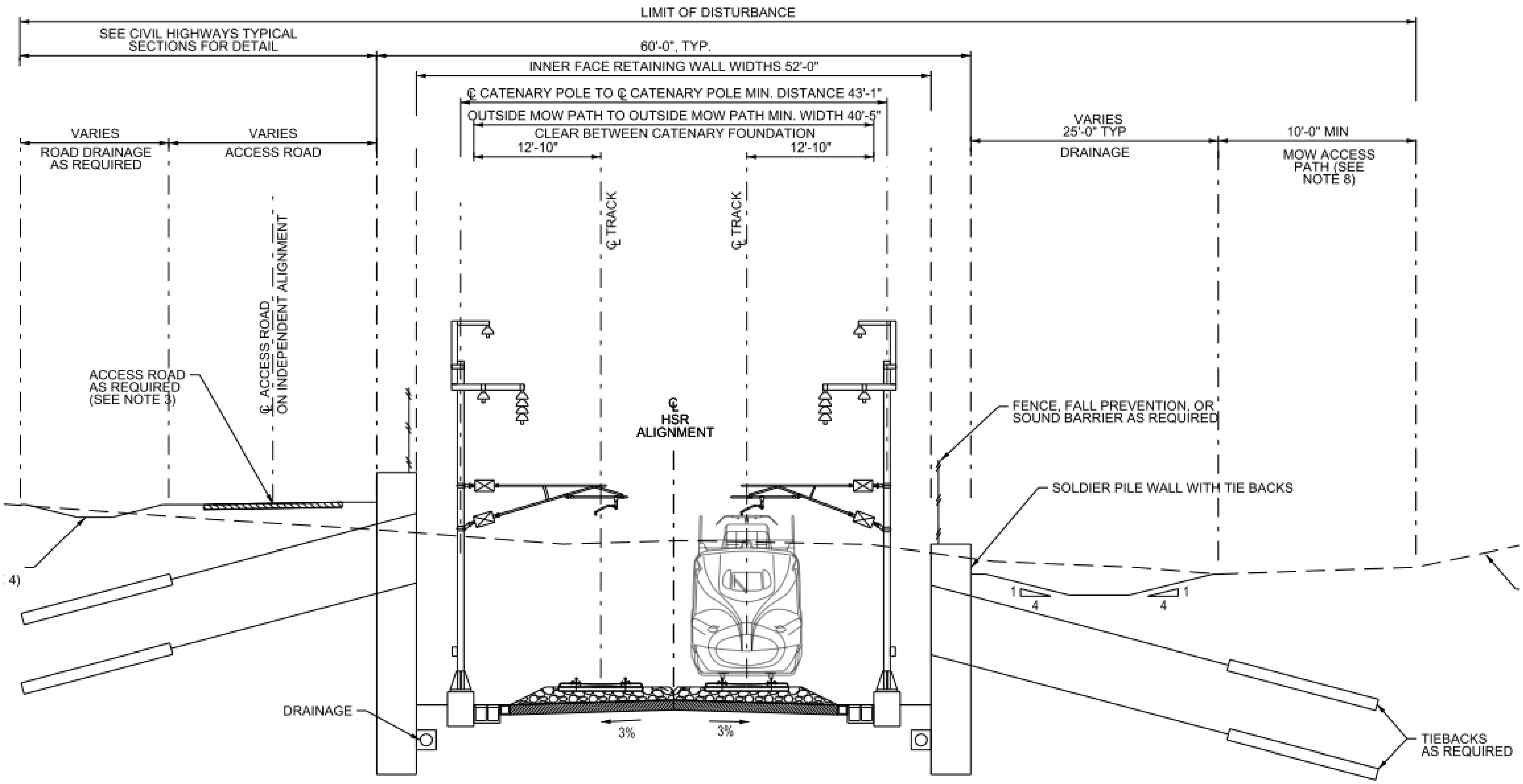
Source: TCRR 2019

Figure 2-3: Retained Fill Typical Section



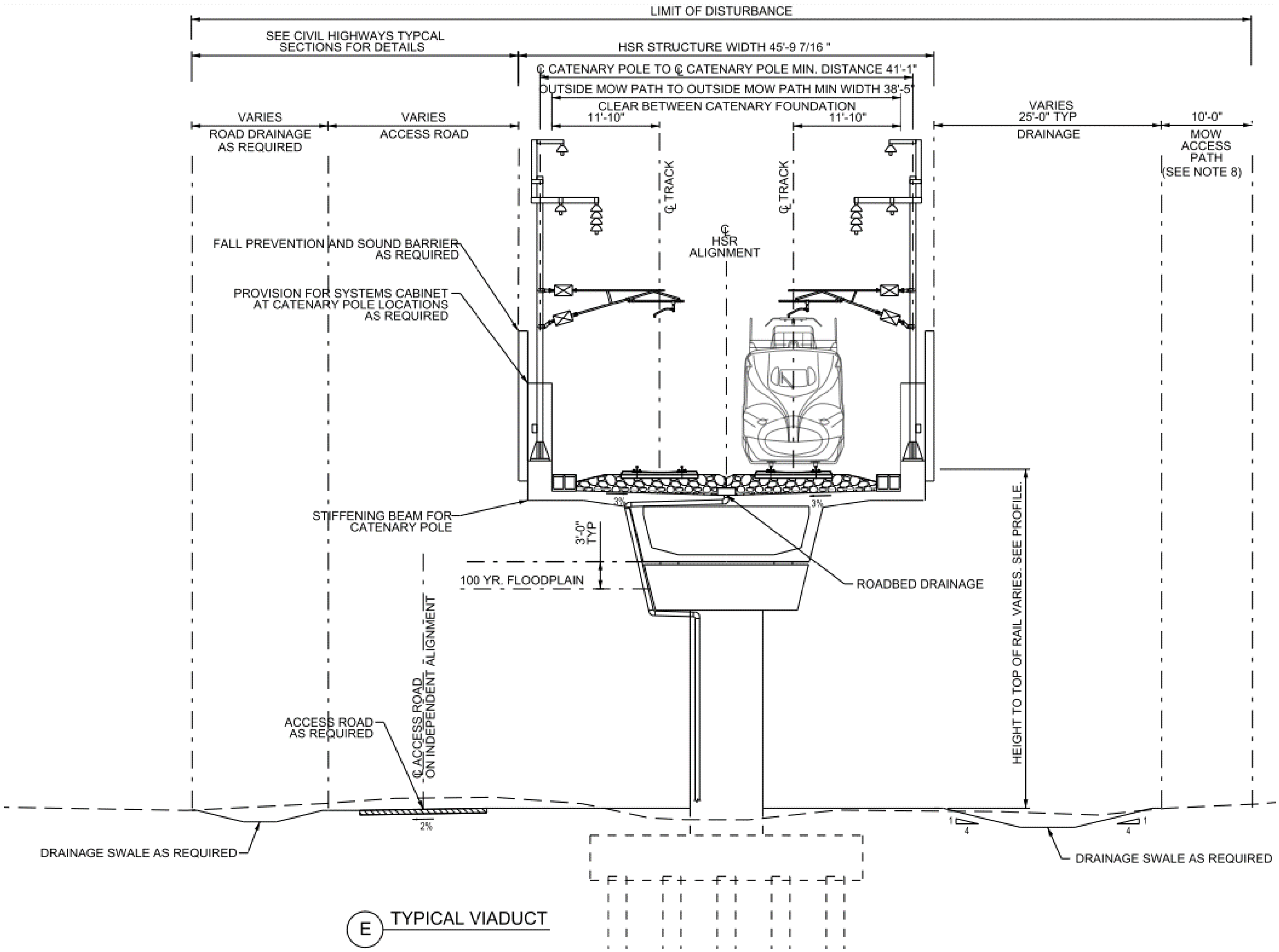
Source: TCRR 2019

Figure 2-4: Retained Cut Typical Section



Source: TCRR 2019

Figure 2-5: Viaduct Typical Section



Source: TCRR 2019

2.2.2 Stations

TCRR is proposing three stations as part of the Project: including an approximately 90-acre terminal station in Dallas, an approximately 60-acre terminal station in Houston and an approximately 115-acre Brazos Valley Intermediate Station in Grimes County, near the town of Roan's Prairie. Each terminal station could accommodate six tracks and three island platforms that would measure 30 feet wide and 705 feet long. Provisions would need to be made for any future expansion of the HSR system, should there be a future plan to extend service beyond the Dallas and Houston Terminal Stations. Although Dallas Area Rapid Transit (DART) or Trinity Railway Express (TRE) or future high-speed service could not operate on extensions of the HSR tracks or along HSR station platforms, it is possible that cross platform connections could be made at both terminal stations.[6,7] The Brazos Valley Intermediate Station would have two mainline tracks with side platforms, measuring 20 feet wide and 705 feet long. Two additional tracks (one on each side of the mainline tracks) are planned to allow for express service trainsets to bypass the station as described in **Appendix F, TCRR Final Conceptual Engineering Design Report (Section 6.7, Stations, Brazos Valley 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, Proposed HSR Operations**. 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 connections to other surface transportation modes, including bus bays, passenger drop-off and pick-up, and taxi and ride sharing services. **Figure 2-6** through **Figure 2-12** illustrate current infrastructure in Japan that could influence the Project station designs. The station locations and alternatives are described in **Section 2.6.3, Summary of Build Alternatives.**

2.2.3 Facilities

The operation of the HSR Project would be supported by a collection of maintenance facilities to repair and maintain the trainsets and track. These facilities include two TMFs and seven maintenance-of-way (MOW) facilities. The program, layout and sizing of these facilities are generally based on similar systems located in Japan (see **Figure 2-13** and **Figure 2-14**). Additional detail of these facilities is described in **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports.**

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[6] As discussed in more detail in **Chapter 4.0, Indirect Effects and Cumulative Impacts**, there are no current planned or programmed expansions of DART, TRE or light rail operations. However, the operation of the HSR station could result in expanded operation of these systems to complement transit connectivity and provide enhanced commuter benefits. Any expansion of DART, TRE, or light rail operations near the station would be a separate project and would require its own separate environmental and planning evaluation.

[7] City of Dallas, "High Speed Rail Update," October 8, 2018, accessed December 2019, https://dallascityhall.com/projects/high-speed-rail/DCH%20Documents/2018-10-8%20MSIS%20High%20Speed%20Rail%20-%20Final.pdf.

Figure 2-6: Exterior of a Japanese HSR Station

Source: TCRR 2016

Figure 2-7: Interior Station Concourse in Taiwan

Source: TCRR 2016

Figure 2-8: Interior Station Concourse in Japan

Source: TCRR 2016

Figure 2-9: Japanese Station Concourse

Source: TCRR 2016

Figure 2-10: Taiwan Station Concessions

Source: TCRR 2016

Figure 2-11: Japanese Station Platform

Source: TCRR 2016

Figure 2-12: Japanese Station Platform Infrastructure

Source: TCRR 2016

Figure 2-13: Japanese Trainset Maintenance Facility

Source: TCRR 2019

Figure 2-14: Japanese Maintenance-of-Way Facility

Source: TCRR 2017

2.2.3.1 Trainset Maintenance Facilities

TMFs would be located in proximity to the terminal stations to serve as cleaning and maintenance facilities for the HSR trainsets. The two TMFs would provide for all periodic inspections, scheduled maintenance, scheduled overhaul 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 trainset storage, trainset car washes and other facilities. A trainset shed would be located at the TMF in Houston and a workshop would be located at the TMF in Dallas. As previously mentioned, the Dallas TMF would also house the Operations Control Center for the system.

2.2.3.2 Maintenance of Way Facilities

In addition to the TMFs, there are seven MOW facilities (five standalone typical facilities and one in each TMF) and a smaller MOW facility near Houston. MOW facilities would be located every 15 to 46 miles along the HSR ROW. Each MOW facility would be approximately 35 acres and have sidings for MOW equipment and sweeper vehicles. MOW facilities would also include maintenance facilities for the MOW equipment and accommodation for administrative functions. Additionally, as part of the operating main line adjacent to four MOW facilities (one on Segment 2A, two on Segment 4, and one MOW on Segment 5), there would be a refuge track of at least 1,575 feet, with catenary to accommodate disabled trainsets that require immediate service.

Siding-off facilities would be constructed on both sides of the main line at locations between MOW bases and designed more than 34 miles apart. The siding-off facilities would be used for staging of equipment close to work sites in advance of maintenance activities. Equipment would be moved to these locations overnight and stored locally during system operating hours, allowing for rapid mobilization during maintenance windows. This would provide for quick mobilization of MOW equipment to work sites between distant MOW bases. Siding-off facilities allow maintenance work to be conducted for longer durations since equipment would not have to travel long distances at the beginning and end of every maintenance work shift. Siding-off facilities would not be used by trainsets and are distinct from the refuge tracks adjacent to MOW facilities (see **Appendix F, TCRR Final Conceptual Engineering Design Report**).

2.2.3.3 Facility Signaling and Communications

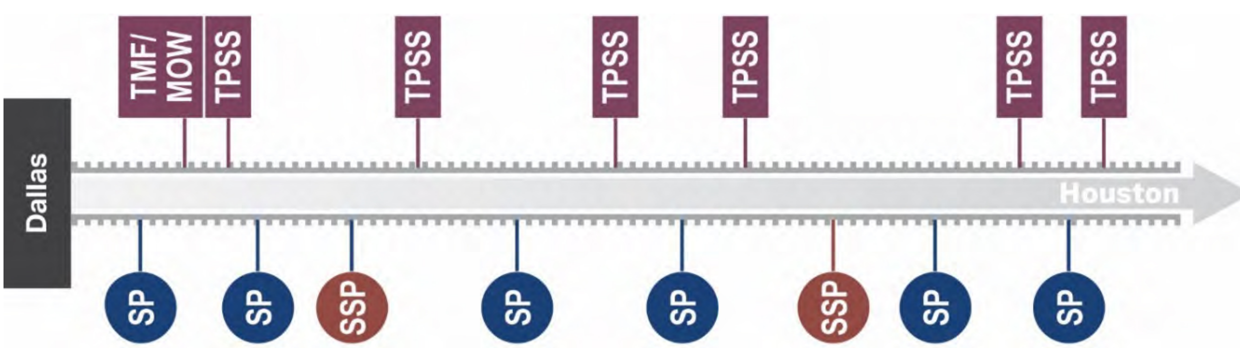
Additionally, the system would require the installation of signaling and communications infrastructure. Main signal houses, intermediate signal houses and sub-signal houses would enclose monitoring systems, train traffic and automatic control devices, signaling cables and power supply devices for signaling equipment. These facilities would typically be between 0.1 and 0.3 acre 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. 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.

2.2.4 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 (SPs), sub-sectioning posts (SSPs) and auto-transformer posts (ATPs) that require certain spacing between facilities to operate the system. **Figure 2-15** shows the general relationship among TPSSs, SPs and SSPs.

Figure 2-15: Facility Configuration



Source: AECOM 2016
Note: Figure is for illustrative purposes only and is not to scale

To provide a seamless power supply for trainset operation, approximately 14 TPSSs, including 2 at the TMFs, would be spaced between 10 and 25 miles apart. **Figure 2-16** illustrates a typical TPSS facility. These TPSSs would receive power from an interconnection with existing 138 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 1 mile of existing 138 kV transmission lines; however, in some instances the connection would be greater than 1 mile. New transmission lines would be required to connect the TPSSs to the existing ERCOT grid. A discussion of new electrical transmission line infrastructure is included in **Chapter 4.0, Indirect Effects and Cumulative Impacts.**

Figure 2-16: 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 6 acres), including allowance for parking and other site features. The substation building would be approximately 2,200 square feet. There would be one additional TPSS facility at both TMF locations.

The SPs would be located between adjacent TPSSs and would be responsible for several important functions in the traction power system. **Figure 2-17** illustrates a typical SP. The sectioning posts would be the junction point where the traction power circuits from adjacent TPSSs meet and allow the trainsets to seamlessly transition between adjacent circuits with minimal interruption to power the trainset. The SSPs would be placed between TPSSs and SPs where the distance is long, but not long enough to demand an additional TPSS. The SPs in conjunction with the SSPs would provide a seamless power supply for the system. It is anticipated that there would be 11 SPs and 9 SSPs.

Figure 2-17: Typical HSR Sectioning Post

Source: TCRR 2019

The secondary traction power facilities, the ATPs, SP and SSP would have similar footprints of approximately 0.5 acre to 1 acre each, including allowance for parking, a small electrical building (approximately 1,600 square feet) and other site features. The footprint for each facility could vary depending on the site conditions.

2.2.5 Proposed HSR Operations

TCRR developed a basic service plan to support conceptual engineering for the Project (see **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports**). 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 and to peak would depend upon demand. Additionally, service levels would vary to respond to demand during weekends, special events and peak/off-peak periods.[8]

A travel time simulation conducted by TCRR on the alternatives presented in **Section 2.6, Description of Alternatives,** 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

[8] Peak periods were defined by TCRR as 7:00 AM to 10:00 AM and 4:00 PM to 7:00 PM.

operations, was added, the average travel time increased to 84 minutes. These times reflect a 3-minute stop at the Brazos Valley Intermediate Station.

Operational assumptions under initial service level include:

- Two terminal stations: One each in Dallas and Houston
- A Brazos Valley Intermediate Station that would serve as a midpoint station located in Grimes County near Roans Prairie. With the addition of a midpoint station, some trainsets may run an express (non-stop) service between Dallas and Houston
- Two trainsets per hour during peak and off-peak hours
- Trainset service every 30 minutes between terminal stations in Dallas and Houston
- Hours of operation from 5:30 AM to 11:30 PM. Daily maintenance and fleet movement would occur when the HSR line would not be in operation
- Anticipated service of 7 days a week, 365 days a year
- Turn-around time at each terminus station of 30 to 40 minutes.
- A total of 15 trainsets, with a minimum of 8 trainsets in operation

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

- Two trainsets per hour during off-peak
- During AM and PM peak service hours, one additional trainset (three total) would be operating
- Trainset service could occur as often as every 20 minutes between terminal stations in Dallas and Houston
- A total of 20 trainsets, with a minimum of 13 trainsets in operation

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

- Six trainsets per hour during peak hours and four trainsets per hour during off peak
- During AM and PM peak service hours, trainset service as often as every 10 minutes between terminal stations in Dallas and Houston
- A total of 30 trainsets, with a minimum of 24 trainsets in operation

2.2.5.1 Amtrak Through-Ticketing Agreement

As discussed in **Section 1.1.3.2, Introduction, Surface Transportation Board**, TCRR and Amtrak entered into a Voluntary Coordination Agreement and then executed a Reservation and Ticketing Agreement to give interstate passengers the ability to travel on, and transfer between, both TCRR and Amtrak systems on a single through ticket. As detailed within TCRR's August 21, 2019, STB filing,[9] it is anticipated that the Project would, after a 3-year ramp-up period, transport 18,300 to 20,500 passengers each year utilizing the single through ticket.

As documented in **Appendix F, TCRR Final Conceptual Engineering Design Report, Appendix G, TCRR Final Conceptual Engineering Plans and Details** and TCRR's August 21, 2019, STB filing, [10] TCRR would provide and manage integrated ticketing and transfer service between the proposed HSR Dallas and Houston Terminal Stations and Amtrak's existing Union Station (Dallas) and Houston Station. Connections between TCRR's and Amtrak's respective stations would include:

[9] TCRR, Petitioners' Response to the Surface Transportation Board's Request for Additional Information, August 21, 2019, https://www.stb.gov/Filings/all.nsf/d6ef3e0bc7fe3c6085256fe1004f61cb/9624ee8dee0f382f8525845e003b1120/$FILE/248366.pdf.
[10] Ibid.

- Dedicated pedestrian walkway and improved sidewalk access from the Dallas HSR Terminal to the Convention Center DART station. This dedicated pedestrian walkway would facilitate safe foot traffic not only to the DART line but also to Dallas Union Station, which is located approximately six blocks farther on. This is included in the HSR Dallas Station design detailed in **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports,** and **Appendix G, TCRR Final Conceptual Engineering Plans and Details**.
- Operation of air-conditioned, rubber tire electric buses (capable of transporting passengers and luggage) between the respective HSR Terminal and Amtrak stations in Dallas and Houston. Vehicles are anticipated to be similar to the Proterra Catalyst 35 all-electric bus, the EMOSS MB16 all-electric mini bus or other commercially available electric vehicles. Maps of anticipated routes are depicted in TCRR's August 21, 2019, STB filing. [11]
    - In Dallas, the transfer service would operate over existing roads (approximately 0.8 mile one-way) between Dallas Union Station and the HSR Dallas Terminal Station utilizing Young Street, South Lamar Street, and Cadiz Street.
    - In Houston, the transfer service would operate over existing roads approximately 7.4 miles one-way) between Houston's Amtrak Station and the HSR Houston Terminal Station utilizing IH-45, IH-10, and IH-610.[12]

TCRR's August 21, 2019, STB filing [13] includes a schedule of anticipated bus transfers based on TCRR's and Amtrak's respective train schedules. It is anticipated that the bus transfers would include:

- 28 one-way transfers a week (4 daily) between Dallas Union Station and the HSR Dallas Terminal Station
- 12 one-way transfers a week between Houston's Amtrak Station and the HSR Houston Terminal Station

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 on **Figure 2-18**.

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.

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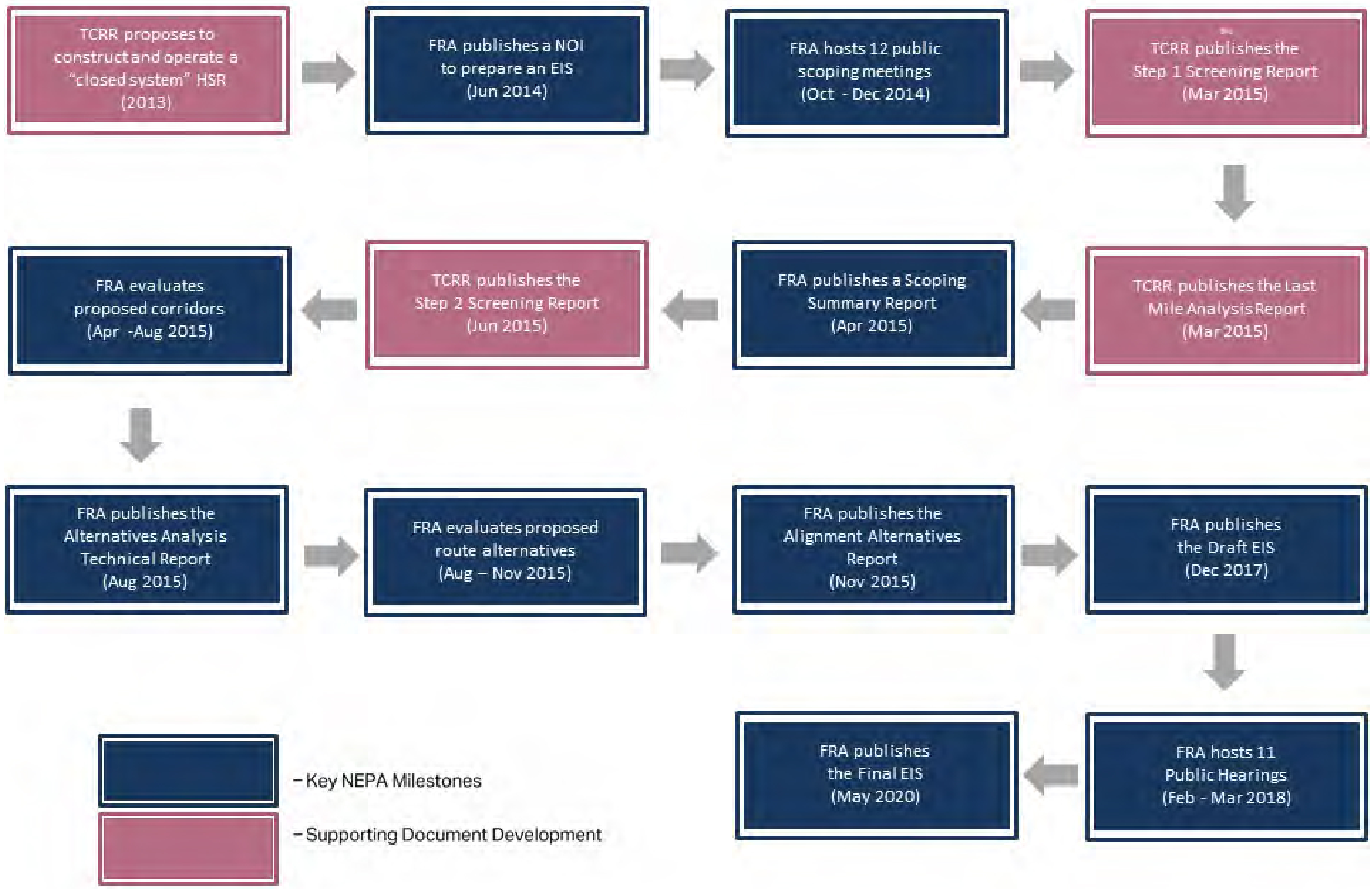
[11] TCRR, Petitioners' Response to the Surface Transportation Board's Request for Additional Information, August 21, 2019, https://www.stb.gov/Filings/all.nsf/d6ef3e0bc7fe3c6085256fe1004f61cb/9624ee8dee0f382f8525845e003b1120/$FILE/248366.pdf.

[12] While TCRR's STB filing depicted connections from TCRR's preferred Houston Terminal Station Option (Northwest Mall), the proposed transfer service is anticipated to be similar from all terminal station options assessed in this EIS (Industrial Site, Northwest Mall and Northwest Transit Center).

[13] TCRR, Petitioners' Response to the Surface Transportation Board's Request for Additional Information, August 21, 2019, https://www.stb.gov/Filings/all.nsf/d6ef3e0bc7fe3c6085256fe1004f61cb/9624ee8dee0f382f8525845e003b1120/$FILE/248366.pdf.

Figure 2-18: Alternatives Development Process



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 identification of the alternatives described in **Section 2.5, Development and Evaluation of Initial Alignment, Station and TMF Alternatives**.

Reasonable alternatives carried forward only include those that meet the Project's Purpose and Need, as described in **Section 1.2, Purpose of and Need for the Dallas to Houston High-Speed Rail Project**. FRA's screening process advanced six end-to-end Build Alternatives (Alternatives A through F), three options for the Houston Terminal Station, and the No Build Alternative for consideration in the EIS. The operation of the Project 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 Project.

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://railroads.dot.gov/elibrary/dallas-houston-high-speed-rail-project-corridor-alternatives-analysis-technical-report.

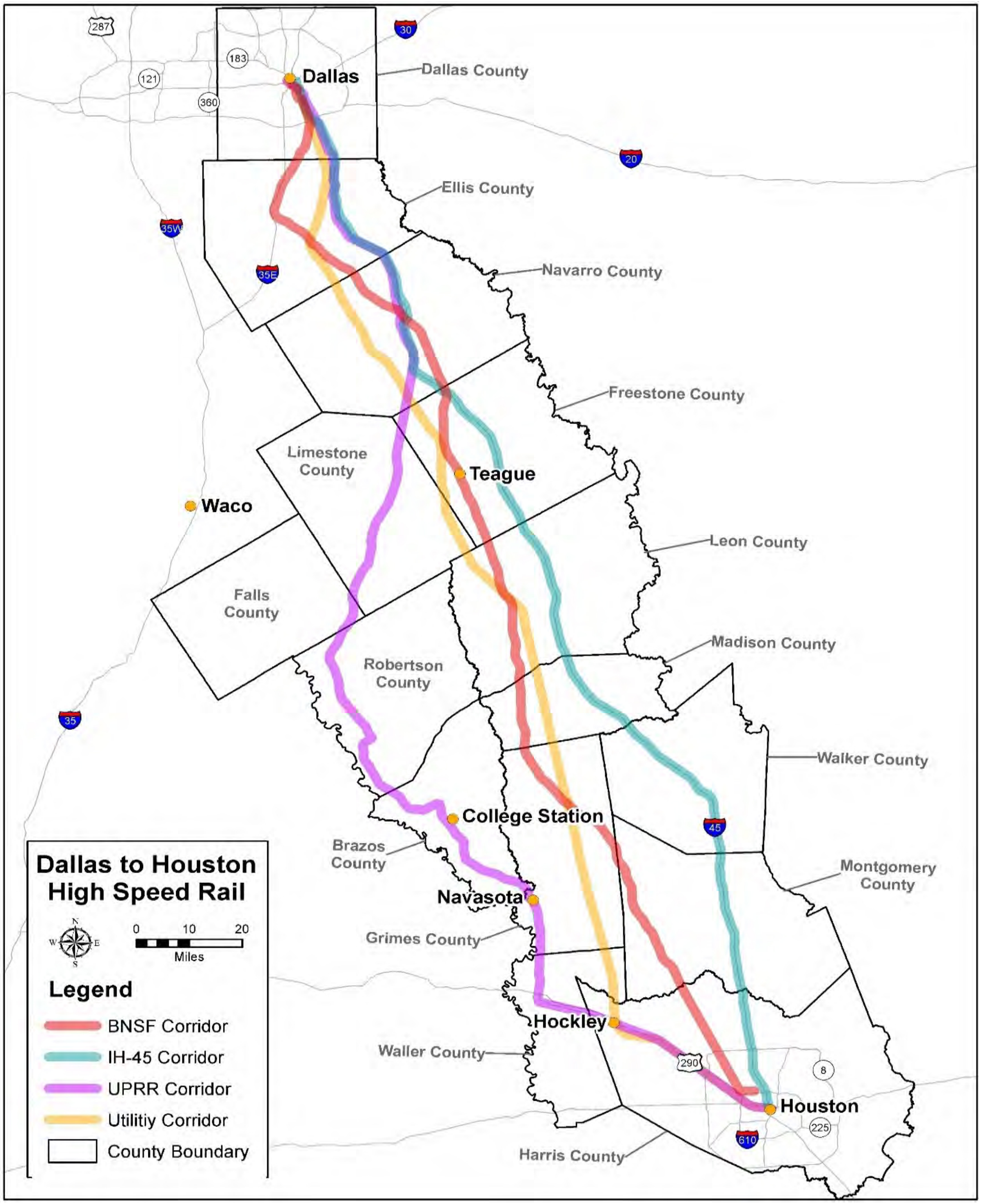
2.4.1 Description of Corridor Alternatives

In accordance with the Passenger Rail Investment and Improvement Act of 2008, TxDOT prepared an annual state rail plan in 2010 and completed subsequent updates.[14] The *Texas Rail Plan* recognizes strategic planning efforts for HSR 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 2-19**) 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.

[14] TxDOT, 2010 Texas Rail Plan, 2010, accessed November 2019, https://web.archive.org/web/20130404181851/https://www.txdot.gov/government/reports/rural-2035/texas-rail-plan/final.html.

Figure 2-19: Potential HSR Corridors



Source: AECOM 2016

- **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 and 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, portions are adjacent to the UPRR corridor to complete the corridor connectivity.

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 "closed system," 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 trainset speeds up to 125 mph.[15] 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 4 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 on **Figure 2-19** using a desktop evaluation of publicly available resources. As discussed in **Section 2.4.2, Description of Other Modes Considered**, 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.[16] For analysis purposes, a general centerline within each corridor was established as a representative

[15] In addition, FRA approval is required for trainset operations through highway-rail crossings at speeds between 110 and 125 mph. Refer to 49 C.F.R. 213.347, https://www.govinfo.gov/content/pkg/CFR-2011-title49-vol4/pdf/CFR-2011-title49-vol4-sec213-347.pdf.

[16] https://railroads.dot.gov/elibrary/dallas-houston-high-speed-rail-project-alignment-alternatives-analysis-report.

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 whether 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 existing railroad ROW on either the BNSF or UPRR corridors, these potential corridor alternatives would not be able to meet TCRR’s objective to employ the N700-Series HSR system as proposed in TCRR’s petition for an RPA or meet a Purpose and Need of the Project to reach high-speed passenger rail travel speeds not to exceed 205 mph.

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 the Purpose and Need of the Project or TCRR’s objectives. Therefore, FRA eliminated these alternatives from further consideration because they did not meet the Project’s Purpose and Need.

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 majority of the BNSF and UPRR ROW 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 trainset 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 Corridor Alternative Retained for Further Analysis

FRA determined 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 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. FRA also determined that portions of the IH-45, BNSF and UPRR Corridors should be retained for further analysis within the *Dallas to Houston High Speed Rail Project Alignment Alternatives Analysis Report* in the event that constraints arose along the Utility Corridor.

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

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

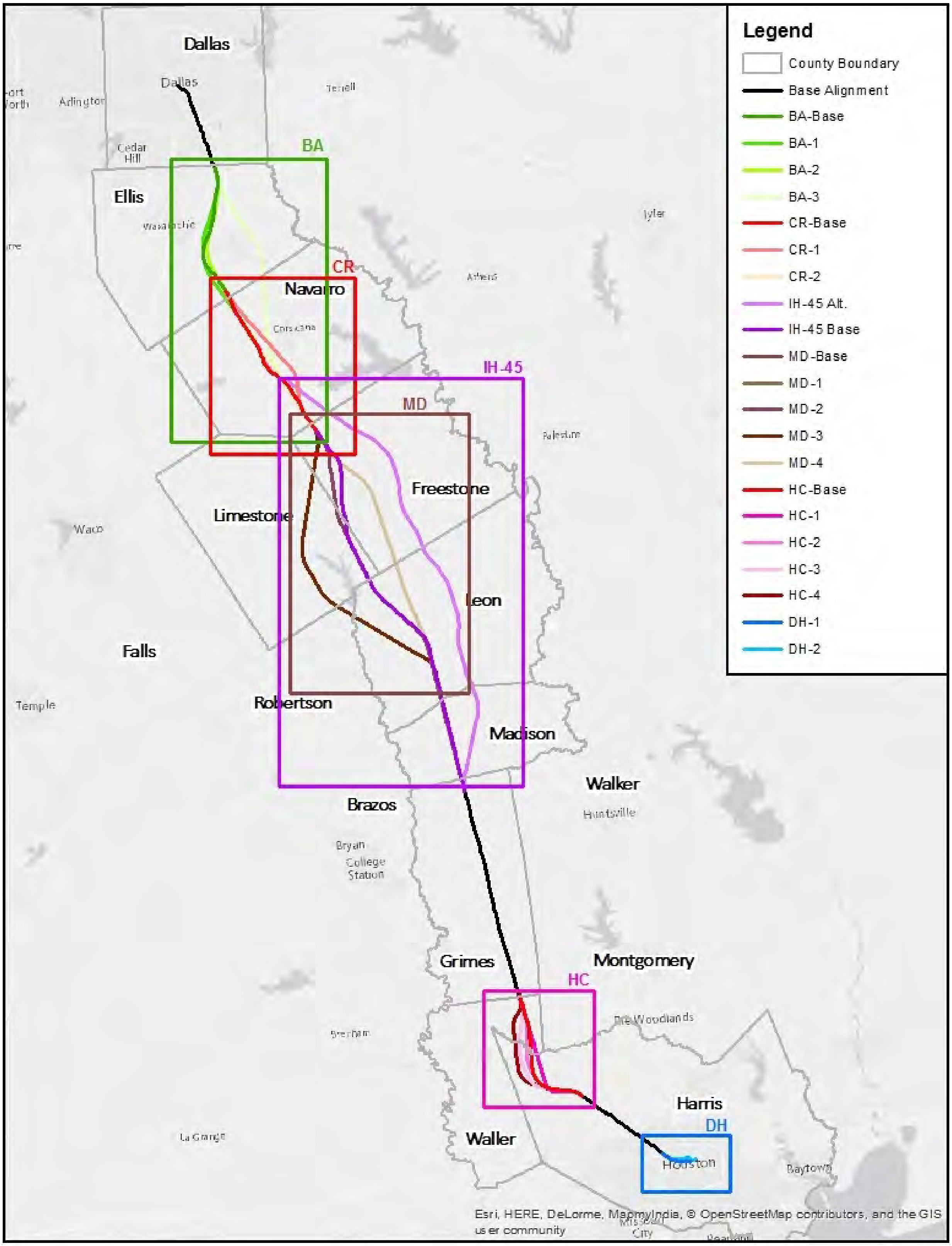
FRA's full *Dallas to Houston High Speed Rail Project Alignment Alternatives Analysis Report*, is available on the FRA Project website: https://railroads.dot.gov/elibrary/dallas-houston-high-speed-rail-project-alignment-alternatives-analysis-report.

2.5.1 Initial Alignment Alternatives

As illustrated on **Figure 2-20**, TCRR evaluated 21 potential initial 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 2-20: 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, Level II Screening**. 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 cause significant environmental impacts and entail prohibitive construction costs.[17] DH-1 would have the potential to cause significant environmental impacts to six areas of concern, including National Historic District Heights Boulevard Esplanade, the U.S. Healthworks Hospital, Houston and Texas Central Railroad archaeology site and Cottage Grove Park. Additionally, DH-1 had the potential to disproportionately impact minority populations. DH-2 also had the potential to create significant environmental impacts to nine areas of concern, including National Historic District Heights Boulevard Esplanade, U.S. Healthworks Hospital, Houston and Texas Central Railroad archaeology site, Cottage Grove Park, Stude Park, White Oak Park and Hogg Park. Given the prohibitive construction costs[18] 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 required 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.[19]

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[17] Texas Central High-Speed Railway, *Last Mile Analysis Report*, March 27, 2015, accessed November 2019, http://www.texascentral.com/wp-content/uploads/2015/11/Last-Mile-Analysis.pdf.

[18] Ibid.

[19] Texas Central High-Speed Railway, *Step 2 Screening of Alignment Alternatives Report*, November 5, 2015, accessed November 2019, 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 Purpose and Need, Alignment Objectives and Design Guidelines	Level II, Stage I Environmental Criteria	Level II, Stage II Combined Environmental Criteria, Cost and Construction Factors	EIS 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 system (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://railroads.dot.gov/elibrary/dallas-houston-high-speed-rail-project-alignment-alternatives-analysis-report.

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 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[a]	Number of NRHP properties and districts within 62.5 feet of the alignment alternatives	National Register of Historic Places
Community Facilities[a]	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[a]	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[a]	Estimated population below the poverty level affected based on census tract data	US Census Bureau (2013 5-year ACS)

Source: AECOM 2016

[a] 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*.[20] 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 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.[21]

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 Screening are also included in **Table 2-1**. These alignment alternatives, in combination with the common segments, were then pieced together to create six end-to-end alignment alternatives (Build Alternatives A through F) described in **Section 2.6, Description of Alternatives**. 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 eight 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[22] using the following criteria: access to existing transportation and roadway networks 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

[20] Texas Central High-Speed Railway, *Step 2 Screening of Alignment Alternatives Report*, November 5, 2015, accessed November 2019, http://www.texascentral.com/wp-content/uploads/2015/11/Step_2_Screening_of_Alignment_Alternatives_Report.pdf.

[21] 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.

[22] Texas Central High-Speed Railway, *Last Mile Analysis Report*, March 27, 2015, accessed November 2019, http://www.texascentral.com/wp-content/uploads/2015/11/Last-Mile-Analysis.pdf.

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 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 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.
- **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 near the BNSF ROW and IH-610. Houston BNSF Station Alternative Location C 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 BNSF Station Alternative Location E:** This station area is near the old Post Office Station (Houston) site, located east of IH-45, west of US 59 and south of IH-10 near the Downtown Aquarium. The site is bounded by Buffalo Bayou, Franklin Street, IH-45 and IH-10. The area is currently identified as mixed use (commercial and industrial). The site provides direct access to Metro LRT, bus transit and Amtrak services. Houston BNSF Station Alternative Location E was identified for consideration because of access to the Texas Medical Center by light rail.
- **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 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, Dallas Station Alternative Location A would offer connectivity to existing DART light rail and bus service. Additionally, it would allow for potential expansion of the TRE commuter rail service and/or Amtrak service. Based on this connectivity, as well as property acquisition and development opportunities, TCRR proposed Dallas Station Alternative Location A to FRA. FRA adopted and carried forward Dallas Station Alternative Location A for further independent evaluation in this EIS.

As discussed in **Section 2.4.1, Description of Corridor Alternatives**, the BNSF Corridor was eliminated from further consideration as part of FRA's *Corridor Alternatives Analysis*. With the identification 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.

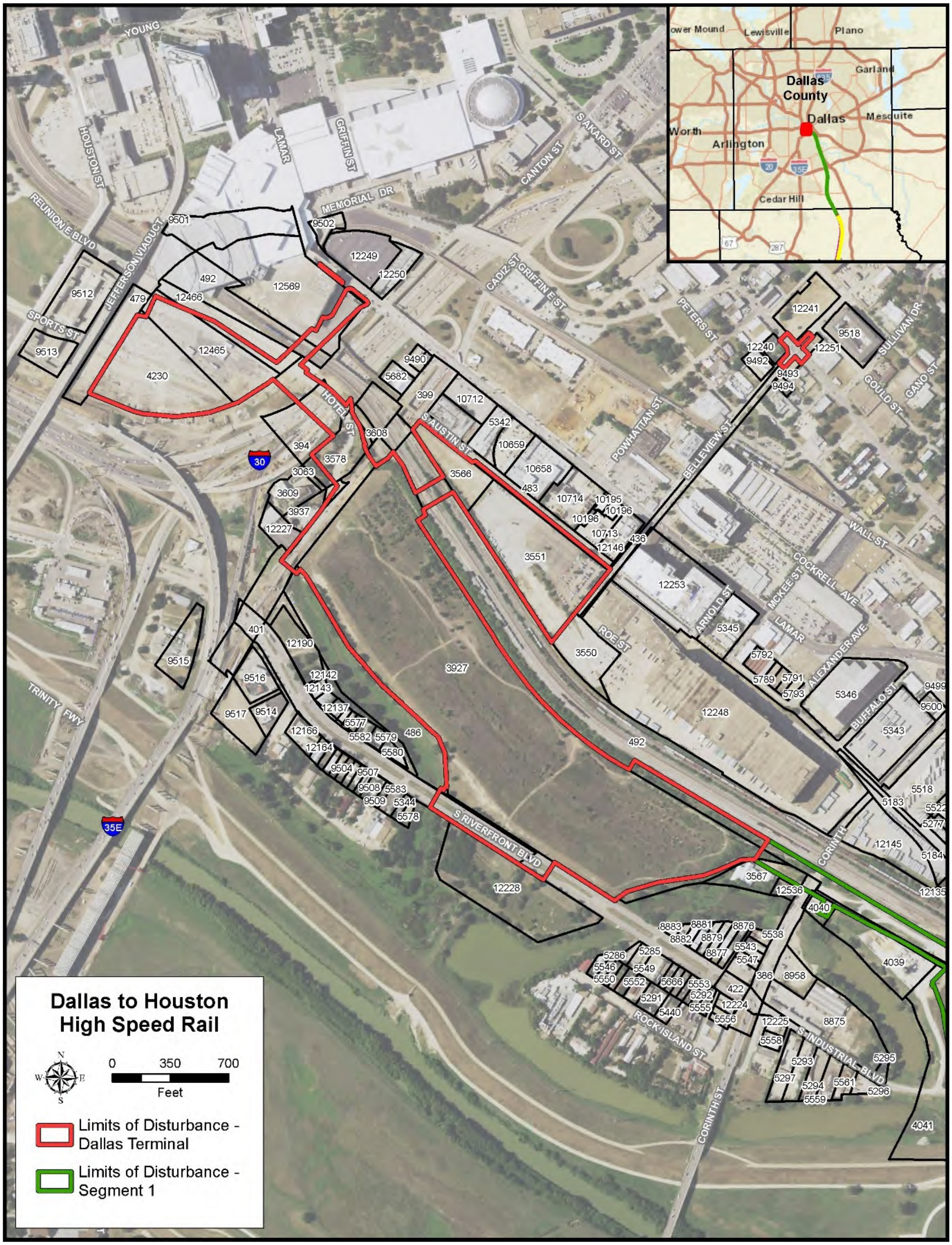
Additionally, as discussed in **Section 2.5.1, Initial Alignment Alternatives**, alternative alignments connecting to Downtown Houston (DH) were eliminated from further consideration as part of FRA's *Alignment Alternatives Analysis*. This eliminated Houston UC Station Alternative Location C, which would 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 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. Based on this connectivity, as well as property acquisition and development opportunities, TCRR proposed Houston UC Station Alternative Location B. As part of the development of Houston UC Station Alternative Location B, TCRR identified three potential station sites within the area. These three sites – Industrial Site Terminal Station Option, Northwest Mall Terminal Station Option and Northwest Transit Center Terminal Station Option – have been carried forward by FRA for independent evaluation and are discussed in more detail in **Section 2.5.2.3, Houston Terminal Station Options**.

2.5.2.2 Dallas Terminal Station

One station is proposed at the Dallas terminus 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 2-21** 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 Final Conceptual Engineering Design and Constructability Reports**).

Figure 2-21: Dallas Terminal



Source: AECOM 2019

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). The City of Dallas is initiating a study for a new multimodal transit station north of the Project Area, with potential future extensions to DART and the TRE commuter rail service, currently terminating at Union Station.[23]

2.5.2.3 Houston Terminal Station Options

Three station options are proposed for the Houston terminus and would be common to all six Build Alternatives and would be located in northwest Houston within the vicinity of US 290, IH-10 and IH-610. **Figure 2-22** through **Figure 2-24** show the proposed station option locations and footprints. 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 Final Conceptual Engineering Design and Constructability Reports**).

- **Industrial Site Terminal Station Option:** The first option would use an industrial site located south of Hempstead Road, west of Post Oak Road and north of Westview Drive.
- **Northwest Mall Terminal Station Option:** The second option 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 West 18th Street.
- **Northwest Transit Center Terminal Station Option:** The third option, 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.

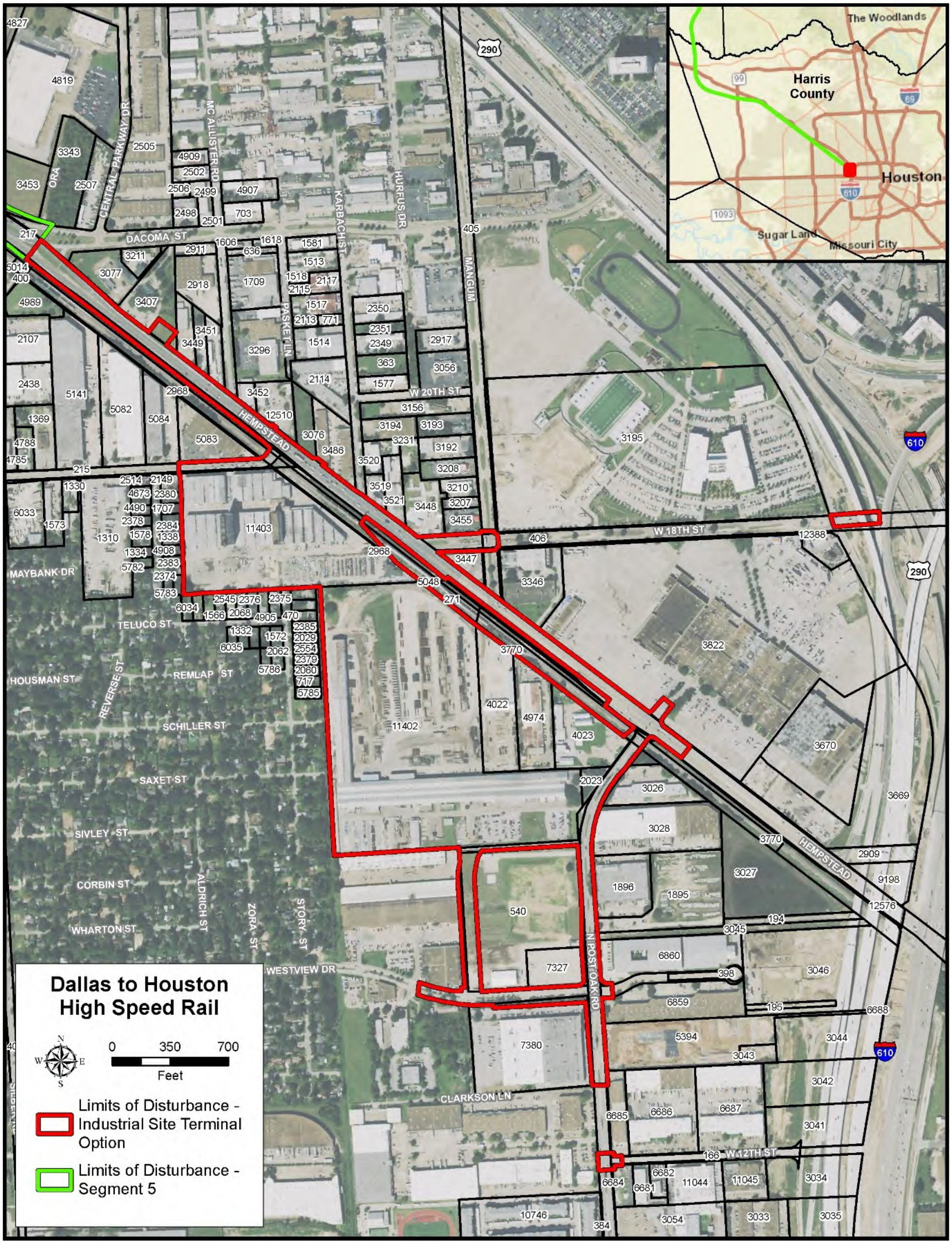
As three station options were proposed for the Houston terminus, this Final EIS conducted an assessment of all three sites as discussed in **Section 2.7.3, Comparison of Houston Terminal Station Option Alternatives**.

2.5.2.4 Brazos Valley Intermediate Station

One intermediate station is proposed in Grimes County, near Roan's Prairie, and would apply to Build 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 2-25** shows the proposed station location and footprint. The overall footprint includes the station building (ticketing, concessions, security, platforms, etc.) parking facilities, siding track, pedestrian access and roadway improvements (see **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports**).

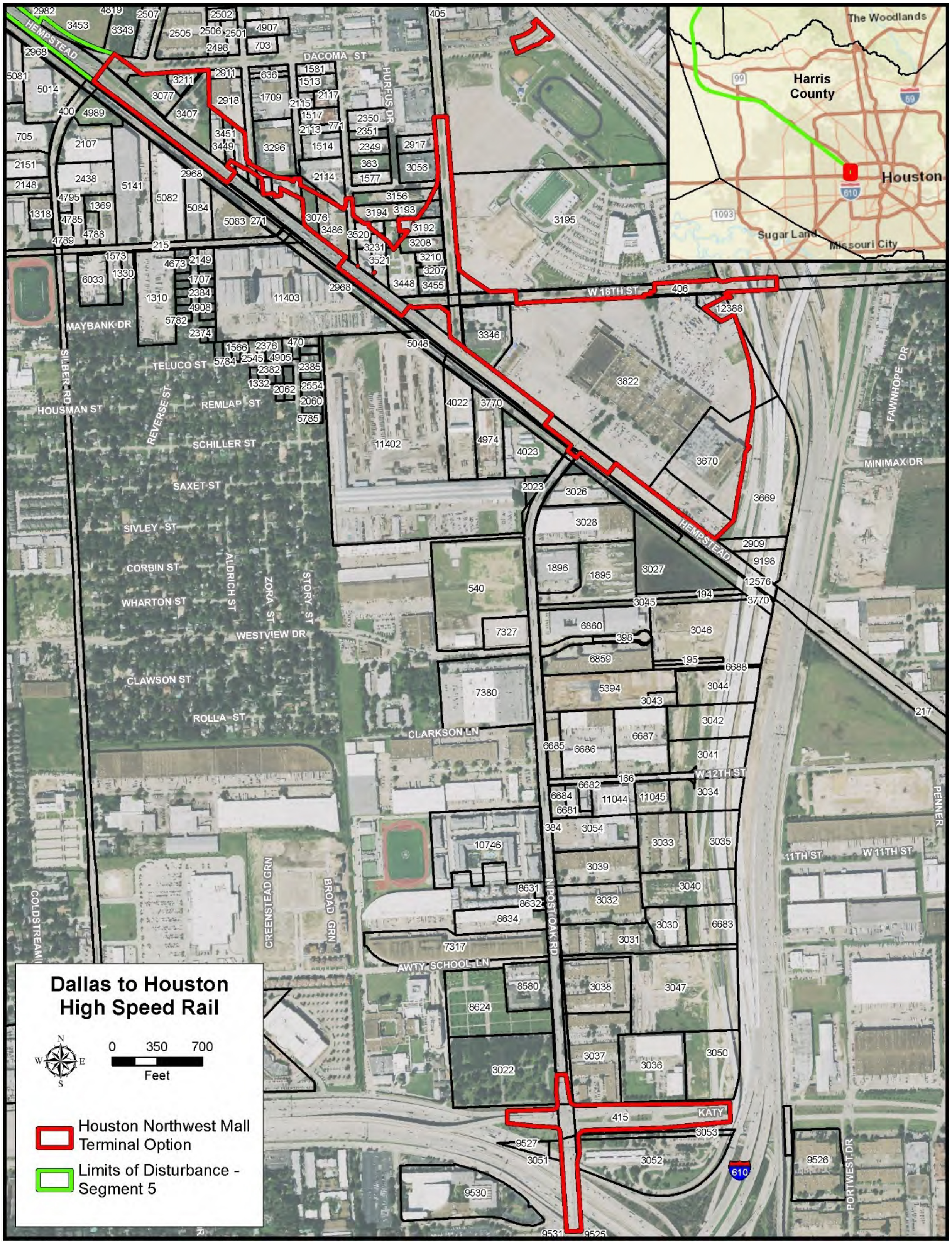
[23] City of Dallas, "High Speed Rail Update," October 8, 2018, accessed December 2019, https://dallascityhall.com/projects/high-speed-rail/DCH%20Documents/2018-10-8%20MSIS%20High%20Speed%20Rail%20-%20Final.pdf.

Figure 2-22: Houston Industrial Site Terminal Station Option



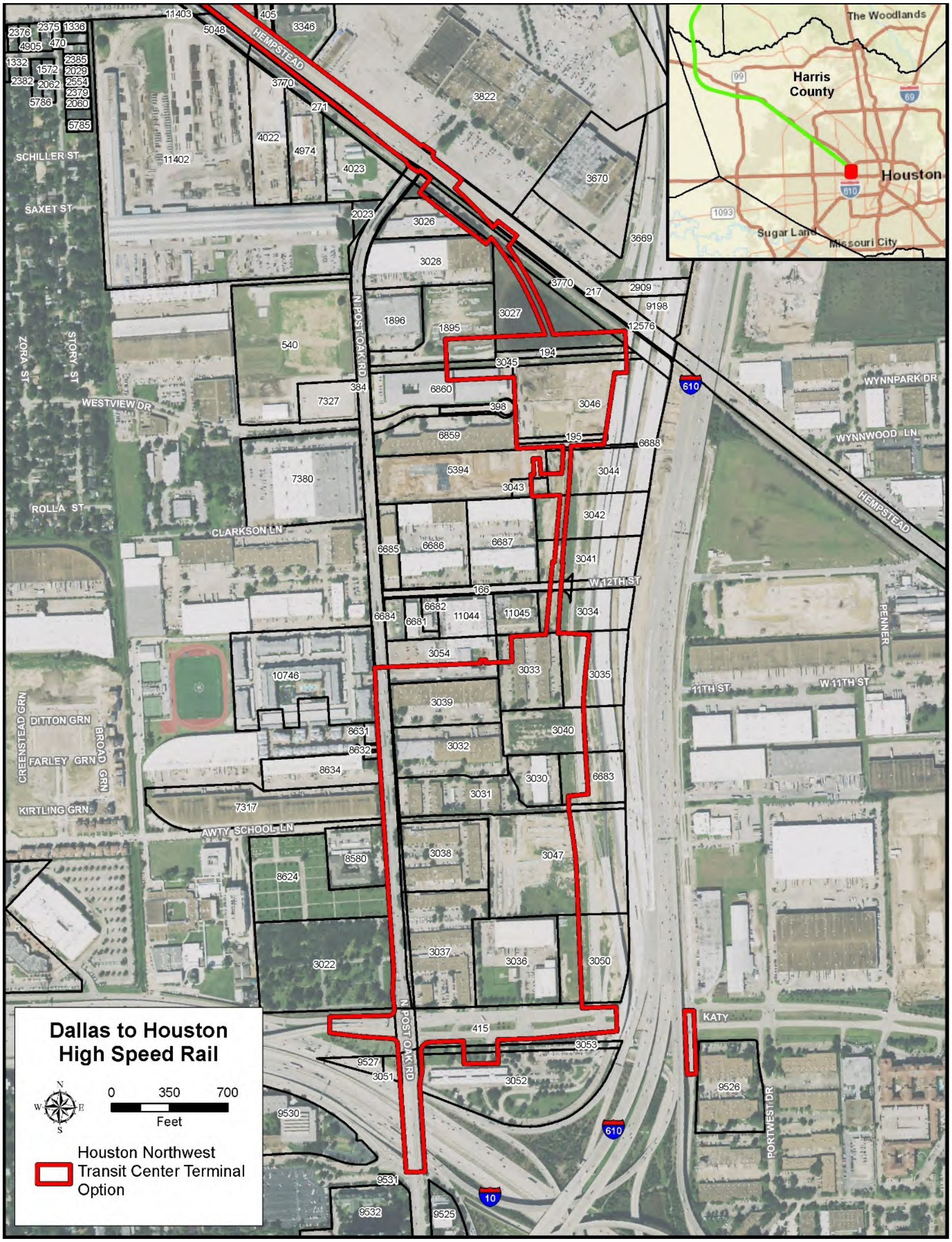
Source: AECOM 2019

Figure 2-23: Houston Northwest Mall Terminal Station Option



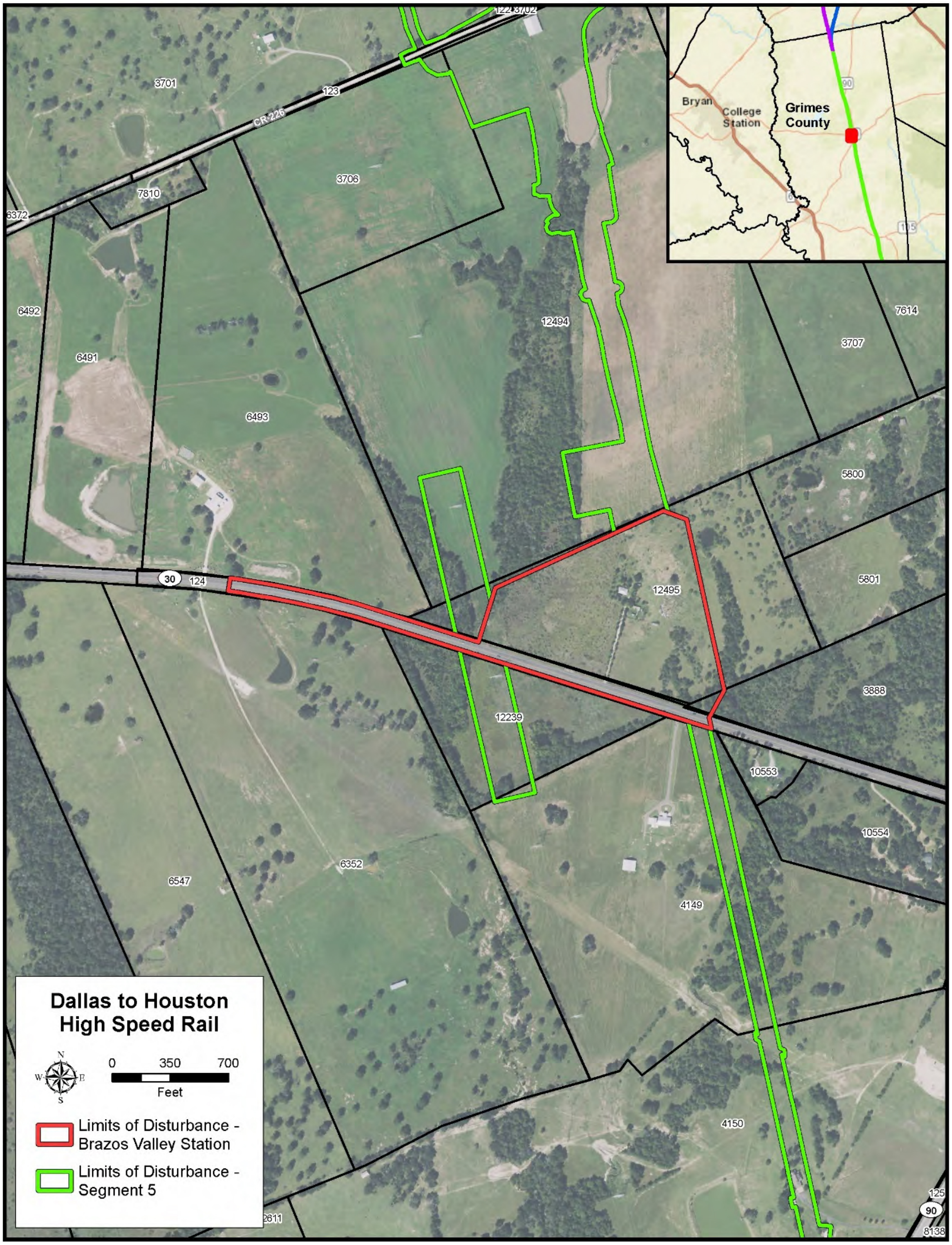
Source: AECOM 2019

Figure 2-24: Houston Northwest Transit Center Terminal Station Option



Source: AECOM 2019

Figure 2-25: Brazos Valley Intermediate Station



Source: AECOM 2019

2.5.3 Initial Trainset Maintenance Facility Alternatives

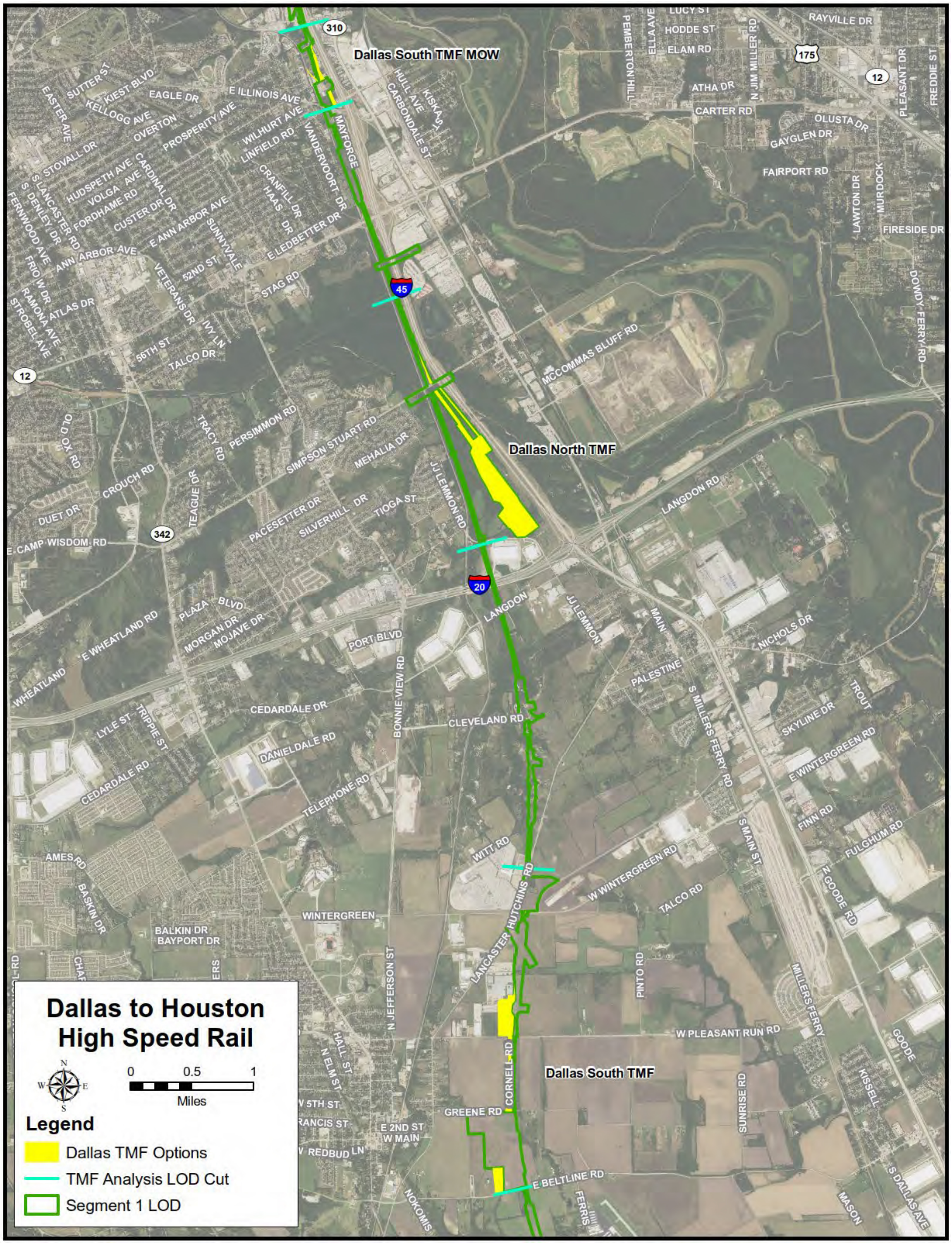
Based on FRA's initial review and screening of the alignment alternatives, TCRR proposed five potential TMF sites (**Figure 2-26** and **Figure 2-27)**. Two of the sites (one in each county) would also require an additional MOW facility to support the operation of the HSR system. This section summarizes the process that FRA undertook to identify the TMF sites that are evaluated in this EIS. FRA's full report is included in **Appendix E, Trainset Maintenance Facility Alternatives Analysis Technical Memorandum**.

TCRR proposed two locations for the TMF in Dallas County, the Dallas North TMF and Dallas South TMF. The Dallas North TMF site would be located north of IH-20 within the City of Dallas, about 7.5 miles from the Dallas Terminal Station. The Dallas South TMF site would be located north of Belt Line Road, approximately 12 miles from the Dallas Terminal Station. The Dallas South TMF would require an additional MOW facility between the TMF and the Dallas Terminal Station, while the Dallas North TMF site would not. For the Draft EIS, FRA evaluated these Dallas locations. However, TCRR's ongoing coordination with stakeholders indicated that the Dallas International Intermodal Terminal and related developments in south Dallas have continued to progress since the release of the Draft EIS. Because of these ongoing developments, TCRR determined that the Dallas South TMF site was not a viable option for the Project, as indicated in **Section 2.5.4, Engineering Refinements**. Both the Dallas North and South TMF sites based on TCRR's updated Project LOD are assessed in this Final EIS.

TCRR also proposed two locations for the TMF in Harris County prior to the Draft EIS. The Houston North TMF site would be located near US 290 and Katy Hockley Road, approximately 27 miles from the Houston Terminal Station options. The Houston South TMF site would be located east of Beltway 8 and south of Hempstead Road, approximately 8.5 miles from the Houston Terminal Station options. The Harris North TMF site and the Houston North TMF site would require an additional MOW facility between the TMF and the Houston Terminal Station, while the Houston South TMF site would not. In the Draft EIS, FRA evaluated the Houston North and Houston South TMF sites. However, due to ongoing stakeholder outreach and engineering design updates detailed in **Section 2.5.4, Engineering Refinements**, and subsequent to the publication of the Draft EIS, TCRR proposed a third location for the Houston TMF, the Harris North TMF site on Castle Road. The Harris North TMF site would be located on Castle Road in northern Harris County, approximately 34 miles from the Houston Terminal Station options. Therefore, all Harris County TMF sites based on TCRR's updated Project LOD are assessed in this EIS. The Harris North TMF site and the Houston North TMF site would require an additional MOW facility between the TMF and the Houston Terminal Station, while the Houston South TMF site would not.

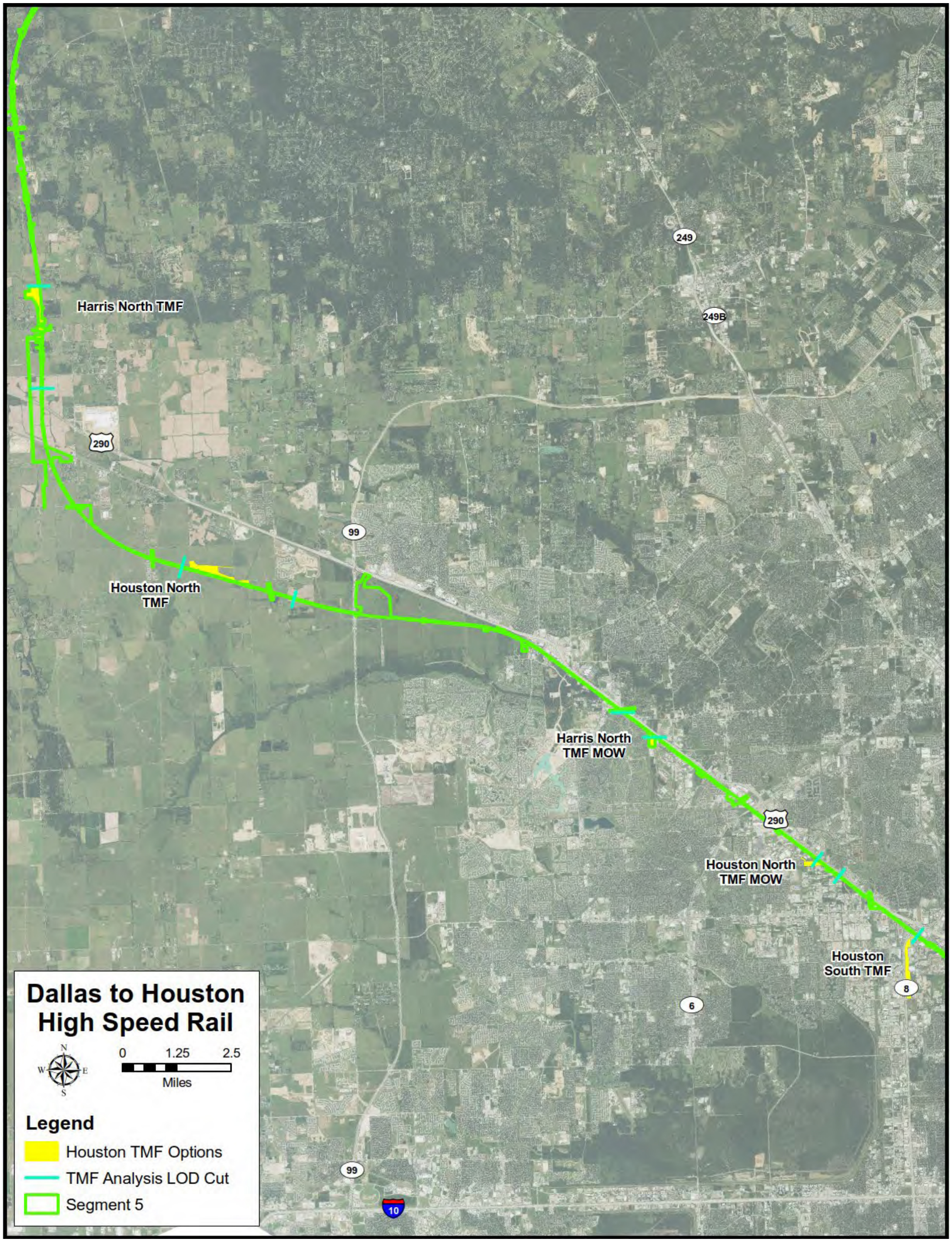
FRA completed an independent review of the five locations for the two TMF sites using a desktop evaluation of publicly available resources similar to the Level II Screening discussed in **Section 2.5.1.2, Level II Screening**. FRA conducted a GIS analysis on 19 environmental evaluation criteria using 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 evaluated the TMF locations in each 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. The results of these assessments for Dallas and Harris County TMFs are summarized in **Table 2-3** and **Table 2-4**. The highlighted cells show the least potentially impactful site for each criterion.

Figure 2-26: Dallas TMF Site Options



Source: AECOM 2019

Figure 2-27: Houston TMF Site Options



Source: AECOM 2019

Table 2-3: Dallas TMF Results										
	Land Use	Structures	Parcel Takes	Prime Farmland	Wetlands	Waterways	Floodplains	Road Crossings	Population below poverty	Minority population
	Acres	No.	No.	Acres	Acres	No.	Acres	No.	No.	No.
Dallas North TMF Site	511.82	31	58	166.96	21.86	13	89.91	48	17	19
Dallas South TMF Site	462.00	35	62	202.91	18.80	11	74.66	60	19	21
Net Difference	49.82	4	4	35.96	3.36	2	15.26	12	2	2

Source: AECOM 2019

Table 2-4: Houston TMF Results										
	Land Use	Structures	Parcel Takes	Prime Farmland	Wetland	Waterway	Floodplain	Road Crossings	Hazardous Materials Sites	
	Acres	No.	No.	Acres	Acres	No.	Acres	No.	Low Risk	Moderate Risk
Harris North TMF	1,655.06	224	103	1,021.15	136.18	67	39.90	124	1	1
Houston North TMF	1,674.09	224	100	1,040.17	137.55	69	39.90	124	0	0
Houston South TMF	1,607.68	239	108	933.38	134.36	66	44.18	128	3	0
Net Difference	66.41	15	8	106.79	3.19	3	3.19	4	3	1

Source: AECOM 2019

Based on the above data, the Dallas North TMF Site would impact fewer structures, parcels, prime farmland and roads. The Dallas South TMF site would impact fewer wetlands, waterways and floodplains compared to the Dallas North TMF site. However, due to engineering design constraints detailed in **Section 2.5.4, Engineering Refinements,** the Dallas South TMF Site was eliminated from further consideration.

FRA's more detailed desktop analysis indicated the Harris North TMF Site would require less acreage and create fewer environmental impacts to wetlands and waterways compared to the Houston North TMF Site. The Houston South TMF Site would have the greatest impact to floodplains and hazardous materials sites. Due to their potential to create greater environmental impacts (including acquisition for the Houston South TMF Site) and engineering design constraints detailed in **Section 2.5.4, Engineering Refinements**, the Houston North and South TMF Sites were eliminated from further consideration.

Therefore, the Dallas North TMF and Harris North TMF Sites were carried forward for further FRA review including fieldwork, modeling and detailed technical evaluation as part of the overall Project LOD in **Chapter 3.0, Affected Environment and Environmental Consequences**.

2.5.4 Engineering Refinements

Throughout the NEPA process, TCRR has continually refined the design of the Build Alternatives to reduce the Project footprint, or LOD, and avoid or minimize impacts to the socioeconomic, natural, cultural and physical environment. These engineering refinements were based on environmental and engineering surveys, stakeholder engagement, public input, design development and the findings of FRA's environmental analyses. Therefore, the Build Alternatives depicted in this EIS differ from the alignment alternatives presented in the Draft EIS.

Based on input received by TCRR through their stakeholder engagement efforts, these refinements resulted in the use of viaduct on approximately 55 percent of the Project, which would allow for greater movement around and under the HSR system. Additionally, TCRR designed 48 percent of the Build Alternatives adjacent to existing infrastructure, which typically includes areas that have previously been disturbed by past development. This design approach minimizes impacts to more environmentally sensitive areas and reduces 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 that may affect or be affected by the Project. TCRR's coordination efforts with the USACE focused on fee lands, streams, wetlands and floodplains. Through coordination with utility infrastructure owners TCRR identified expected approaches to maintenance and protection of utilities along the Build Alternatives. Through coordination with electrical transmission service providers within the Study Area, including Oncor Electric Delivery (Oncor) and CenterPoint Energy (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 (although these modifications and connections would ultimately be determined by Oncor and CenterPoint, as well as the Public Utility Commission of Texas (PUCT)).

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 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*.[24] TCRR also coordinated design development with various transportation providers within the corridor, such as DART, Gulf Coast Commuter Rail District and the Metropolitan Transit Authority of Harris County (see **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports**). These planned projects and others are discussed in more detail in **Chapter 4.0, Indirect Effects and Cumulative Impacts**.

Design modifications made by TCRR since the Draft EIS resulted in approximately 17.5 percent of the track centerline being shifted to an area outside of the previous LOD. Also, as a result of these design modifications, the overall footprint of the Project was reduced by approximately 23 percent.

[24] City of Lancaster, *Lancaster Regional Airport Master Plan*, accessed May 2020, http://lancaster-tx.com/DocumentCenter/View/2765/Lancaster-Regional-Airport-Master-Plan?bidId=.

2.5.4.1 Engineering Refinements between Draft and Final EIS

2.5.4.1.1 Updated LOD Definition

The LOD in this Final EIS has been updated to include areas where modifications to existing electrical transmission line infrastructure would also be required. This aspect of the Project was generally described in the Draft EIS in **Chapter 4.0, Indirect Effects and Cumulative Impacts,** as an activity that would be designed and led by impacted utilities. Through further coordination with transmission providers (e.g., Oncor and CenterPoint), TCRR has refined (1) anticipated modifications to electrical transmission infrastructure along all Build Alternatives and (2) anticipated connections with existing power grid to serve the traction power demand of the Project. FRA's independent coordination with these utility providers (summarized in **Chapter 9.0, Public and Agency Involvement**) has confirmed that the design assumptions (included as **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports,** and **Appendix G, TCRR Final Conceptual Engineering Plans and Details**) are reasonable, and as such have been included by the FRA within the LOD of this Final EIS. Impacts associated with the anticipated modification of existing electrical transmission lines are discussed throughout **Chapter 3.0, Affected Environment and Environmental Consequences,** while the potential impacts associated with the construction of new electrical transmission lines are included in **Chapter 4.0, Indirect Effects and Cumulative Impacts.**

2.5.4.1.2 Preferred Alternative Design Refinement

After release of the Draft EIS, TCRR continued to refine and optimize the design of the Preferred Alternative, Build Alternative A, in order to address stakeholder input, respond to comments, reduce and avoid adverse environmental impacts identified during the Draft EIS and improve constructability. Revisions to Build Alternative A are categorized into four main groups and generally described in the following sections, with additional details located in **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports,** and **Appendix G, TCRR Final Conceptual Engineering Plans and Details**.

Alignment and Profile Refinements and Optimizations

- **Richmond Realignment**: The alignment of Segment 3A near the City of Richmond in Navarro County was optimized to minimize impacts to existing county roads and shifted east in response to several thousand public comments about potential natural resources and stakeholder impacts.
- **Ennis Realignment**: The alignment of Segment 2A near the City of Ennis in Ellis County was shifted west to avoid parcels with documented environmental contamination.
- **Castle Road Realignment**: The alignment of Segment 5 was shifted east to reduce impacts to a historic property (Resource ID HA.004a) that is eligible for listing in the National Register of Historic Places (NRHP).
- **Hempstead Road Revisions**: The alignment configuration and profile elevation of Segment 5 adjacent to Hempstead Road in Houston were revised to account for the US 290/Hempstead managed lanes project and planned improvements to Hempstead Road as defined through ongoing coordination with TxDOT and City of Houston.

Station Design Refinements and Optimizations

- **Houston Northwest Mall Terminal Station Option**: Station optimized and refined to align parallel with Hempstead Road and shifted to the northwest to account for the US 290/Hempstead managed lanes project and planned improvements to Hempstead Road.

- **Dallas Terminal Station**: The approach into the Dallas Terminal Station was refined to more closely follow the UPRR freight railroad and to decrease distance to DART's Cedars Station. The Dallas Terminal Station was refined to address USACE and stakeholder inputs received as part of TCRR's initial Section 408 permission request and coordination with the City of Dallas (i.e., Dallas City Council Resolution No. 17-1200,[25] which terminated the planned Trinity Parkway).

General HSR Program Refinements and Optimizations

- **Houston TMF Relocation**: Due to planned developments, land ownership changes, and to account for the raised HSR profile to allow for the Houston Major Thoroughfare and Freeway Plan, the TMF location was shifted north along the Castle Road realignment.
- **Houston MOW Facility Relocation**: To eliminate conflicts with the proposed TXDOT US 290/Hempstead managed lane project, refinements also included the relocation of the Houston MOW facility.
- **Systems Relocations**: Based on input from utility providers in the Project corridor, several TPSSs were relocated. Refinements also included relocations of smaller facilities (sectioning posts, communication houses, etc.) to coincide with access road and reflect updated design criteria, such as spacing requirements for communication houses.
- **Dallas TMF**: The Draft EIS identified the Dallas South TMF site as the preferred location; however, following the publication of the Draft EIS the Dallas International Intermodal Terminal and related developments in south Dallas advanced and precluded the development of a TMF at the Dallas South location. Consequently, the Dallas North TMF is the only remaining viable location for the Dallas TMF.
- **Emergency Access**: Design was updated to include emergency response and maintenance staging areas (ERMSA).

LOD Refinements and Optimizations

- **Reduced Viaduct**: Throughout Build Alternative A, the width of viaduct sections was reduced with continued engineering to minimize impacts to environmentally sensitive floodplains and wetlands.
- **Facility Placement**: Throughout Build Alternative A, ancillary facilities such as detention basins, systems facilities, access roads and other Project elements were reconfigured, consolidated or relocated to avoid environmentally sensitive areas or to avoid impacts to multiple parcels.
- **Road Over Rail**: TCRR reduced road over rail crossings that require reconfiguration of existing county roads (and other private roads where practicable).

While refinements occurred to Build Alternative A, all six Build Alternatives (A through F) are assessed in this EIS.

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 Project (Build Alternatives A through F and Houston Terminal Station options). This is also known as the alternative of no action as required by NEPA. Under the No Build Alternative, FRA would not issue an RPA 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.

[25] City of Dallas, Official Action of the Dallas City Council, 17-1200, Item 49, August 9, 2017, accessed May 2020, http://citysecretary2.dallascityhall.com/pdf/CC2017/080917Min.pdf.

Travel between Dallas and Houston would continue via existing highway (IH-45) and airport (DFW, DAL, IAH and HOU) infrastructure. For purposes of describing future transportation conditions in 2040 under the No Build Alternative, planned and programmed projects were included in traffic modeling detailed in **Section 3.11, Transportation**. Additional projects included in the No Build Alternatives are the Integrated Pipeline Project in Navarro and Ellis Counties. The impacts of these projects are discussed in **Section 4.4, Indirect Effects and Cumulative Impacts, Cumulative Impacts**.

The No Build Alternative would not meet the specified Purpose and Need for this Project. The No Build Alternative would not provide congestion relief, improve safety on IH-45, or 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 the six end-to-end Build Alternatives A through F considered in this EIS. For analytical purposes in this EIS, each alternative is divided into segments, as depicted on **Figure 2-28**. Segment descriptions are included to illustrate the differences between the Build Alternatives. Segment descriptions include identification of more significant facilities such as stations, TMFs, MOW facilities and TPSSs only.

2.6.2.1 Segment 1 (18.3 miles)

Segment 1 is located in Dallas County (**Appendix D, Project Footprint Mapbook, Sheets 1-24**). 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 East 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, North Lancaster/Hutchins Road, East Pleasant Run Road and East Beltline Road. South of East 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.

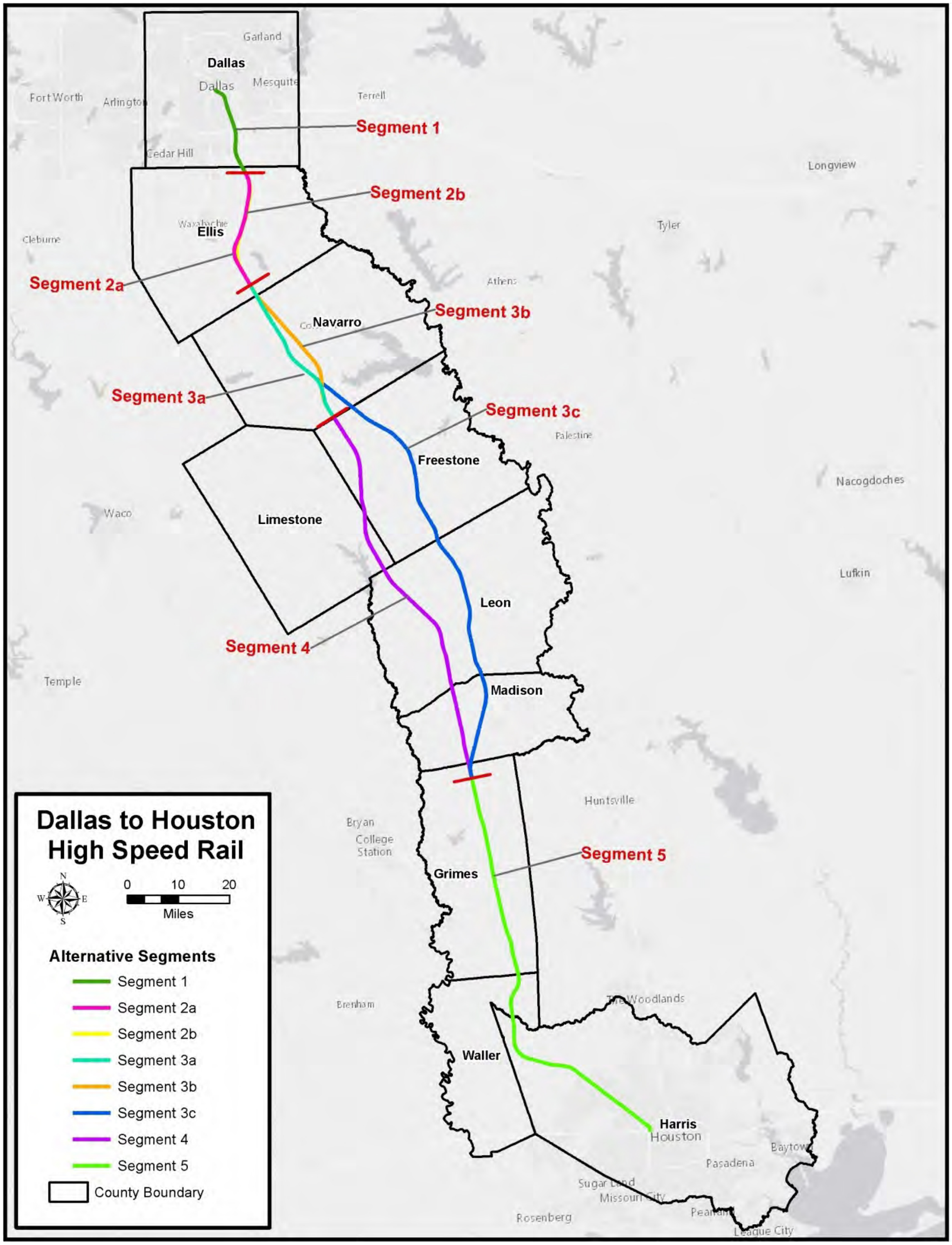
Segment 1 includes the Dallas Terminal, Dallas TMF and a TPSS. The locations of these facilities are outlined in **Table 2-5**.

Table 2-5: Facility Locations on Segment 1

Type of Facility	Proposed Location(s)
Dallas Terminal	IH-30 and Lamar Street
Dallas TMF	Between Simpson Stuart Road and JJ Lemmon Road, west of IH-45
TPSS	Wilson and Watermill

Source: TCRR 2019

Figure 2-28: Build Alternatives Advanced to EIS, by Segment



Source: AECOM 2019

2.6.2.2 Segment 2A (23.4 miles)

Segment 2A is located in Ellis County (**Appendix D, Project Footprint Mapbook, Sheets 24-55**). Segment 2A begins approximately 1.5 miles south of the Ellis County line, crossing FM 983 and Wester Road. 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 facility 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	Bacak Road and eastbound lane (north of FM 34)
TPSS	Old Waxahachie Road and Boren Drive

Source: TCRR 2019

2.6.2.3 Segment 2B (23.2 miles)

Segment 2B is located in Ellis County (**Appendix D, Project Footprint Mapbook, Sheets 56-87**). 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 facility 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 2019

2.6.2.4 Segment 3A (30.8 miles)

Segment 3A is located in Ellis and Navarro Counties (**Appendix D, Project Footprint Mapbook, Sheets 87-124**). Segment 3A begins 2 miles north of the Navarro County line and deviates from Segment 3b just south of FM 985 before it would cross into Navarro County. Segment 3A continues south towards Barry, passes to the east of Barry and crosses FM 22. The alignment continues southeast, crossing FM 744 and SH 31 west 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 at the Navarro–Freestone County line. 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 CR 5137
TPSS	SH 709 and FM 3194

Source: TCRR 2019

2.6.2.5 Segment 3B (31.1 miles)

Segment 3B is located in Ellis and Navarro Counties (**Appendix D, Project Footprint Mapbook, Sheets 125-163**). 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 at the Navarro–Freestone County line.

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 southwest CR 1000
TPSS	SH 709 and southwest CR 30

Source: TCRR 2019

2.6.2.6 Segment 3C (113.1 miles)

Segment 3C is located in Navarro, Freestone, Leon, Madison and Grimes Counties (**Appendix D, Project Footprint Mapbook, Sheets 164-312**). West 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 six 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	SH 22 and CR 5137
TPSS	SH 709 and FM 3194
TPSS	TX 27 and IH-45
TPSS	IH-45 and CR 660
TPSS	IH-45 and CR 304
TPSS	FM 978 and FM 2289

Source: TCRR 2019

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 313-415**). Segment 4 begins at the Freestone County line and travels southeast crossing over FM 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 US 79. It continues south crossing FM 391 as it travels towards Concord and crosses SH 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, 2019

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 415-524**). Segment 5 continues south along the utility easement, crossing FM 155 and 39, before crossing SH 30 just west of Roans Prairie, and the proposed Brazos Valley Intermediate 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 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 the Brazos Valley Intermediate Station, one TMF, two MOW facilities, one siding off track and four 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	CR 123 and CR 126
TPSS	TX 90 and SH 39/CR 155
Brazos Valley Intermediate Station	TX 90 and SH 30
Siding Off Tracks	FM 1774 and CR 215
TPSS	High Oaks Drive and CR 311
TMF	Waller-Spring Creek Road and Binford Road
TPSS	Betka Road and Kickapoo Road
TPSS	Hempstead Highway and Huffmeister Road
MOW	Telge Road and US 290

Source: TCRR, 2019

Table 2-13 illustrates which segments create each Build Alternative. Each of the Build Alternatives, A through F, are designed for the proposed HSR infrastructure and operations outlined in **Section 2.2, Proposed HSR Infrastructure and Operations,** and are illustrated on **Figure 2-29** through **Figure 2-34**.

2.6.2.9 Houston Terminal Station Options

As detailed in **Section 2.5.2.3, Houston Terminal Station Options**, the Houston Terminal Station would be located in northwest Houston within the vicinity of US 290, IH-10 and IH-610. The three terminal station options are the Industrial Site, Northwest Mall and Northwest Transit Center (**Figure 2-22** through **Figure 2-24**).

- **Industrial Site Terminal Station Option:** The first proposed option would use an industrial site located south of Hempstead Road, west of Post Oak Road and north of Westview Drive.
- **Northwest Mall Terminal Station Option:** The second proposed station option 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 West 18th Street.
- **Northwest Transit Center Terminal Station Option:** The third proposed option 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.

2.6.3 Summary of Build Alternatives

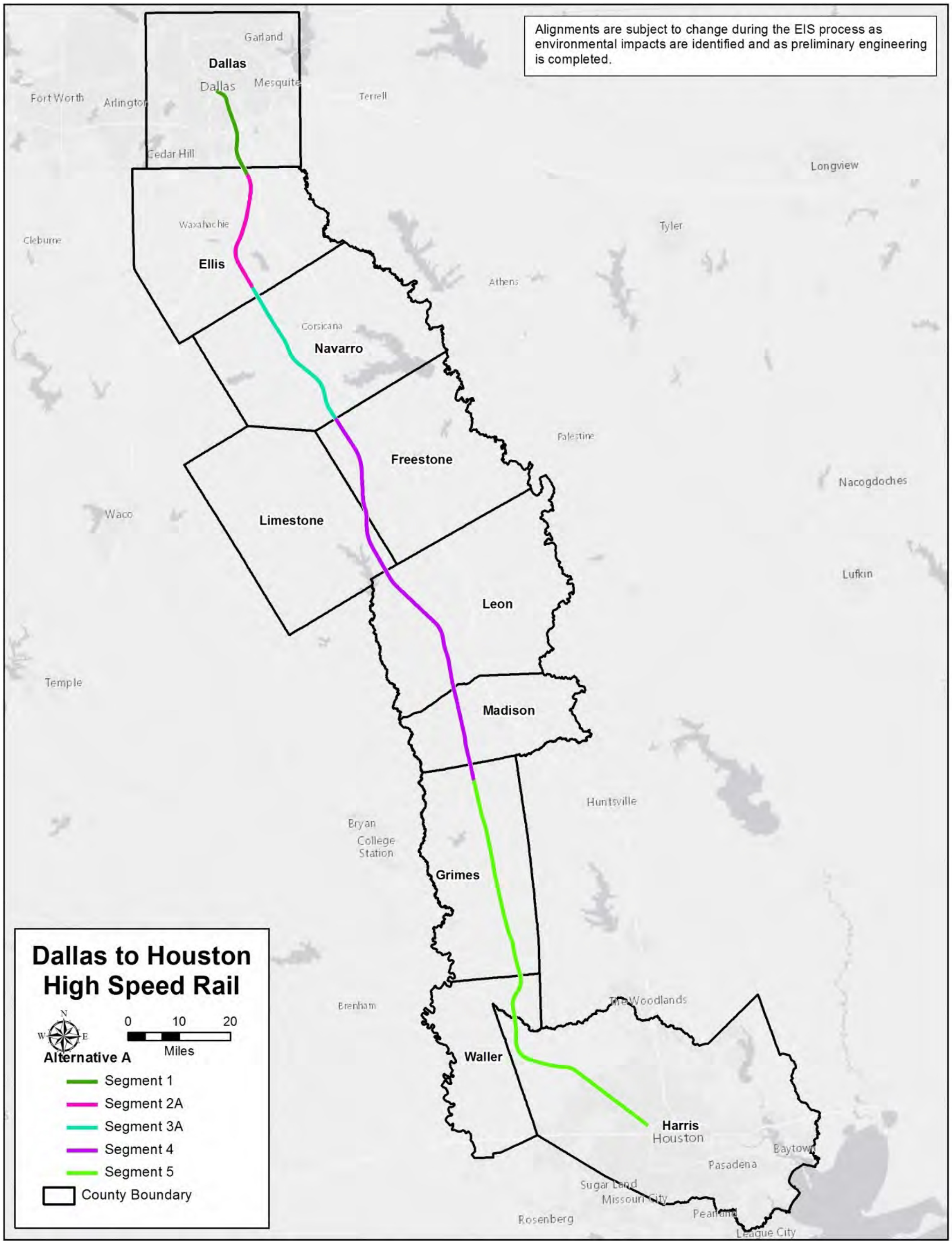
Table 2-13 identifies the segments that create each Build Alternative and **Figure 2-29** through **Figure 2-34** illustrate the six end-to-end Build Alternatives. Detailed maps can be found in **Appendix D, Project Footprint Mapbook**.

Table 2-13: Build Alternatives A through F

Alternative	Segment
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

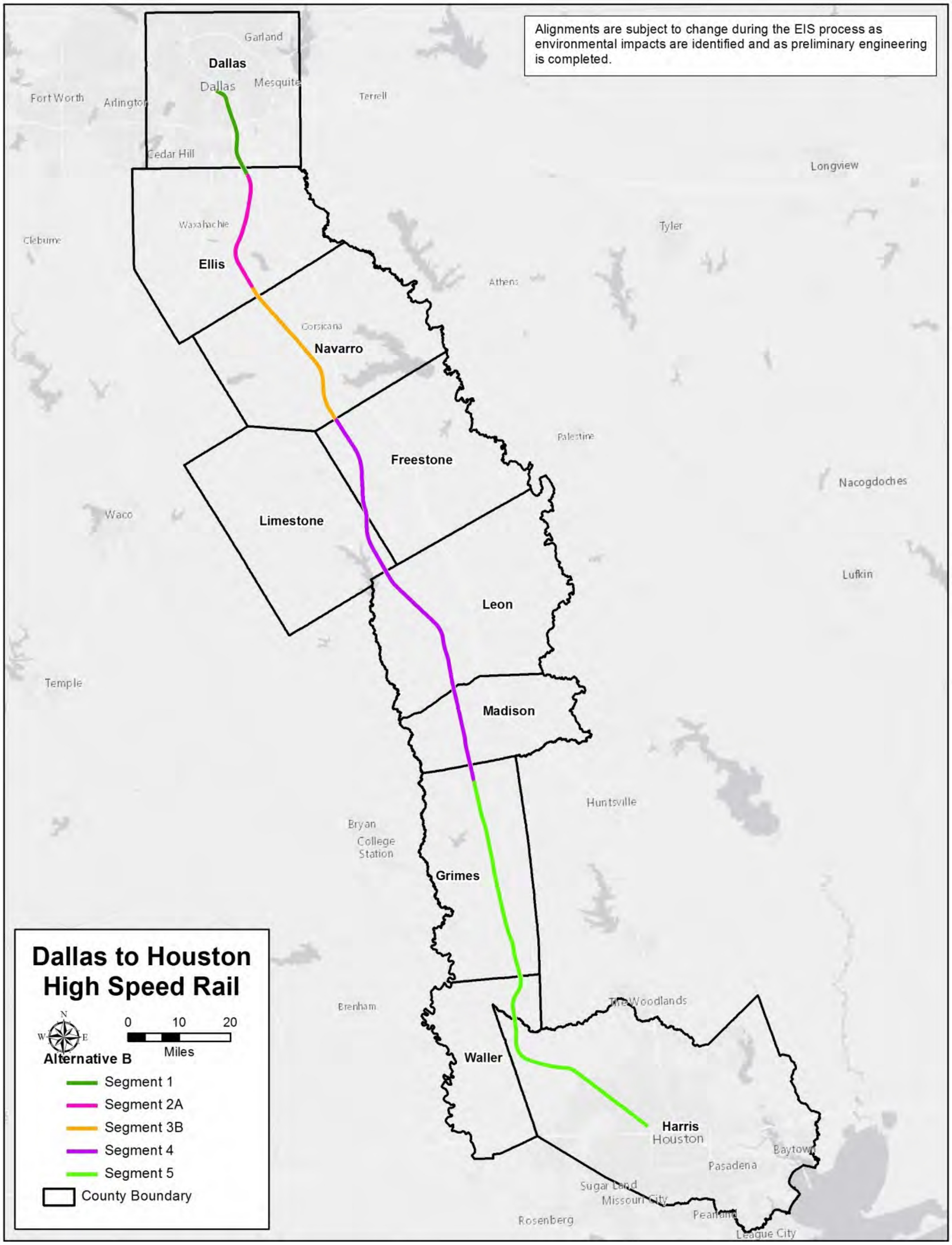
Source: AECOM 2016

Figure 2-29: EIS End-to-End Build Alternative A



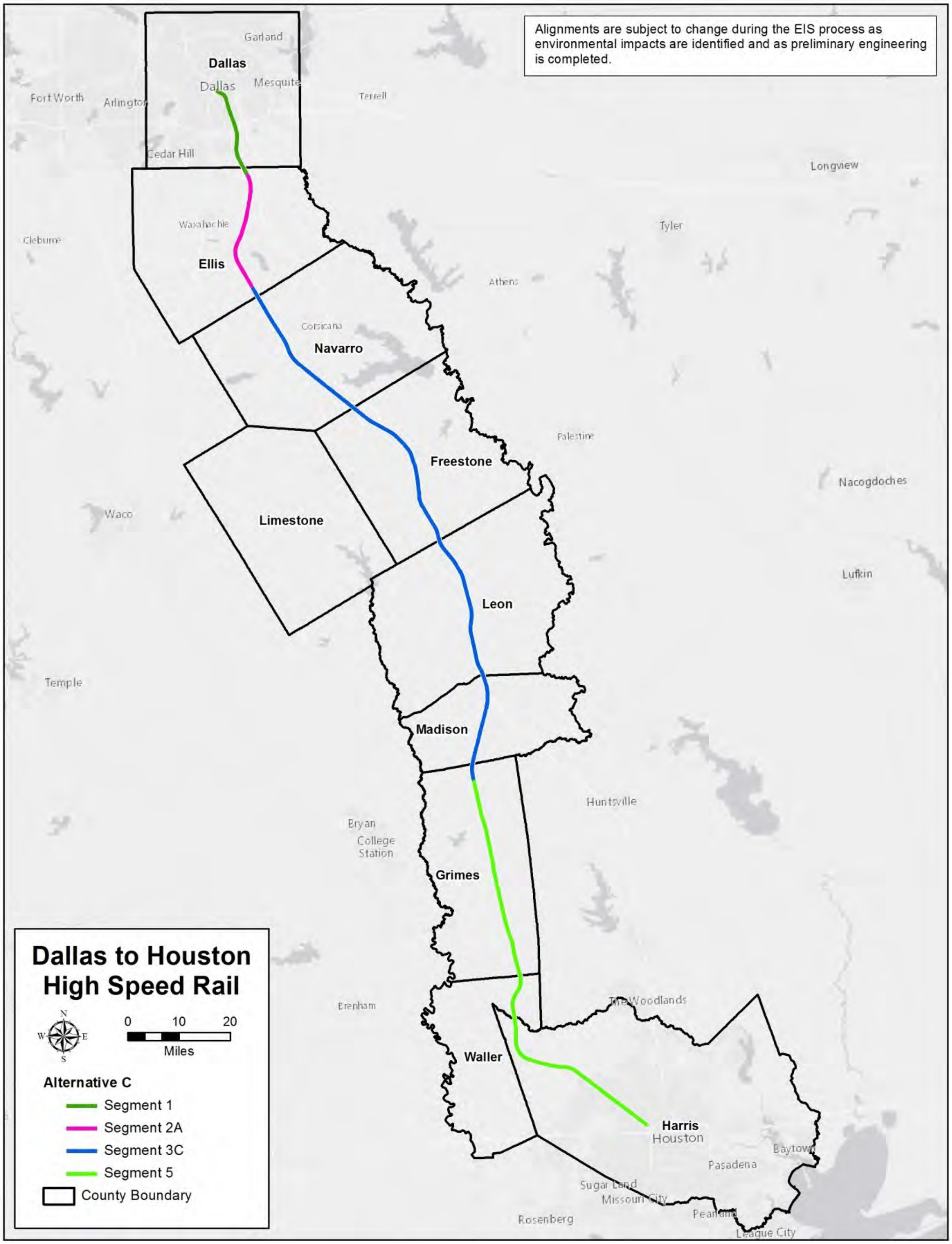
Source: AECOM 2019

Figure 2-30: EIS End-to-End Build Alternative B



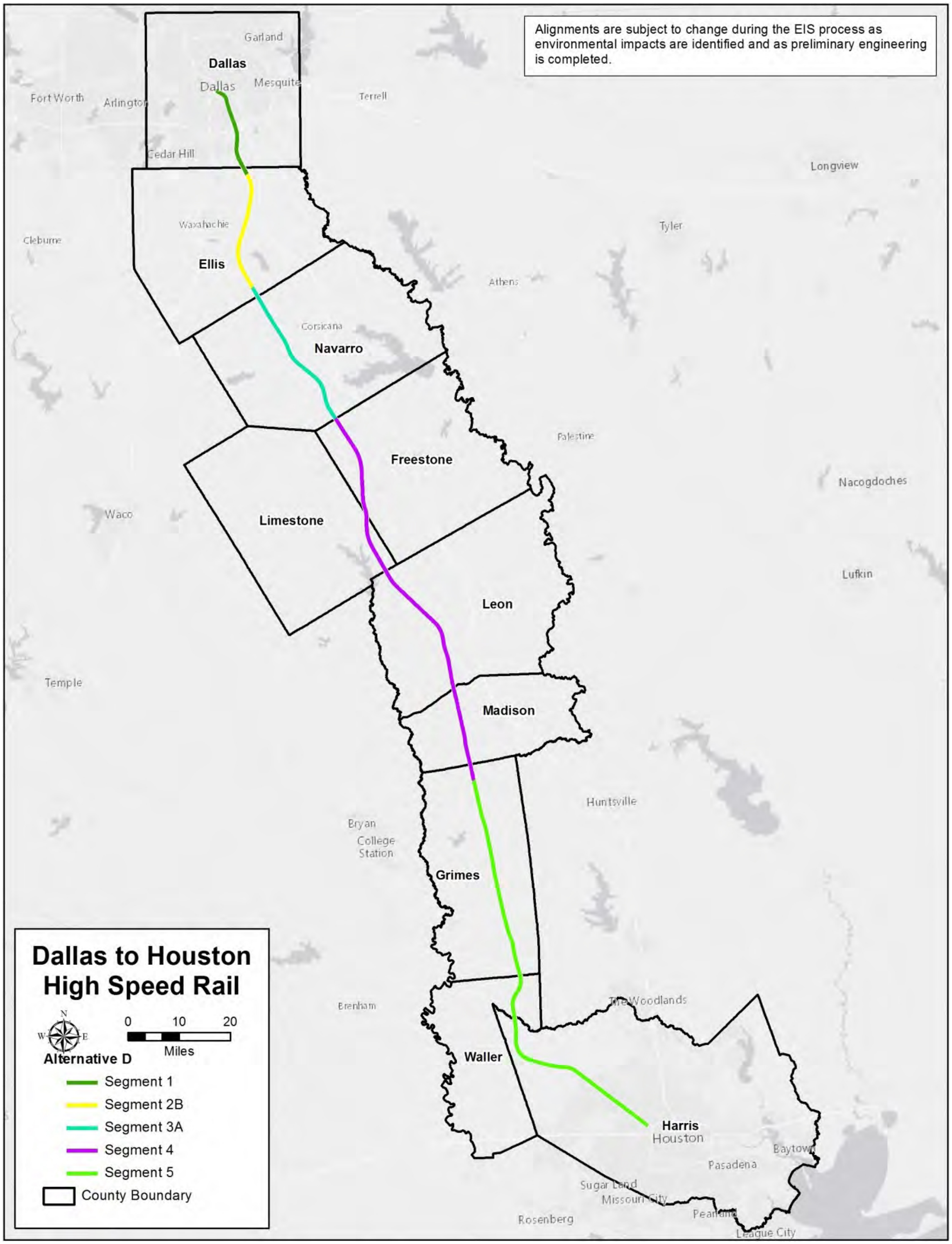
Source: AECOM 2019

Figure 2-31: EIS End-to-End Build Alternative C



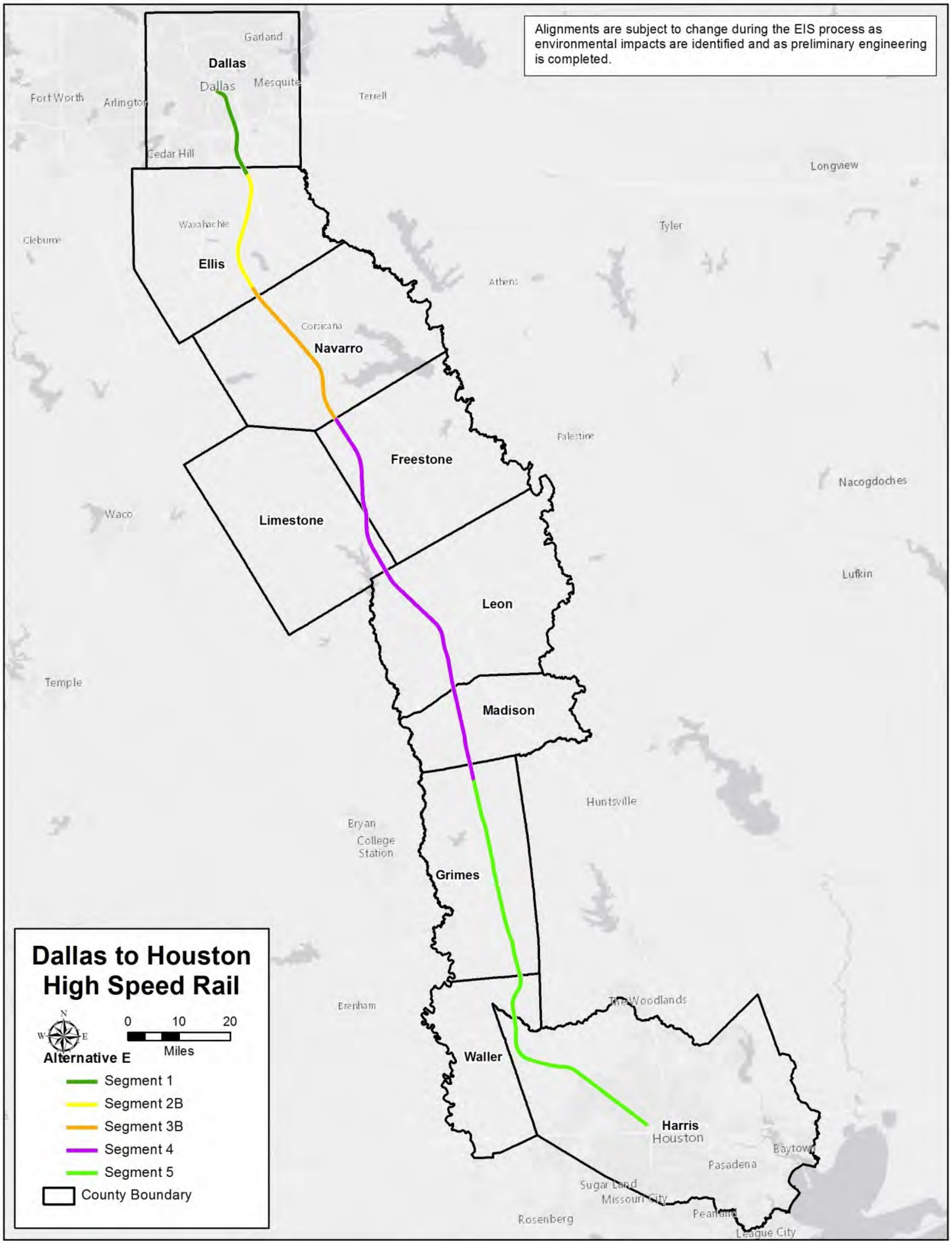
Source: AECOM 2019

Figure 2-32: EIS End-to-End Build Alternative D



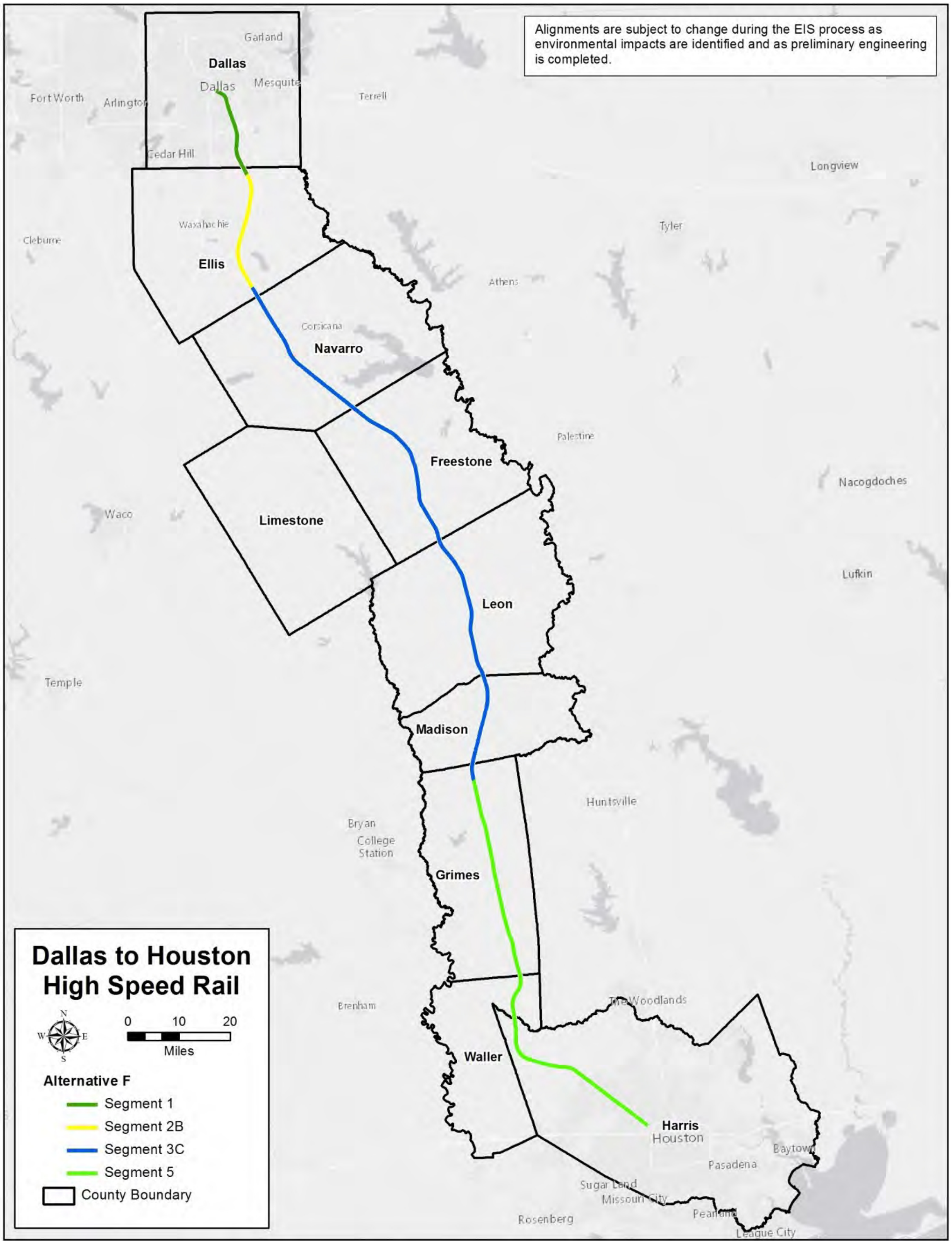
Source: AECOM 2019

Figure 2-33: EIS End-to-End Build Alternative E



Source: AECOM 2019

Figure 2-34: EIS End-to-End Build Alternative F



Source: AECOM 2019

2.7 Preferred Alternative

FRA, as the lead federal agency, after considering the comparative analysis of the No Build Alternative, the Build Alternatives and Houston Terminal Station options presented in this EIS and the potential impacts of the Build Alternatives, identifies Build Alternative A and the Houston Northwest Mall Terminal Station Option as the Preferred Alternative. FRA identified Build Alternative A as the Preferred Alternative in the Draft EIS published December 22, 2017. In identifying the Preferred Alternative in this EIS, FRA has considered environmental, technical, public comments on the Draft EIS and other factors, including the alternative that would best meet the cooperating agencies' defined plans, policies and regulations.

Build Alternative A (see **Figure 2-29**) is comprised of Segment 1 (including the Dallas Terminal Station and a TMF), Segment 2A (including an MOW facility), Segment 3A, Segment 4 (including two MOW facilities) and Segment 5 (including two MOW facilities, a TMF, and the Brazos Valley Intermediate Station). 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 East 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, North Lancaster/Hutchins Road (TMF facility), East Pleasant Run Road and West Beltline Road. South of West Beltline Road, the alignment extends west of Lancaster Airport before turning southwest to enter Ellis County and cross FM 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. The alignment 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 west 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, FM 27 (MOW facility) and FM 1366. As the alignment 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 SH 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 Intermediate 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. Approximately 129 miles of the Preferred Alternative, Build Alternative A, is constructed on viaduct, 27 miles by cut construction and 79 miles on embankment.

While the Draft EIS did not identify a preferred option for the Houston Terminal Station in Harris County, this EIS identifies the Houston Northwest Mall Terminal Station Option as the preferred terminal station location.

Although FRA is identifying a Preferred Alternative in this Final EIS, FRA analyzed all Build Alternatives and the Houston Terminal Station options in this Final EIS.

2.7.1 Statutory Considerations

Important regulatory requirements that must be addressed in the identification of a preferred alternative for this Project are Section 404 of the CWA[26] (Section 404), Section 14 of the Rivers and Harbors Act[27] (Section 408) and provisions of Section 4(f) of the Department of Transportation Act.[28]

Under Section 404 and 408 requirements, the USACE 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 federally authorized civil works projects (USACE Projects) 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 the USACE Project associated with Lake Bardwell, requiring Section 408 authorization from the USACE.

Segment 1 is common to all Build Alternatives—proceeding south from the Dallas Terminal Station all Build Alternatives must cross the Trinity River. Either Segment 2A or 2B, located in Ellis County, would be a component of 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,[29] 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 described in **Chapter 7.0, Section 4(f) and Section 6(f) Evaluation**, Section 4(F) prohibits the use of a Section 4(f) property unless there is no feasible or prudent alternative to such use and the project includes all possible planning to minimize harm to the property resulting from such use; or a project as a whole, including any measure(s) to minimize harm, has a *de minimis*, or minimal, impact on the Section 4(f) property. Segments 1 and 5, common to all Build Alternatives, would impact three Section 4(f) resources along common segments in Dallas and Harris Counties. Additionally, Segment 3C (on Build Alternative C) would require the use of an additional Section 4(f) property, Fort Boggy State Park.be The Houston Industrial Site Terminal Station Option would require the use of one Section 4(f) property (HA.208 Tex-Tube Complex). The Houston Northwest Mall and Houston Northwest Transit Center Terminal Station Options would not impact Section 4(f) resources.

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

[26] 33 U.S.C. 1344.
[27] 33 U.S.C. 408.
[28] 49 U.S.C. 303.
[29] USACE, ER 1130-2-550 Chapter 17, September 30, 2013, Accessed May 2020, https://www.saw.usace.army.mil/Portals/59/docs/recreation/Land%20Use/USACE%20Non-Recreation%20Outgrant%20Policy%20ER1130-5-550%20Ch.%2017%20.pdf.

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
- Elderly and Handicapped
- Socioeconomic
- Electromagnetic Fields
- Environmental Justice
- Greenhouse Gas Emissions

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. The highlighted cells show the least potentially impactful site for each criterion.

All three Build Alternatives would result in impacts to impaired waterbodies and groundwater wells, with Build Alternative B having the most at approximately 1,003 feet of impaired waterbodies and 13 groundwater wells.

All three Build Alternatives would result in severe and moderate noise and vibration impacts to several residences. Alternative B would have the most noise impacts at 12 severe and 290 moderate noise impacts to residences.

Build Alternatives A and B would have an impact on the same number of moderate-risk hazardous materials sites (155), while Build Alternative C would impact the most moderate-risk hazardous materials sites (165). Build Alternative C has the potential to impact approximately 29 more low-risk hazardous materials sites compared to Build Alternative A.

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 394 additional acres of protected species habitat compared to Build Alternatives A and B.

Determinations related to waters of the U.S. require USACE consideration. Temporary impacts to wetlands and waterbodies would be comparable across Build Alternatives A, B and C. Temporary stream crossings would be 7,483 feet less for Build Alternative A than Build Alternative C. Permanent stream impacts under Build Alternative B would be approximately 6,733 feet greater compared to Build Alternative A and approximately 10,535 feet greater compared to Build Alternative C. Permanent impacts to wetlands across all three Build Alternatives would range from 48 to 64 acres, with Build Alternative B having the potential to permanently impact the fewest acres of wetlands. Permanent impacts to waterbodies would range from 21 to 28 acres, with Build Alternative A having the potential to impact the most waterbodies. FRA has taken a conservative approach regarding jurisdictional determinations. The waterbodies data have not been revised to note USACE jurisdiction, which means all waterbodies are assumed jurisdictional at this time. USACE site assessments are ongoing and the identification of non-jurisdictional features by the USACE as part of the Section 404 Individual Permits (**WW-CM#4: CWA Section 404, Individual Permit**) will refine the evaluation of impacts to waterbodies, potentially resulting in the identification of different impacts to waterbodies than those described in **Table 2-14**.

Table 2-14: Comparison of Build Alternatives A, B and C				
Evaluation Criteria	**Measure**	**Alt A**	**Alt B**	**Alt C**
Water Quality (Section 3.3)				
Impaired Waterbodies – 303(d) List	Feet	344.7	517.4	496
Impaired Waterbodies Total	Feet	830.0	1,002.7	981.3
Groundwater Wells	Count	9	13	7
Noise and Vibration (Section 3.4)				
Severe Noise Impact Residential	Count	10	12	10
Moderate Noise Impact Residential	Count	280	290	275
Hazardous Materials and Solid Waste (Section 3.5)				
Low-Risk Hazardous Material Sites	Count	297	298	326
Moderate-Risk Hazardous Material Sites	Count	155	155	165
Natural Ecological Systems and Protected Species (Section 3.6) [1]				
Protected Species Modeled Habitat - Temporary	Acres	328	328	325
Protected Species Modeled Habitat - Permanent	Acres	1,058	1,058	1,452
Waters of the U.S. (Section 3.7)				
Stream Crossings – Temporary	Feet	83,459	83,791	90,942
Stream Crossings – Permanent	Feet	38,898	45,631	35,096
Wetlands – Temporary	Acres	59.5	59.0	44.3
Wetlands – Permanent	Acres	50.0	47.4	63.4
Waterbodies – Temporary	Acres	33.5	36.3	30.4
Waterbodies – Permanent	Acres	27.6	27.2	21.1
Floodplains (Section 3.8)				
Impacts to 100-Year Floodplain	Acres	616	557	642
Impacts to 500-Year Floodplain	Acres	132	132	133
Permanent Impacts to 100-Year and 500-Year Floodplains	Acres	529	479	579
Temporary Impacts to 100-Year and 500-Year Floodplains	Acres	219	210	196
Total Acres of Impacted Floodplain	Acres	748	689	775
Total Number of Bridge/Viaduct Crossings of FEMA Zone AE	Count	63	63	71
Total Number of Bridge/Viaduct Crossings of FEMA Zone A	Count	126	142	137
Utilities and Energy (Section 3.9)				
New Electric TPSS Connections	Count	13	12	13
Electric Utility Pole Adjustments	Count	85	85	74
Total Electric Connections and Adjustment	Count	98	97	87
Abandoned Oil and Gas Wells	Count	37	37	22
Aesthetics and Scenic Resources (Section 3.10)				
Total Number of Adverse Visual Resource Impacts	Count	11	11	10
Transportation (Section 3.11)				
Road Modifications [2] (*Public and Private*)	Count	138	150	102
Road Modifications [3] (*Public only*)	Count	59	66	79
Length added to Public Roads (miles)	Miles	16.8	21.4	46.9

Source: AECOM, 2019

Notes: Specific impacts are not included in this comparison table if they are equal across Build Alternatives A, B and C.

1. Threatened and Endangered Species acreages include habitat for species with mapped habitat that may be impacted, including Houston toad, large-fruited sand verbena and Navasota ladies'-tresses. Threatened and endangered species in the Study Area that may be impacted but that do not have mapped habitat include the interior least tern and the whooping crane.
2. Road modifications reflect the number of reroutes, road adjustments or road over rail constructions that would occur. Some roads are affected by multiple modifications (such as IH-45). Modifications do not reflect total number of roads but total number of road construction sites.
3. Shared access roads are included in roadway modification lengths. Shared access roads will be developed to provide for maintenance, emergency response access and private property access with a corresponding reduction in the number of new public roads to decrease burden on roadway authorities. Shared access roads would be constructed and maintained by TCRR.
4. Anxiety Aerodrome would be directly impacted by Segment 3B, which is part of Alternatives B and E.
5. Indirect impacts to special status farmland in **Section 3.13, Land Use,** are defined as a 25-foot setback added to the LOD to account for indirect loss of productive farmland to accommodate the use of farm and ranch equipment or impacts such as induced wind and changes in irrigation.

Table 2-14: Comparison of Build Alternatives A, B and C				
Evaluation Criteria	**Measure**	**Alt A**	**Alt B**	**Alt C**
Length removed from Public Roads (miles)	Miles	5.1	5.0	27.2
Impacts to airports [4]	Count	0	1	0
Land Use (Section 3.13)				
LU Conversion – Temporary	Acres	2,553.4	2,532.9	2,393.2
LU Conversion – Permanent	Acres	6,619.8	6,814.0	7,295.6
Special Status Farmland – Temporary	Acres	1,710.8	1,690.4	1,459.8
Special Status Farmland – Permanent	Acres	3,534.5	3,764.3	3,573.4
Special Status Farmland – Indirect [5]	Acres	847.5	888.2	697.3
Displacement – Commercial (primary)	Count	42	42	65
Displacement – Residence (primary)	Count	235	255	239
Displacement – Community Facilities (primary)	Count	2	2	3
Estimated Permanent Parcel Acquisitions	Count	1,731	1,814	1,789
Estimated Temporary Parcel Acquisitions	Count	272	277	259
Estimated Structure Acquisitions – Agriculture	Count	196	223	196
Estimated Structure Acquisitions – Commercial	Count	12	12	18
Estimated Structure Acquisitions – Cultural/Civic Resources	Count	2	2	1
Estimated Structure Acquisitions – Oil and Gas	Count	12	12	17
Estimated Structure Acquisitions – Residence	Count	49	50	51
Estimated Structure Acquisitions – Transportation and Utilities	Count	0	0	1
Safety and Security (Section 3.16)				
Permanent Road Modifications resulting in 1 minute or more in additional through travel time	Count	12	13	9
Total fire and EMS service areas bisected by construction	Count	56	57	51
Fire and EMS providers with high potential for construction effects	Count	3	4	5
Fire and EMS providers with localized potential for construction effects	Count	8	7	6
Recreational Facilities (Section 3.17)				
Parks	Count	0	0	1
Environmental Justice (Section 3.18)				
Number of Minority and/or Low-Income block groups intersected by the Study Area	Count	80	80	81
Number of all block groups intersected by the Study Area	Count	118	118	119
Cultural Resources (Section 3.19)				
Adverse Impacts to Historic Properties	Count	14	14	13
Soils and Geology (Section 3.20)				
LOD Area	Acres	9,173.4	9,347.1	9,689.0
Shrink-Swell Potential – Low	Acres	2,593.6	2,585.8	2,848.3
Shrink-Swell Potential – Moderate	Acres	1,458.4	1,465.1	1,485.0

Source: AECOM, 2019

Notes: Specific impacts are not included in this comparison table if they are equal across Build Alternatives A, B and C.

1. Threatened and Endangered Species acreages include habitat for species with mapped habitat that may be impacted, including Houston toad, large-fruited sand verbena and Navasota ladies'-tresses. Threatened and endangered species in the Study Area that may be impacted but that do not have mapped habitat include the interior least tern and the whooping crane.
2. Road modifications reflect the number of reroutes, road adjustments or road over rail constructions that would occur. Some roads are affected by multiple modifications (such as IH-45). Modifications do not reflect total number of roads but total number of road construction sites.
3. Shared access roads are included in roadway modification lengths. Shared access roads will be developed to provide for maintenance, emergency response access and private property access with a corresponding reduction in the number of new public roads to decrease burden on roadway authorities. Shared access roads would be constructed and maintained by TCRR.
4. Anxiety Aerodrome would be directly impacted by Segment 3B, which is part of Alternatives B and E.
5. Indirect impacts to special status farmland in **Section 3.13, Land Use,** are defined as a 25-foot setback added to the LOD to account for indirect loss of productive farmland to accommodate the use of farm and ranch equipment or impacts such as induced wind and changes in irrigation.

Table 2-14: Comparison of Build Alternatives A, B and C				
Evaluation Criteria	**Measure**	**Alt A**	**Alt B**	**Alt C**
Shrink-Swell Potential – High	Acres	2,284.0	2,477.1	2,471.2
Shrink-Swell Potential – Very High	Acres	2,727.9	2,697.5	2,781.8
Erosion Potential – Low	Acres	1,611.6	1,591.3	1,914.1
Erosion Potential – Moderate	Acres	4,511.2	4,619.9	4,786.6
Erosion Potential – High	Acres	2,963.5	3,036.8	2,907.9
Corrosion Potential – Low	Acres	55.3	71.8	81.4
Corrosion Potential – Moderate	Acres	2,204.8	2,182.0	2,761.1
Corrosion Potential – High	Acres	6,824.5	6,992.5	6,764.5
Prime Farmland Soils	Acres	5,245.3	5,454.7	5,033.2

Source: AECOM, 2019

Notes: Specific impacts are not included in this comparison table if they are equal across Build Alternatives A, B and C.

1. Threatened and Endangered Species acreages include habitat for species with mapped habitat that may be impacted, including Houston toad, large-fruited sand verbena and Navasota ladies'-tresses. Threatened and endangered species in the Study Area that may be impacted but that do not have mapped habitat include the interior least tern and the whooping crane.
2. Road modifications reflect the number of reroutes, road adjustments or road over rail constructions that would occur. Some roads are affected by multiple modifications (such as IH-45). Modifications do not reflect total number of roads but total number of road construction sites.
3. Shared access roads are included in roadway modification lengths. Shared access roads will be developed to provide for maintenance, emergency response access and private property access with a corresponding reduction in the number of new public roads to decrease burden on roadway authorities. Shared access roads would be constructed and maintained by TCRR.
4. Anxiety Aerodrome would be directly impacted by Segment 3B, which is part of Alternatives B and E.
5. Indirect impacts to special status farmland in **Section 3.13, Land Use,** are defined as a 25-foot setback added to the LOD to account for indirect loss of productive farmland to accommodate the use of farm and ranch equipment or impacts such as induced wind and changes in irrigation.

Build Alternatives A, B and C would impact 557 to 642 acres of 100-year floodplains. Build Alternative B intersects 85 acres less than Build Alternative C and 59 acres less than Build Alternative A.

All three Build Alternatives would have approximately the same amount of electrical connections and adjustments of existing infrastructure. Build Alternative C has the potential to permanently impact 15 fewer abandoned oil and gas wells compared to Build Alternatives A and B.

Transportation impacts would be mitigated through reroutes and regrading roadways. Build Alternative A would have the fewest modifications to existing public roads (59). Build Alternative C would result in the greatest length of public roadways removed (27 miles), as well as miles added (47 miles). Build Alternative A would result in the least length of roadway removed (5 miles) and least length added (17 miles). Additionally, Build Alternative C would require the realignment of the frontage road along IH-45 for a length of approximately 48 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 B would be the only alternative with a permanent impact to an airport.

Build Alternative A has the potential to permanently convert approximately 194 acres less of land use compared to Alternative B and 676 acres less compared to Build Alternative C. For special status farmland, Build Alternative C would permanently impact approximately 362 acres less than Build Alternative A and 612 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. As detailed in **Section 3.13, Land Use**, primary displacements include structures located directly within the proposed LOD or within 50 feet of the LOD. Build Alternatives A and B would result in fewer displacements of businesses (commercial structures) compared to Build Alternative C, and while Build Alternatives A and C would have similar residential displacement, Build Alternative B would result in the displacement of several more homes. Build Alternative B would require the largest number of land parcels, while Build Alternative A would require the least (88 less than Build Alternative B). Build Alternatives A and B would require the acquisition of fewer commercial structures (six less) compared to Build Alternative C. Build Alternatives A and C would also result in the acquisition of fewer agricultural structures (barns/sheds) compared to Build Alternative B (27 more). All three Build Alternatives would result in a similar number of homes additionally acquired (in addition to those displaced discussed above) by the Project; therefore, overall Build Alternative A would displace or acquire the most residences (26 more than Build Alternative B).

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. As the identification and evaluation of historic properties is ongoing, the evaluation of, and assessment of effects to, cultural resources on the Preferred Alternative will continue in a phased approach as provided for in 36 C.F.R. 800.4(b)(2) and 36 C.F.R. 800.5(a)(3) and the Section 106 Programmatic Agreement.

Build Alternatives A, B and C would use three properties along common segments in Dallas and Harris Counties that are protected by Section 4(f). Additionally, Build Alternative C would use an additional Section 4(f) property, Fort Boggy State Park.

When the environmental impacts of Build Alternatives A, B and C are compared, Build Alternative A would have the fewest permanent impacts to the socioeconomic, natural, physical and cultural resources environment as noted in **Table 2-14** and described in the preceding text. Therefore, FRA identified Build Alternative A as the Preferred Alternative in both the Draft EIS and this Final EIS.

2.7.3 Comparison of Houston Terminal Station Option Alternatives

Chapter 3.0, Affected Environment and Environmental Consequences, describes the socioeconomic, natural, physical and cultural resources evaluation criteria used to compare all Houston Terminal Station options. For most resource areas, there are no distinguishable differences among the Houston Terminal Station options. Environmental resources that have a negligible difference in the identification of a preferred alternative include:

- Air Quality
- Water Quality
- Noise and Vibration
- Natural Ecological Systems and Protected Species
- Floodplains
- Utilities and Energy
- Aesthetics and Scenic Resources
- Elderly and Handicapped
- Electromagnetic Fields
- Safety and Security
- Recreational Facilities
- Environmental Justice
- Soils and Geology
- Greenhouse Gas Emissions

As previously discussed, and detailed in **Chapter 7.0, Section 4(f) and Section 6(f) Evaluation,** the Houston Industrial Site Terminal Station Option would require the use of a Section 4(f) protected resource. Because there are feasible and prudent alternatives that would avoid the use of the Houston Industrial Site Terminal Station Option, FRA eliminated it from consideration as the preferred station option. Environmental resources that differentiate between the Houston Northwest Mall and Northwest Transit Center Terminal Station Options are presented in **Table 2-15**. These resources are not weighted, meaning that no one criterion is more significant than another. The highlighted cells show the least potentially impactful site for each criterion.

The Northwest Transit Center Terminal Station Option would impact more moderate-risk (5 more) and low-risk (6 more) hazardous materials sites than the Houston Northwest Mall Terminal Station Option.

While permanent impacts to wetlands across the terminal options are similar (0 acres; not shown in **Table 2-15**), overall temporary impacts to wetlands and other waterbodies would be 1.7 acres more at the Houston Northwest Transit Center Terminal Station Option. All waterbodies are assumed to be within USACE jurisdiction 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 differing impacts to waterbodies than those described in **Table 2-15**.

Table 2-15: Comparison of Houston Terminal Station Options (Northwest Transit Center and Northwest Mall)			
Evaluation Criteria	**Measure**	**Northwest Transit Center**	**Northwest Mall**
Hazardous Materials and Solid Waste (Section 3.5)			
Low-Risk Hazardous Material Sites	Count	6	0
Moderate-Risk Hazardous Material Sites	Count	8	3
High-Risk Hazardous Material Sites	Count	0	0
Waters of the U.S. (Section 3.7)			
Wetlands – Temporary	Acres	1.6	0.0
Waterbodies – Temporary	Acres	0.10	0.0
Transportation (Section 3.11)			
Intersections at LOS E or F	Count	22	24
Land Use (Section 3.13)			
LU Conversion – Temporary	Acres	11.8	27.4
LU Conversion – Permanent	Acres	88.7	75.8
Displacement – Commercial (primary)	Count	15	22
Displacement – Community Facility (primary)	Count	1	0
Estimated Permanent Parcel Acquisitions	Count	43	40
Estimated Temporary Parcel Acquisitions	Count	0	1
Estimated Structure Acquisitions – Commercial	Count	0	1
Socioeconomics and Community Facilities (Section 3.14)			
Community Facility	Count	1	0
Cultural Resources (Section 3.19)			
Adverse Impacts to Historic Properties	Count	1	0

Source: AECOM 2019

Both terminal station options would impact similar numbers of intersections.

The Houston Northwest Mall Terminal Station Option has the potential to permanently convert approximately 13 fewer acres of land compared to the Houston Northwest Transit Center Terminal Station Option. The Houston Northwest Mall Terminal Station Option would permanently acquire three fewer parcels than the Houston Northwest Transit Center Terminal Station Option. The Houston Northwest Transit Center Terminal Station Option would impact one cultural resource and one community facility (Awty International School Annex), while the Houston Northwest Mall Terminal Station Option would impact no cultural resources or community facilities but would displace more commercial businesses.

When the environmental impacts of each station option are compared, the Houston Northwest Mall Terminal Station Option would have fewer permanent impacts to the socioeconomic, natural, physical and cultural resources environment as noted in **Table 2-15** and described in the preceding text. Therefore, FRA identified the Houston Northwest Mall Terminal Station Option as the preferred Houston terminal station in this Final EIS.

2.7.4 Preferred Alternative Impacts

Overall impacts of the Preferred Alternative, Build Alternative A and Houston Northwest Mall Terminal Station Option, are summarized in **Table 2-16**. Direct impacts of the Preferred Alternative, and Build Alternatives A through F and the three Houston Terminal Station options, are detailed in **Chapter 3.0, Affected Environment and Environmental Consequences**, while indirect and cumulative impacts are addressed in **Chapter 4.0, Indirect Effects and Cumulative Impacts**.

Table 2-16: Summary of Preferred Alternative Direct Impacts					
Evaluation Criteria		Measure	Build Alternative A	Houston Northwest Mall Terminal Station Option	Total
Air Quality (Section 3.2)					
Air Quality Impacts		N/A	Net emissions benefit for permanent operations, temporary construction impacts.		
Water Quality (Section 3.3)					
Impaired Waterbodies – 303(d) List		Feet	344.7	0	344.7
Impaired Waterbodies with TMDLs		Feet	485.3	0	485.3
Impaired Waterbodies Total		Feet	830	0	830
Active Public Water System Wells		Count	1	0	1
Groundwater Wells		Count	9	0	9
Reservoir/Dam Crossings		Count	0	0	0
Noise and Vibration (Section 3.4)					
Severe Noise Impact	Residential	Count	10	0	10
	Institutional	Count	0	0	0
Moderate Noise Impact	Residential	Count	280	0	280
	Institutional	Count	1	0	1
Vibration Impact	Residential	Count	0	0	0
	Institutional	Count	0	0	0
Hazardous Materials and Solid Waste (Section 3.5)					
Low-Risk Hazardous Material Sites		Count	297	0	297
Moderate-Risk Hazardous Material Sites		Count	155	3	158
High-Risk Hazardous Material Sites		Count	4	0	4
Natural Ecological Systems and Protected Species (Section 3.6) [1]					
Protected Species Modeled Habitat – Temporary		Acres	328	0	328
Protected Species Modeled Habitat – Permanent		Acres	1,058	0	1,058
Waters of the U.S. (Section 3.7)					
Stream Crossings – Temporary		Feet	83,459	0	83,459
Stream Crossings – Permanent		Feet	38,898	0	38,898
Wetlands – Temporary		Acres	59.5	0	59.5
Wetlands – Permanent		Acres	50.0	0	50.0

Source: AECOM 2019

1. Threatened and Endangered Species acreages include habitat for species with modeled habitat (as detailed in **Section 3.6, Natural Ecological Systems and Protected Species**) that may be impacted, including Houston toad, large-fruited sand verbena and Navasota ladies'-tresses. Threatened and endangered species in the Study Area that may be impacted but that do not have modeled habitat include the interior least tern and the whooping crane.
2. A single landscape unit is shared between Segment 5 and the Houston Terminal Station Options; therefore, the total number of beneficial landscape units is the same as Build Alternative A.
3. Totals for rail impacts do not include rail at Houston Terminal Stations. Totals also include DART-owned rail lines in Dallas County
4. Road modifications reflect the number of reroutes, road adjustments or road over rail constructions that would occur. Some roads would be affected by multiple modifications (such as IH-45). Modifications do not reflect total number of roads but total number of road construction sites.
5. Shared access roads are included in roadway modification lengths. Shared access roads will be developed to provide for maintenance, emergency response access and private property access with a corresponding reduction in the number of new public roads to decrease burden on roadway authorities. Shared access roads will be constructed and maintained by TCRR.
6. Anxiety Aerodrome would be directly impacted by Segment 3B, which is part of Alternatives B and E.
7. Indirect impacts to special status farmland in **Section 3.13, Land Use**, are defined as a 25-foot setback added to the LOD to account for indirect loss of productive farmland to accommodate the use of farm and ranch equipment or impacts such as induced wind and changes in irrigation.
8. The "Community Facilities" category in **Section 3.14, Socioeconomics and Community Facilities**, encompasses categories of affected structures and facilities that are broken down into more defined categories within **Section 3.13, Land Use**; therefore, values between the two sections are not identical. Refer to the section for a complete definition of each category.
9. Children's health and safety impacts are the result of temporary construction effects. These impacts will no longer exist once construction has ended.
10. The Midlothian Quarry and Plant in Ellis County was identified at approximately one-half-mile west of Segment 2A. Exact limits would need to be field-verified to confirm or discount presence in the Study Area.

Table 2-16: Summary of Preferred Alternative Direct Impacts				
Evaluation Criteria	**Measure**	**Build Alternative A**	**Houston Northwest Mall Terminal Station Option**	**Total**
Waterbodies – Temporary	Acres	33.5	0	33.5
Waterbodies – Permanent	Acres	27.6	0	27.6
Floodplains (Section 3.8)				
Impacts to 100-Year Floodplain	Acres	616	0	616
Impacts to 500-Year Floodplain	Acres	132	0	132
Permanent Impacts to 100-Year and 500-Year Floodplains	Acres	529	0	529
Temporary Impacts to 100-Year and 500-Year Floodplains	Acres	219	0	219
Total Acres of Impacted Floodplain	Acres	748	0	748
Total Number of Bridge/Viaduct Crossings of FEMA Zone AE	Count	63	NA	63
Total Number of Bridge/Viaduct Crossings of FEMA Zone A	Count	126	NA	126
Utilities and Energy (Section 3.9)				
New Electric TPSS Connections	Count	13	0	13
Electric Utility Pole Adjustments	Count	85	0	85
Total Electric Connections and Adjustment	Count	98	0	98
Abandoned Oil and Gas Wells	Count	37	0	37
Aesthetics and Scenic Resources (Section 3.10)				
Total Number of Beneficial [2]	Count	2	1	2
Total Number of Neutral	Count	8	0	8
Total Number of Adverse	Count	2	0	2
Total Number of Adverse Visual Resource Impacts	Count	11	0	11
Transportation (Section 3.11)				
Rail Crossings [3]	Count	27	0	27
Road Modifications [4] (*Public and Private*)	Count	138	0	138
Road Modifications [5] (*Public only*)	Count	59	0	59
Length added to Public Roads (miles)	Miles	16.8	0	16.8

Source: AECOM 2019

1. Threatened and Endangered Species acreages include habitat for species with modeled habitat (as detailed in **Section 3.6, Natural Ecological Systems and Protected Species**) that may be impacted, including Houston toad, large-fruited sand verbena and Navasota ladies'-tresses. Threatened and endangered species in the Study Area that may be impacted but that do not have modeled habitat include the interior least tern and the whooping crane.
2. A single landscape unit is shared between Segment 5 and the Houston Terminal Station Options; therefore, the total number of beneficial landscape units is the same as Build Alternative A.
3. Totals for rail impacts do not include rail at Houston Terminal Stations. Totals also include DART-owned rail lines in Dallas County
4. Road modifications reflect the number of reroutes, road adjustments or road over rail constructions that would occur. Some roads would be affected by multiple modifications (such as IH-45). Modifications do not reflect total number of roads but total number of road construction sites.
5. Shared access roads are included in roadway modification lengths. Shared access roads will be developed to provide for maintenance, emergency response access and private property access with a corresponding reduction in the number of new public roads to decrease burden on roadway authorities. Shared access roads will be constructed and maintained by TCRR.
6. Anxiety Aerodrome would be directly impacted by Segment 3B, which is part of Alternatives B and E.
7. Indirect impacts to special status farmland in **Section 3.13, Land Use**, are defined as a 25-foot setback added to the LOD to account for indirect loss of productive farmland to accommodate the use of farm and ranch equipment or impacts such as induced wind and changes in irrigation.
8. The "Community Facilities" category in **Section 3.14, Socioeconomics and Community Facilities**, encompasses categories of affected structures and facilities that are broken down into more defined categories within **Section 3.13, Land Use**; therefore, values between the two sections are not identical. Refer to the section for a complete definition of each category.
9. Children’s health and safety impacts are the result of temporary construction effects. These impacts will no longer exist once construction has ended.
10. The Midlothian Quarry and Plant in Ellis County was identified at approximately one-half-mile west of Segment 2A. Exact limits would need to be field-verified to confirm or discount presence in the Study Area.

Table 2-16: Summary of Preferred Alternative Direct Impacts				
Evaluation Criteria	**Measure**	**Build Alternative A**	**Houston Northwest Mall Terminal Station Option**	**Total**
Length removed from Public Roads (miles)	Miles	5.1	0	5.1
Impacts to airports [6]	Count	0	0	0
Number of Intersections at LOS E or F	Count	NA	24	24
Elderly and Handicapped (Section 3.12)				
Elderly and Handicapped Impacts	NA	Project would be designed, constructed and operated in compliance with ADA; therefore, there would be no impacts related to accessibility of the HSR system for the elderly and handicapped.		
Land Use (Section 3.13)				
Existing Land Use Conversion – Temporary	Acres	2,553.4	27.4	2,580.8
Existing Land Use Conversion – Permanent	Acres	6,619.8	75.8	6,695.6
Special Status Farmland – Temporary	Acres	1,710.8	0.0	1,710.8
Special Status Farmland – Permanent	Acres	3,534.5	0.0	3,534.5
Special Status Farmland – Indirect [7]	Acres	847.5	0	847.5
Displacement – Commercial (primary)	Count	42	22	64
Displacement – Residence (primary)	Count	235	0	235
Displacement – Community Facilities (primary) [8]	Count	2	0	2
Estimated Permanent Parcel Acquisitions	Count	1,731	40	1,771
Estimated Temporary Parcel Acquisitions	Count	272	1	273
Estimated Structure Acquisitions – Agriculture	Count	196	0	196
Estimated Structure Acquisitions – Commercial	Count	12	1	13
Estimated Structure Acquisitions – Community Facilities	Count	0	0	0
Estimated Structure Acquisitions – Cultural/Civic Resources	Count	2	0	2
Estimated Structure Acquisitions – Oil and Gas	Count	12	0	12
Estimated Structure Acquisitions – Residence	Count	49	0	49
Estimated Structure Acquisitions – Transportation and Utilities	Count	0	0	0

Source: AECOM 2019

1. Threatened and Endangered Species acreages include habitat for species with modeled habitat (as detailed in **Section 3.6, Natural Ecological Systems and Protected Species**) that may be impacted, including Houston toad, large-fruited sand verbena and Navasota ladies'-tresses. Threatened and endangered species in the Study Area that may be impacted but that do not have modeled habitat include the interior least tern and the whooping crane.
2. A single landscape unit is shared between Segment 5 and the Houston Terminal Station Options; therefore, the total number of beneficial landscape units is the same as Build Alternative A.
3. Totals for rail impacts do not include rail at Houston Terminal Stations. Totals also include DART-owned rail lines in Dallas County
4. Road modifications reflect the number of reroutes, road adjustments or road over rail constructions that would occur. Some roads would be affected by multiple modifications (such as IH-45). Modifications do not reflect total number of roads but total number of road construction sites.
5. Shared access roads are included in roadway modification lengths. Shared access roads will be developed to provide for maintenance, emergency response access and private property access with a corresponding reduction in the number of new public roads to decrease burden on roadway authorities. Shared access roads will be constructed and maintained by TCRR.
6. Anxiety Aerodrome would be directly impacted by Segment 3B, which is part of Alternatives B and E.
7. Indirect impacts to special status farmland in **Section 3.13, Land Use**, are defined as a 25-foot setback added to the LOD to account for indirect loss of productive farmland to accommodate the use of farm and ranch equipment or impacts such as induced wind and changes in irrigation.
8. The "Community Facilities" category in **Section 3.14, Socioeconomics and Community Facilities**, encompasses categories of affected structures and facilities that are broken down into more defined categories within **Section 3.13, Land Use**; therefore, values between the two sections are not identical. Refer to the section for a complete definition of each category.
9. Children's health and safety impacts are the result of temporary construction effects. These impacts will no longer exist once construction has ended.
10. The Midlothian Quarry and Plant in Ellis County was identified at approximately one-half-mile west of Segment 2A. Exact limits would need to be field-verified to confirm or discount presence in the Study Area.

Table 2-16: Summary of Preferred Alternative Direct Impacts				
Evaluation Criteria	**Measure**	**Build Alternative A**	**Houston Northwest Mall Terminal Station Option**	**Total**
Socioeconomics and Community Facilities (Section 3.14)				
Communities with Disrupted Character and Cohesion	Count	4	0	4
Economic Impacts	NA	Positive		
Employment	Job Years	317,207		
Earnings	2019 billions	$14.50		
Tax Revenue	NA	Positive		
Children's Health and Safety [9]	Count	0	0	0
Community Facilities [8]	Count	5	0	5
Electromagnetic Fields (Section 3.15)				
EMF Impacts	NA	No electromagnetic interference (EMI) or adverse EMF exposure would occur from the Project.		
Safety and Security (Section 3.16)				
Permanent Road Modifications resulting in 1 minute or more in additional through travel time	Count	12	0	12
Permanent Road Modifications reducing through travel time by 1 minute or more	Count	0	0	0
Total fire and EMS service areas bisected by construction	Count	56	0	56
Fire and EMS providers with high potential for construction effects	Count	3	0	3
Fire and EMS providers with localized potential for construction effects	Count	8	0	8
Recreational Facilities (Section 3.17)				
Parks	Count	0	0	0
Environmental Justice (Section 3.18)				
Number of Minority and/or Low-Income block groups intersected by the Study Area	Count	80	7	87

Source: AECOM 2019

1. Threatened and Endangered Species acreages include habitat for species with modeled habitat (as detailed in **Section 3.6, Natural Ecological Systems and Protected Species**) that may be impacted, including Houston toad, large-fruited sand verbena and Navasota ladies'-tresses. Threatened and endangered species in the Study Area that may be impacted but that do not have modeled habitat include the interior least tern and the whooping crane.
2. A single landscape unit is shared between Segment 5 and the Houston Terminal Station Options; therefore, the total number of beneficial landscape units is the same as Build Alternative A.
3. Totals for rail impacts do not include rail at Houston Terminal Stations. Totals also include DART-owned rail lines in Dallas County
4. Road modifications reflect the number of reroutes, road adjustments or road over rail constructions that would occur. Some roads would be affected by multiple modifications (such as IH-45). Modifications do not reflect total number of roads but total number of road construction sites.
5. Shared access roads are included in roadway modification lengths. Shared access roads will be developed to provide for maintenance, emergency response access and private property access with a corresponding reduction in the number of new public roads to decrease burden on roadway authorities. Shared access roads will be constructed and maintained by TCRR.
6. Anxiety Aerodrome would be directly impacted by Segment 3B, which is part of Alternatives B and E.
7. Indirect impacts to special status farmland in **Section 3.13, Land Use**, are defined as a 25-foot setback added to the LOD to account for indirect loss of productive farmland to accommodate the use of farm and ranch equipment or impacts such as induced wind and changes in irrigation.
8. The "Community Facilities" category in **Section 3.14, Socioeconomics and Community Facilities**, encompasses categories of affected structures and facilities that are broken down into more defined categories within **Section 3.13, Land Use**; therefore, values between the two sections are not identical. Refer to the section for a complete definition of each category.
9. Children's health and safety impacts are the result of temporary construction effects. These impacts will no longer exist once construction has ended.
10. The Midlothian Quarry and Plant in Ellis County was identified at approximately one-half-mile west of Segment 2A. Exact limits would need to be field-verified to confirm or discount presence in the Study Area.

Table 2-16: Summary of Preferred Alternative Direct Impacts

Evaluation Criteria	Measure	Build Alternative A	Houston Northwest Mall Terminal Station Option	Total
Number of all block groups intersected by the Study Area	Count	118	11	129
Identified Minority and/or Low-Income Communities	Count	5	1	5
Disproportionately High and Adverse Impact to Minority and/or Low-Income Communities	NA	No	No	No
Cultural Resources (Section 3-19)				
Adverse Impacts to Historic Properties	Count	14	0	14
Soils and Geology (Section 3.20)				
LOD Area	Acres	9,173.4	103.9	9,277.3
Shrink-Swell Potential – Low	Acres	2,593.6	0	2,594.6
Shrink-Swell Potential – Moderate	Acres	1,458.4	19.2	1,477.6
Shrink-Swell Potential – High	Acres	2,284.0	0	2,284.0
Shrink-Swell Potential – Very High	Acres	2,727.9	0	2,728.9
Erosion Potential – Low	Acres	1,611.6	0	1,612.6
Erosion Potential – Moderate	Acres	4,511.2	3.2	4,514.4
Erosion Potential – High	Acres	2,963.5	16.2	2,979.7
Corrosion Potential – Low	Acres	55.3	0	55.3
Corrosion Potential – Moderate	Acres	2,204.8	0	2,205.8
Corrosion Potential – High	Acres	6,824.5	19.4	6,844.9
Prime Farmland Soils	Acres	5,245.3	0	5,245.3
Surface Mines[10]	Count	0	0	0
Greenhouse Gas Emissions (Section 3.21)				
GHG Emissions	NA	No long-term increases in GHG emissions, the Project would likely reduce GHG emissions by shifting the modes of travel		

Source: AECOM 2019

1. Threatened and Endangered Species acreages include habitat for species with modeled habitat (as detailed in **Section 3.6, Natural Ecological Systems and Protected Species**) that may be impacted, including Houston toad, large-fruited sand verbena and Navasota ladies'-tresses. Threatened and endangered species in the Study Area that may be impacted but that do not have modeled habitat include the interior least tern and the whooping crane.
2. A single landscape unit is shared between Segment 5 and the Houston Terminal Station Options; therefore, the total number of beneficial landscape units is the same as Build Alternative A.
3. Totals for rail impacts do not include rail at Houston Terminal Stations. Totals also include DART-owned rail lines in Dallas County
4. Road modifications reflect the number of reroutes, road adjustments or road over rail constructions that would occur. Some roads would be affected by multiple modifications (such as IH-45). Modifications do not reflect total number of roads but total number of road construction sites.
5. Shared access roads are included in roadway modification lengths. Shared access roads will be developed to provide for maintenance, emergency response access and private property access with a corresponding reduction in the number of new public roads to decrease burden on roadway authorities. Shared access roads will be constructed and maintained by TCRR.
6. Anxiety Aerodrome would be directly impacted by Segment 3B, which is part of Alternatives B and E.
7. Indirect impacts to special status farmland in **Section 3.13, Land Use**, are defined as a 25-foot setback added to the LOD to account for indirect loss of productive farmland to accommodate the use of farm and ranch equipment or impacts such as induced wind and changes in irrigation.
8. The "Community Facilities" category in **Section 3.14, Socioeconomics and Community Facilities**, encompasses categories of affected structures and facilities that are broken down into more defined categories within **Section 3.13, Land Use**; therefore, values between the two sections are not identical. Refer to the section for a complete definition of each category.
9. Children's health and safety impacts are the result of temporary construction effects. These impacts will no longer exist once construction has ended.
10. The Midlothian Quarry and Plant in Ellis County was identified at approximately one-half-mile west of Segment 2A. Exact limits would need to be field-verified to confirm or discount presence in the Study Area.

3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This Final EIS assesses the potential beneficial and adverse environmental impacts of FRA's proposed rulemaking to enable effective safety oversight of the operation of an HSR system based on the Japanese Tokaido Shinkansen technology.

The Final EIS considers impacts from TCRR's proposed approximately 240-mile, for-profit HSR system connecting Dallas and Houston based on the Japanese N700-Series Tokaido Shinkansen technology (the Project), as described in **Section 2.2, Alternatives Considered, Proposed HSR Infrastructure and Operations,** and in the petition for rulemaking submitted by TCRR. The HSR service between Dallas and Houston is the only proposed service or future operating location TCRR has identified to FRA and therefore FRA determined it was appropriate to evaluate the potential project-specific impacts of this proposed service. The potential impacts that would result from implementing this specific Project are identified and discussed in this **Chapter 3.0, Affected Environment and Environmental Consequences**. **Sections 3.1, General Organization for Analysis,** and **3.1.1, General Methodology for Project-Specific Analysis,** outline the organization and methodology for the Project-specific analysis in this chapter, respectively.

However, because FRA's proposed rulemaking would enable the safe operation of the HSR System, or "System" in other, unidentified locations, in this Final EIS, FRA also considered impacts for application of the technology independent of location. **Section 3.1.2, Impacts of the TCRR HSR System Independent of Location,** considers the reasonably foreseeable potential beneficial and adverse environmental impacts of implementing TCRR's HSR service in any location, even though FRA is aware of no proposal to operate such service.

3.1 General Organization for Analysis

Section 3.1.2, Impacts of the TCRR HSR System Independent of Location, evaluates and documents the reasonably foreseeable potential beneficial and adverse environmental impacts of implementing TCRR's HSR system in any location.

The remainder of **Chapter 3.0, Affected Environment and Environmental Consequences,** describes the existing human, social and natural environment analyzed for the No Build and Build Alternatives for the Project. 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 Waters of the U.S.
- 3.8 Floodplains
- 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 Safety and Security
- 3.17 Recreational Facilities
- 3.18 Environmental Justice
- 3.19 Cultural Resources
- 3.20 Soils and Geology
- 3.21 Greenhouse Gas Emissions

The following subsection explains how each resource section is organized. The final subsection describes the general methodology that applies to all resources.

Beginning with Section 3.2, each resource section of **Chapter 3.0, Affected Environment and Environmental Consequences,** is organized as follows:

- **Introduction:** describes the resource being analyzed and specific terminology and references related to the particular section of the Final EIS. If for any reason the format of a resource section deviates from this outline, the modification is noted and explained.
- **Regulatory Context:** outlines relevant federal and state laws, regulations, orders and policies applicable to the Project.
- **Methodology:** defines the Study Area for the resource and describes the methodology and data sources used to analyze impacts. The Study Area varies depending on the resource being discussed.
- **Affected Environment:** describes the existing condition in the context of the Study Area for each Build Alternative and Houston Terminal Station option. 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 and Houston Terminal Station option. 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:** describes the measures that would be implemented to avoid, minimize or mitigate impacts. Additionally, any compliance measures required by local, state or federal regulation are described.
- **Build Alternatives Comparison:** provides a comparison of the Build Alternatives and Houston Terminal Station options, considering the findings from the resource area studied.

Appendices and technical memoranda provide additional details on the Project and the resource analysis process. The technical memoranda, included in **Appendix E, Technical Memoranda**, are related to the affected environment and environmental consequences analyses. These appendices are titled to match their corresponding environmental elements in **Chapter 3.0, Affected Environment and Environmental Consequences**.

3.1.1 General Methodology for Project-Specific Analysis

This section describes the methodology that applies to the analysis of resources. For each of the 20 resources, FRA analyzed the impacts of the Build Alternatives compared to the No Build Alternative. Methodology specific to a resource is detailed within that section and corresponding technical memoranda in **Appendix E, Technical Memoranda**.

3.1.1.1 Alternatives

For each resource, FRA analyzed the potential impacts of the Project. The alternatives analysis detailed in **Chapter 2.0, Alternatives Considered**, identifies the No Build Alternative, six Build Alternatives, and three Houston Terminal Station options. Each section of this chapter describes the impacts of the six Build Alternatives and the three Houston Terminal Station options on the subject resource as compared to those from the No Build Alternative.

3.1.1.2 Service Levels

To support the resource analyses, FRA incorporated Project assumptions to address the overall operations of the Project. As described in **Section 2.2.5, Alternatives Considered, Proposed HSR Operations**, there are three operational scenarios considered by TCRR (initial, future and peak service levels).

- **Initial service level:** represents the initial or "opening day" scenario for an anticipated 2026 initial build, which would include two trainsets during peak hours and two trainsets during off-peak hours[1]
- **Future service level:** 2040 horizon year, which would include three trainsets during peak hours and two trainsets during off-peak hours
- **Peak service level:** represents the ultimate maximum configuration of the Project in the 2040 horizon year, which would include six trainsets during peak hours and four trainsets during off-peak hours.

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. Since the Draft EIS, TCRR has continued to refine their ridership projections. As a result, TCRR's projected ridership numbers have increased since the publication of the Draft EIS. However, for purposes of this Final EIS, FRA continues to use the original ridership projections from the Draft EIS as this represents a more conservative estimate of impacts. In response to public comment, AECOM on behalf of FRA, independently evaluated the ridership inputs, assumptions and methodology used by TCRR, which included both business and personal travel patterns as detailed in TCRR's original June 19, 2018, and updated March 25, 2019, Ridership Forecast Reports. Based on the independent evaluation, FRA determined that TCRR used a reasonable approach to conduct their ridership assessment, and the outputs of the TCRR's ridership assessment are reasonable based on the methodology. As the ridership forecast approach and outputs were deemed reasonable, FRA continued to use the ridership estimate (5 to 7 million) in both the Draft EIS and Final EIS. A summary of AECOM's review is included in **Appendix J, Miscellaneous Memoranda, Ridership Demand Forecasting Methodology Assessment**.

Additionally, TCRR's Ridership Forecast Reports were based on 2029 and 2050 horizon years, while **Appendix F, TCRR Final Conceptual Engineering Design Report**, utilized horizon years of 2026 and 2040.

[1] Peak periods were defined by TCRR as 7:00 AM to 10:00 AM and 4:00 PM to 7:00 PM.

Service levels described in both documents were the same for both 2026 and 2029. However, the 2050 service level in the TCRR's Ridership Forecast Report (four trainsets during peak hours and four trainsets during off-peak hour) was less than the peak service level described in **Appendix J, Miscellaneous Memoranda, Ridership Demand Forecasting Methodology Assessment** (six trainsets during peak hours and four trainsets during off-peak hour). For the purposes of resource analysis in the Final EIS, FRA utilized the peak service level detailed in TCRR's Final Conceptual Engineering Report (see **Appendix F, TCRR Final Conceptual Engineering Design Report**), or the ultimate maximum configuration of the Project in 2040, to determine potential Project impacts, as this larger service level would represent a more conservative estimate of impacts (e.g., due to more anticipated trainsets).

3.1.1.3 Limits of Disturbance

For evaluation purposes, this Final EIS assesses the proposed limits of disturbance (LOD) and, as necessary, a resource-specific Study Area. The LOD includes both the permanent and temporary Project footprint as identified by TCRR to construct and operate the Project.

TCRR's Final Conceptual Engineering Report (see **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports**) 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 Conceptual Engineering Documentation (see **Appendix G, TCRR Final Conceptual Engineering Plans and Details**), which defines the physical LOD and conceptual details for infrastructure configuration, systems and facilities for the Project construction and operation.

The LOD is comprised of the permanent operational and the temporary construction footprints of the six Build Alternatives and Houston Terminal Station options as described in more detail below.

- The LOD includes the rail infrastructure, access roads, drainage swales and ancillary facilities (e.g., stations [Dallas Terminal Station, Brazos Valley Intermediate Station and Houston Terminal Station Options], trainset maintenance facility (TMF), maintenance-of-way (MOW) facilities, traction power substations (TPSS), maintenance roads and signal houses). For planning purposes, the proposed footprint for stations, maintenance and ancillary facilities were estimated to be 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 or the permanent footprint of the Project. Potential impacts from the permanent HSR ROW are assessed throughout this chapter.
- In addition to the proposed permanent HSR ROW, construction of the Project would include the permanent relocation or alteration of existing utilities and easements (i.e., underground pipelines, aboveground electrical transmission lines or existing roads). These activities, including the proposed footprint of relocated roads, also included the LOD. Potential impacts from the relocation or alteration of existing utilities and easements are assessed throughout this chapter.

  As discussed in **Sections 2.2.4, Alternatives Considered, Traction Power Supply,** and **2.5.4, Alternatives Considered, Engineering Refinements**, the LOD in the Final EIS has been updated to include potential indirect impacts from potential new electrical transmission lines to meet the traction power demand of the Project from the existing power grid. These potential transmission line routes have been developed by TCRR through coordination with electrical providers (i.e., Oncor and CenterPoint). The final design and construction of the transmission lines would be determined by the utility provider. The impacts of the potential electrical transmission line routes are assessed in **Chapter 4.0, Indirect Effects and Cumulative Impacts**.

- The LOD also includes areas that would be used temporarily to construct the Project. These Project-specific locations designated by TCRR would be used temporarily or short-term during the construction period of the Project (e.g., construction laydown areas, workspace areas and modifications to existing utility easements [e.g., pole adjustments of electrical utilities or cathodic protection]). It is anticipated that, in most cases, these areas would require temporary construction easements. Potential temporary impacts from construction are assessed throughout this chapter.

The LOD, on average, is approximately 9,418 acres per Build Alternative and averages 328 feet wide. The minimum ROW required would be 100 feet to accommodate track, overhead catenary system (OCS), access roads and security fencing. As depicted in **Appendix D, Project Footprint Mapbook**, the ROW varies throughout the corridor based on construction type and location of facilities. Note that potential land acquisition and easements are subject to ROW negotiation between TCRR and the property owner. Depending on these negotiations, TCRR may choose to acquire property beyond the Project footprint. These areas are unknown, not reasonably foreseeable and not included in this analysis. Within the six end-to-end Build Alternatives, 48 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 existing infrastructure to avoid or minimize impacts.

3.1.1.4 Modifications Incorporated into the Final EIS since the Draft EIS

Modifications including refinements to engineering and releases of updated resource data have occurred since the publication of the Draft EIS. These modifications, as described in the following paragraphs, are incorporated into this Final EIS.

As detailed in **Section 2.5.4, Alternatives Considered, Engineering Refinements**, TCRR continued to refine the conceptual design after the release of the Draft EIS based on the results of environmental and engineering surveys, stakeholder engagement, design development and the findings of the environmental analyses. These modifications included:

- Alignment and profile refinements and optimizations
- Station refinement and optimizations
- General HSR system refinements and optimizations (e.g., TMF relocations and addition of emergency access points)
- LOD refinements and optimizations

Due to TCRR's continued refinement of the Preferred Alternative, approximately 27.5 miles (12 percent) of the centerline of Build Alternative A shifted to a location outside of the LOD assessed in the Draft EIS. Additionally, the LOD of Build Alternative A in the Final EIS is approximately 9,173 acres, a reduction of approximately 9 percent from the Draft EIS. This updated conceptual design (included as **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports,** and **Appendix G, TCRR Final Conceptual Engineering Plans and Details)** completed as of July 1, 2019 (including memorandum listing Final Conceptual Engineering Report Clarifications and Corrections dated May 6, 2020), is the basis for the evaluation included in this Final EIS.

In addition to the engineering refinements, this Final EIS includes updated publicly available data, additional data gathered through recent field work and revised modeling based on the updated/additional data. For example, on September 23, 2019, the DFW and Houston-Galveston-Brazoria (HGB) nonattainment areas (NAA) were re-designated from moderate to serious nonattainment for the 2008 ozone (O_3) National Ambient Air Quality Standards (NAAQS), which resulted in a reduction of applicable *de minimis* levels, namely nitrogen oxide (NO_x) from 100 tons per year to 50 tons per year. **Section 3.2, Air Quality,** has been revised to include updated construction emissions modeling and estimates based on modifications to the proposed construction activities.

Furthermore, as noted in **Appendix H, Response to Draft EIS Comments**, data and analysis of resources throughout this chapter have been clarified, updated and/or expanded in response to public comments received during the Draft EIS public comment period. For instance, a property in Harris County was identified from public comments as a visual receptor and an updated analysis has been incorporated into **Section 3.10, Aesthetics and Scenic Resources.**

After the release of the Draft EIS, FRA conducted additional listening sessions and outreach to minority and/or low-income communities impacted by the Project. The summary of these discussions and analyses, including updated census data, have been incorporated into **Section 3.18, Environmental Justice**.

FRA also modified the approach to describing potential impacts in this Final EIS. Specifically, this Final EIS no longer describes impacts as "significant" or "not significant." However, the significance of the potential impacts continues to be described in terms of their context and intensity. Where adverse impacts would occur, FRA has identified ways to mitigate those impacts. By conducting the EIS, FRA acknowledges that the Project has the potential to significantly impact the natural and human environment.

In some resource areas, compliance and mitigation measures are presented differently in the Final EIS than in the Draft EIS. Redundant compliance and mitigation measures were removed from the Final EIS. Others were revised to apply more broadly than contemplated in the Draft EIS, better identify the entity responsible for mitigation and more precisely describe the measures, including the geographic area within which they apply. FRA also added new measures where appropriate to mitigate impacts.

As stated in the Executive Summary of the Final EIS, shaded areas in the Final EIS are intended to provide the reader with a simplified way to identify much of the revised language, modifications and/or refinements that differ from the text in the Draft EIS. However, the shading is not a word-for-word representation and not all modifications are shaded. Though not specifically shaded, all tables and figures in the Final EIS have been updated as appropriate. Furthermore, **Appendix D, Mapbooks,** and **Appendix E, Technical Memoranda,** have also been updated in the Final EIS, though not specifically shaded.

Additionally, some sections/chapters of the Final EIS that changed since the Draft EIS are not shaded due to the extent of reorganization of text, expansion and/or updates to both methodology and data. These include:

- **Section 3.10, Aesthetics and Scenic Resources**
- **Section 3.18, Environmental Justice**
- **Chapter 4.0, Indirect Effects and Cumulative Impacts**
- **Chapter 7.0, Section 4(f) and Section 6(f) Evaluation**

3.1.2 Impacts of the TCRR HSR System Independent of Location

As stated above, FRA's proposed rulemaking would enable the safe operation of the TCRR HSR system independent of location. Therefore, this section evaluates and documents the reasonably foreseeable potential beneficial and adverse environmental impacts of implementing TCRR's HSR system in any location within the United States.

3.1.2.1 Methodology for Analysis of Impacts of TCRR HSR Independent of Location

FRA identified and evaluated potential impacts from TCRR implementing the System independent of location. The impact analysis is based on the definition of the technology proposed in TCRR's petition for rulemaking. For the purpose of this analysis, FRA also assumed the design and operating characteristics applied in other locations would be similar to those of the Dallas to Houston HSR Project. Therefore, the discussion of the potential impacts in the following sections is based on the TCRR proposed technology and assumed design and operating characteristics that would be general to the System, wherever implemented.

The impact analysis was reasonably based on the evaluation of potential impacts between Dallas and Houston detailed further in this chapter. The evaluation of potential Project-specific impacts provides an informed basis for the evaluation the potential construction and operations impacts of the System in general. FRA has determined this is a reasonable approach to impact analysis considering the subject of TCRR's petition for rulemaking and the scope of FRA's proposed rule.

3.1.2.1.1 Definition of TCRR Proposed HSR System

TCRR proposes to implement an HSR system between Dallas and Houston based on the Central Japan Railway Company's Tokaido Shinkansen system, including its design safety elements, systems approach, culture of safety, and accident avoidance principles covering all aspects of system design, operations, inspection, testing, maintenance and training. TCRR is proposing to replicate the Tokaido Shinkansen system with minimal modifications.

TCRR's proposed technology includes:

- Electric-powered HSR passenger rail system
- Vehicle and operating procedures based on the Tokaido Shinkansen system
- Dedicated ROW ("closed system") that is not interconnected with any other railroad system and HSR trainset operations independent and separated from existing roadways and other infrastructure (i.e., no at-grade crossings)
- Double main-track railway that avoids bi-directional service on the same track
- Continuously welded rail on main line tracks
- Power delivered to the trainset through a 25 kV OCS from a TPSS
- HSR trainsets operating at speeds not to exceed 205 mph
- Passenger rail service only (hazardous materials and other conventional heavy freight would not be transported on the trainsets or within the HSR ROW)
- HSR system monitored and controlled from a system-wide Operations Control Center
- Automatic train control system controlling trainset movements at all locations

3.1.2.1.2 Design and Operating Characteristics Assumptions

FRA's proposed RPA only applies to TCRR; therefore, any project implemented in another location using the System must be implemented by TCRR. For the purpose of this analysis, FRA assumed the design and operating characteristics for a project in another location would be similar to those of the Dallas to Houston HSR Project (as detailed in **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports,** and **Appendix G, TCRR Final Conceptual Engineering Plans and Details**).

Section 3.0 of the TCRR Final Concept Engineering Design Report describes the specific design criteria standards that TCRR developed for the Dallas to Houston HSR Project. Some of the design standards are specific to Texas and may vary if TCRR implemented the System in another state. The following summarizes the design and operating characteristics that FRA assumed in the environmental impact analysis in this **Section 3.1.2.1**:

- Operations over 18 hours per day, 7 days per week and the remaining 6 hours per day allocated to a maintenance window
- Daily maintenance and fleet movement when the HSR line is not in revenue operation
- Linear HSR ROW that varies in width (minimum of 100 feet) that includes the track, OCS, access road and security fencing (although the specific footprint and length is not known)
- Double-track system on main track either on viaduct (bridge-like structure), at-grade (embankment) or retained cut/fill
- When on viaduct, spacing of piers ranging from 80 to 140 feet, with a typical spacing of 110 feet
- System ROW enclosed with security fencing when track is at-grade (embankment) or on retained cut/fill
- Stations, TMFs, MOW facilities, facility signaling and communications and traction power supply, including TPSS

3.1.2.1.3 Ridership Assumptions

Because ridership is an important input to the environmental analysis of transportation systems, for the purposes of this evaluation FRA also assumed that:

- TCRR would select locations to implement the System that would generate ridership sufficient to support the investment.
- Some travelers between population centers where the System would be implemented would shift from automobile trips to HSR trips (i.e., mode shift).
- In order to contribute to ridership sufficient to support the investment, mode shift would be substantial enough to offset certain impacts associated with vehicular travel, such as air quality emissions and greenhouse gas (GHG).

3.1.2.1.4 General Impact Assumptions

Because the assumed goal of the System is to transport people between population centers, and high speed transportation is logically implemented over longer distances (compared to other forms of rail transit such as light rail or commuter rail), FRA assumed that implementation of the System would result in both urban and rural impacts and that terminals would be located in or near urban areas.

For the purpose of this analysis, FRA also assumed the alignment and cross-section would be designed to balance TCRR design objectives (speed); design, construction and operations costs; and impacts to the natural, physical and human environment.[2] Therefore, FRA also assumed that the alignment would balance trade-offs between design speed (i.e. curvature) and impacts. In other words, if a project alignment was modified to incorporate tighter curvature to avoid impacts to buildings, major structures, major waterbodies and/or regulated features, the design speed would decreased and may not meet TCRR objectives.

Viaduct sections are bridge-like structures elevated with pier support structures. Where the System is on viaduct, it would generally avoid and/or minimize impacts to waterbodies, farmlands, transportation

[2] For instance, the Dallas to Houston HSR Project was designed with track alignment held to the minimum horizontal curve radius (17,100 feet by Central Japan Railway Company standards) and maximum superelevation (7 7/8 inches in the NPRM) and to not exceed 205 mph, as detailed within **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports.**

facilities and other features. Pier support structures result in permanent impacts; however, impacts to features may be avoided or minimized with strategic spacing of pier support structures.

Where the System is constructed at-grade (embankment) or on retained cut/fill, the System would create a linear barrier. The linear barrier results from the “closed system” and security fencing.

3.1.2.2 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. Flatter topography does not hinder or trap air movement like hills and mountains do. Extended hot summers and stagnant, foggy conditions are conducive to either forming or retaining air pollutants within the lower atmosphere.

Operation

Because the HSR System is electric-powered, operation of the System would not result in an increase in emissions or GHG pollutants or adverse impacts to air quality. As described in **Section 3.1.2.1.3, Ridership Assumptions,** FRA assumed that some travelers between populations centers would shift from auto trips to HSR trips (i.e., mode shift) and that the mode shift would be substantial enough to offset certain impacts associated with vehicular travel. This shift from automobile traffic to HSR ridership could reduce overall regional emissions and result in beneficial impacts to air quality. For the same reason, operation of the System could reduce regional criteria and GHG pollutants.

Construction

Construction of the System could be expected to temporarily increase local and regional emissions of particulate matter (fugitive dust) and pollutant emissions from fuel combustion (diesel PM, carbon monoxide [CO], carbon dioxide [CO_2], NO_x, volatile organic compounds [VOCs] and sulfur compounds) during the construction period. While construction emissions generated would be largely a function of System length, these impacts would be short-term during the period of construction. It is possible to mitigate many of the air quality impacts occurring during construction. For example, fugitive dust from construction could be mitigated by using dust suppression techniques such as soil binders or watering, covering or wetting materials during transport and limiting construction vehicle speeds on non-paved roads. Additionally, emissions could be mitigated by sourcing materials near the construction site and using existing freight rail lines to transport materials.

3.1.2.3 Water Quality

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. Waterbodies include rivers, streams, canals, lakes, drinking water reservoirs and retention or detention basins, including waterbodies that drain to a certain point and the connected groundwater features. Surface water impacts are generally evaluated by watershed level and groundwater by aquifers. 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.

Operation

FRA assumed the System would be designed to maintain existing drainage patterns and minimize potential contamination impacts to surface water quality, groundwater quality and water supplies. However, operation of the System could have potential permanent impacts on surface water quality including impaired stream segments. Impacts could result from stormwater runoff and operation activities, such as maintenance of culverts or bridges, fueling and trainset maintenance activities and obtaining water supplies for the operational facilities and trainsets. Impacts can be mitigated through soil erosion preventive measures, efforts to keep runoff rates similar to existing conditions and measures to prevent collected sediment and contamination from entering water in watersheds. Stabilization measures to reduce soil erosion and sedimentation protect adjacent waterbodies. Examples of stabilization measures include retention basins, grassy swales and constructed wetlands.

Potential permanent physical impacts could occur to groundwater wells, including public water system wells, if construction of the System were to overlap the location of the wells. This could result in sediments and contamination reaching the groundwater supply. This potential impact could be avoided by plugging and abandoning and/or relocating the wells prior to the start of construction.

Construction

Construction of the System would involve ground disturbances, such as excavation and grading, which could contribute to short-term impacts from erosion and sedimentation; therefore, the volume of sediment in stormwater could increase. Sedimentation and stormwater runoff from construction may result in total suspended solids (TSS) such as rock, soil, and debris fragments entering into downstream water resources. Suspended solids may also contain bacteria, nutrients, particles and other constituents attached to sediment or carried separately by stormwater that contribute to pollutant loading. Increased pollutant loading in runoff may impact surface water, groundwater quality and water supply. While this could impact all types of waterbodies, threatened or impaired waterbodies and reservoirs or other public water supplies could be more sensitive to construction stormwater runoff.

Increased water demand could occur for the duration of construction. Aside from drinking water for construction crews, water could be used for construction activities such as dust suppression and mixing concrete.

Construction impacts can be mitigated through temporary stormwater controls and sediment control measures, stabilizing disturbed areas during construction, storing dredged and fill material in a way that prevents sedimentation runoff to waterbodies and restoring and re-vegetating temporary construction areas.

3.1.2.4 Noise and Vibration

FRA assesses noise and vibration impacts per their guidance in the FRA, *High-Speed Ground Transportation Noise and Vibration Impact Assessment*, Final Report DOT/FRA/ORD-12/15, September 2012. 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 a project with the existing noise and are based on changes in noise exposure using a sliding scale. The FRA noise impact criteria include no impact, moderate impact and severe impact. Within the moderate impact range, 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. Within the severe impact range, changes in the noise due to a project could be highly annoying and cause strong, adverse reactions from the community. Severe noise impacts should be avoided if possible. Noise impacts are greater in areas with low existing noise levels.

To provide a sense for what 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 a 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 a severe noise impact.

FRA vibration impact criteria are based on well-documented research and industry standards and depend on land use and building category. Unlike noise, however, the vibration criteria are absolute and do not depend on the existing levels. Also, unlike noise, there is only one level of impact and impacts are only assessed at buildings and not at open land such as parks. For train operations, the FRA vibration criteria address human annoyance effects and effects on sensitive activities. For construction, the FRA vibration criteria also address potential damage effects to buildings.

<u>Operational Noise</u>

Operational noise impacts primarily due to trainsets passing near receivers located close to the tracks. FRA guidance generally projects noise exposure for a trainset passing at a speed of 205 mph to be 90 dBA at a reference distance of 50 feet from the centerline of the track. Sound levels of 90 dBA are considered very loud (louder than a jack hammer at the same distance). According to the FRA guidance[3] the largest screening distance for noise impact is 1,300 feet (new rail corridor in rural area). The distance is based on assumptions for the trainset operations and existing environment and is meant to provide a distance within which any potential impacts from HSR operations would be identified. Beyond this distance, no impacts would occur.

FRA guidance promotes the application of noise mitigation for severe impacts wherever feasible. Based on the existing noise levels in the quietest areas along the Dallas to Houston HSR corridor, which are representative of the lowest noise levels likely to be encountered in any inhabited area, severe noise impacts for the System would not be expected beyond 350 feet of the centerline of the track. Noise can be mitigated through sound barriers or sound insulation treatments for buildings, such as adding an extra layer of glazing to windows, sealing holes in exterior surfaces that act as sound leaks and providing forced ventilation and air conditioning so that windows do not need to be opened.

FRA also 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 trainsets. This effect would be confined to an area very close to the tracks. FRA guidelines indicate that 200 mph trainset operations could increase annoyance within about 45 feet of the track centerline. Assuming TCRR designed the System similarly to the Dallas to Houston HSR Project, the startle effect would typically be within the ROW limits of the rail corridor.

<u>Construction Noise</u>

The screening distances for potential construction noise impacts at residential locations, typically representing the most sensitive land use category, provide an indication of the intensity of noise impact for each construction activity. These estimates, shown in **Table 3.4-10**, show that the potential for

[3] FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.

construction noise impact at residential sites could extend to distances of 40 to 200 feet from daytime construction and to distances of 125 to 200 feet from nighttime construction of the System.

Noise impacts from construction can be mitigated using a number of methods, such as installing temporary sound barriers, limiting or avoiding nighttime construction near residential neighborhoods, locating stationary construction equipment as far as possible from noise-sensitive sites and re-routing construction-related truck traffic along roadways that will cause the least disturbance to residents.

Operational Vibration

Operational vibration impacts are primarily due to trainsets passing near receivers located close to the tracks. The largest impact screening distance for operational vibration is 275 feet (frequent operation at speeds of 200 to 300 mph near residential land use) in FRA guidance. As stated above with regard to operational noise, the distance obtained from the FRA guidance manual is based on assumptions for the HSR operations and existing environment and is meant to provide a distance within which any potential impacts from HSR operations would be identified.

Construction Vibration

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. During construction, some activities may cause perceptible ground-borne vibration, most notably pile driving for structures and vibratory compaction for ground improvements. Where these activities occur within 50 feet of underground utilities, they could result in vibration damage. These impacts could be mitigated by relocation and/or encasement of underground utilities within 50 feet of locations where pile driving or vibratory compaction occur. Impacts should be mitigated by relocating or encasing utilities. Potential vibration impacts, other than those from pile driving and vibratory compaction within 50 feet of structures, should be limited to annoyance effects 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 construction vibration impacts could 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 TMFs that include pile driving.

Vibration impacts from construction can be mitigated by routing heavily loaded trucks away from residential streets, phasing demolition, earthmoving and ground-impacting operations so as not to occur in the same time period or avoiding pile-driving in vibration-sensitive areas.

3.1.2.5 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. 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 use, handling and storage are regulated by USDOT and by the Occupational Safety and Health Act. Solid waste and hazardous waste are regulated by EPA. 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.

Operation

The System would only provide passenger rail service, and the transportation of hazardous materials in revenue service and joint operations with heavy freight equipment would not be permitted on the trainsets or within the HSR ROW. However, the operation and maintenance of the System could involve transporting, using and storing hazardous materials not in revenue service, and could generate hazardous waste. Hazardous materials could include diesel fuel, lubricants, hydraulic fluids and cleaning products used during the routine maintenance of the ROW, rail vehicles and stations. Wastes that 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 System could involve handling, transporting, generating and disposing of hazardous and solid waste. Based on the type of waste, the waste should be transferred to a landfill or recycling facility and disposed of appropriately according to federal, state and local requirements.

Construction

Impacts as a result of the construction of the System could 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 immediately adjacent to the System footprint. Careful consideration of hazardous materials concerns throughout the planning and development process could address these potential impacts as early as possible, as well as ensure compliance with federal, state and local environmental health and safety regulations.

Construction of the System could 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 could result in hazardous materials spills or releases that might impact human health or the environment. Safe handling, use, storage and disposal of these materials during construction and contingency plans to address discovery of hazardous materials could avoid a potentially adverse effect.

Relocation of existing oil or gas wells and pipelines may be necessary during construction of the System. Accidental damage to oil wells or pipelines during construction could result in oil and gas-related contamination. Remediation, such as that described in **Section 3.5.6.2, Hazardous Materials and Solid Waste, Mitigation Measures**, could mitigate contamination due to accidental damage.

3.1.2.6 Natural Ecological Systems and Protected Species

Operations

According to the *FRA Interim Criteria for Train Noise Effects on Animals*, the noise exposure limit for domestic (livestock and poultry) and wild animals (mammals and birds) is 100 decibels.[4] For HSR trainsets 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, which would be within the fenced boundaries of the

[4] FRA, "Interim Criteria for Train Noise Effects on Animals," last updated October 24, 2012, https://railroads.dot.gov/elibrary/high-speed-ground-transportation-noise-and-vibration-impact-assessment.

ROW. Where the HSR tracks would be on embankment and there would be wildlife or livestock crossings enclosed in a culvert, noise levels would be mitigated and reduced by shielding that is inherent in the design, either below the viaduct or within the culvert.

As artificial nighttime lighting can attract and disorient night-migrating birds, during operation, lighting for the System could be limited to stations and down-shielded. Due to the design of security fencing and OCS that is likely to discourage the birds from flying within the HSR tracks, strikes with trainsets are extremely unlikely to occur. However, to monitor and mitigate strike occurrences with wildlife in general, during the operation any obvious wildlife/bird mortality could be recorded and documented as noted in **NR-MM#7: Wildlife Mortality Recording Forms**.

Following construction, the necessary removal of trees and other vegetation that have the potential to interfere with the safe and reliable operation of the System would need to be performed during routine maintenance activities.

Construction

Natural Ecological Systems and Protected Species, frequently referred to as natural resources, includes plant and animal species, including Federally and state-listed threatened or endangered species, and the habitats where they occur. The System could 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. The construction of the System could result in the disturbance and potential mortality of wildlife, particularly during vegetation clearing and grading. If vegetation were to be removed during the breeding bird season, late winter through spring and summer, active bird nests (i.e., a nest that contains viable eggs and/or chicks) and potentially adult birds could be destroyed.

Construction impacts to vegetation and habitat could be minimized and/or avoided by deploying qualified biologists to conduct surveys prior to and during construction activities. Surveys could be conducted for protected species and their habitat to identify sensitive habitats and develop mitigation measures to avoid endangered species and their habitats. Qualified biologists could also identify protected species and relocate individuals so that direct mortality is avoided. Compliance and mitigation measures that could be implemented as necessary are described in **Section 3.6.6, Natural Ecological Systems and Protected Species, Avoidance, Minimization and Mitigation** (e.g., **NR-CM#4: Section 7 Consultation and a Biological Opinion**, or **NR-CM#5: Aquatic Invasive Species Transport** may not be warranted based on the location of the System).

3.1.2.7 Waters of the U.S.

This section examines jurisdictional waters of the U.S., which include intrastate rivers, streams, wetlands and waterbodies. Due to the linear nature of the System, the curvature restrictions described in **Section 3.1.2.1.4, General Impact Assumptions**, and the length required to connect urban areas, FRA assumes that the System would cross waters of the U.S.

Operations

Permanent impacts could occur where viaduct, bridge support structures, access roads, stations, MOW facilities and TMFs or embankments would be placed within waters of the U.S. Spanning waters of the U.S. typically avoids permanent impacts. As described in **Section 3.1.2.1.4, General Impact Assumptions,** FRA assumes pier spacing would range from 80 to 140 feet, with a typical pier spacing of 110 feet. Waters of the U.S. that are narrower than 140 feet could generally be spanned. Operational impacts to waters of the U.S. would be limited to maintenance of culverts or bridges, and ongoing vegetation maintenance within the permanent ROW of the System. Impacts to waters of the U.S. require permits and approvals from USACE (and applicable state agencies) that would include permit provisions to avoid, minimize and mitigate impacts. Mitigation could include designing and constructing crossings of waters of the U.S. to maintain low flows, avoiding and/or minimizing stream relocations and compensating for impacts through wetland or stream mitigation credits.

Construction

Temporary construction impacts could include grading and temporary fill from construction access, staging and laydown areas. Mitigation could include restoring impacted areas to pre-construction contours or removing temporary fills from waters of the U.S. (e.g., temporary equipment crossings or temporary disturbances in construction areas around and beneath the HSR System).

3.1.2.8 Floodplains

As described in **Section 3.1.2.1, Methodology for Analysis of Impacts of TCRR HSR Independent of Location,** FRA assumed the System would be designed to avoid and minimize crossings of mapped stream channels. Many regulatory floodplains and unregulated stream segments could be fully spanned and potential impacts avoided. However, the System could still impact regulatory floodplains.

Operation

The placement of HSR track and supporting facilities (e.g., permanent roads, parking areas, access/maintenance areas, terminals and non-vegetated embankments) could 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 could 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.

Where the HSR track and supporting facilities (e.g., permanent roads, parking areas, access/maintenance areas, terminals and non-vegetated embankments) were built in floodplains, there could be a permanent incremental increase in floodplain elevation. Stations and other infrastructure in highly urbanized areas could increase impervious surface area, which could contribute additional volumes of stormwater runoff to existing stormwater drainage systems. Impacts can be mitigated with detention or retention basins sized according to industry-standard hydrologic runoff computations, swales, vegetative strips and soil stabilization measures that reduce peak flow rates.

Construction

During construction, workspace areas, laydown yards and construction workspace could have a temporary impact to the floodplains. Impacts can be mitigated with temporary erosion and sedimentation controls, revegetation, temporary detention basins, swales, vegetative strips and other best management practices (BMP).

3.1.2.9 Utilities and Energy

Operation

FRA assumed the HSR System would require support from existing utility and energy infrastructure, including power from the existing grid for the HSR trainsets, stations, TMFs and MOW facilities. FRA assumed the System would obtain electricity from the existing energy grid. Due to the size and expected electrical demand of the System, existing electricity reserves and electrical transmission capacity could be affected. FRA used the evaluation of energy consumption for the Dallas to Houston HSR Project to estimate energy consumption for a System implemented in another location. As described in **Section 3.9.5.2.3, Utilities and Energy, Environmental Consequences, Build Alternatives, Fuel,** the fuel consumption savings estimated for the Dallas to Houston HSR Project by reducing passenger vehicle travel would be approximately 37.4 million gallons of gasoline, or 4,285,420 million British thermal units (MMBtu) annually. By comparison, the annual operation of the HSR Project would consume approximately 1,554,571 MMBtus, resulting in a net savings in energy of 2,730,849 MMBtus. Because the Dallas to Houston HSR Project would save more energy annually (2,730,849 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. Based on assumptions that the overall design and operating characteristics (and therefore the expected electrical demand and related expenditures) for a project in another location would be similar to those of the Dallas to Houston HSR Project, as detailed in **Section 3.1.2.1.4, General Impact Assumptions,** the energy savings would be similar for a Project implemented in another location.

Construction

Due to the linear nature of the System, it would likely intersect water and sewer utility lines, electricity lines, crude oil lines, natural gas lines, oil and gas wells and associated access roads. Mitigation could involve relocation, re-routing, vertical adjustments, modification or well abandonment. Construction of the System would require electricity at laydown areas and construction sites, primarily for lighting and power tools.

3.1.2.10 Aesthetics and Scenic Resources

Aesthetics and scenic resources include the visible natural and cultural landscape features that contribute to a viewer’s perception of an area.

Operation

Once constructed, the System could have permanent visual impacts by introducing infrastructure (HSR rail, ancillary facilities and stations) and lighting, fencing and an OCS. Permanent visual impacts could be more adverse in rural areas where the setting and topography are more natural. The System would generally have less of an impact in urban areas where the setting is more compatible with infrastructure. Where a terminus station would replace underutilized or abandoned structures or lots, the System could have a positive visual impact.

Visual impacts can be mitigated with visual screening such as vegetation (including trees and shrubs), walls, berms or natural-looking constructed landforms. Stations and associated structures such as elevators, escalators and walkways can be designed with attractive architectural elements or features that add visual interest to the streetscapes near them. The station streetscape can also integrate trees and landscaping to soften and buffer the appearance of guideways, columns and elevated stations.

Construction

The construction of the System could introduce temporary, visual impacts from fencing, lighting and clearing of trees. Construction impacts can be mitigated by minimizing the removal of vegetation. Vegetation can be beat down, mowed or covered with protective surface matting rather than removed.

Crowns and roots from cut vegetation can be left undisturbed to allow for re-sprouting. Trees that do not present a safety or engineering hazard or otherwise interfere with operations could be left in the ROW.

3.1.2.11 Transportation

Implementing the System could impact the transportation network, including roadways, transit services, on-road pedestrian and bicycle facilities and airports.

Operations

Introducing the System as a new mode of transportation could change the regional transportation network and result in a long-term shift in how people travel, particularly between terminal locations. As described in **Section 3.1.2.1.4, General Impact Assumptions**, FRA assumed the System would shift riders from long-distance automobile trips. The number of automobile trips shifted would be location specific. Once operational, local transit services that connect to stations would likely see increases in ridership. The shift from long-distance automobile trips to HSR transportation and the ridership increases for connecting local transit services would be a beneficial impact, offering more mobility options and in some cases, reducing urban congestion. Depending on the transit connections to proposed stations in urban areas and parking provided at the station, automobile traffic could increase around station areas. Local jurisdictions could require traffic impact analysis to assess and mitigate for this impact.

As the System is "closed" and not interconnected with any other railroad system, operations would be independent and separated from existing roadways and other infrastructure. The HSR tracks would not be shared with other rail traffic and there would be no at-grade road crossings (meaning a car would not have to wait for a trainset to pass and then drive over the tracks to the other side of the system.) Although the System may cross freight railroads, light rail transit lines, impacts would be limited to temporary disruption of service during construction.

Roads that cross the System may be impacted. Road crossings and configurations include:

- **Road under railway:** There are two conditions where this configuration would occur: (1) the road would be depressed (below grade) beneath the railway or (2) the road would remain at-grade while the railway would be elevated (viaduct).
- **Road over railway:** Either the road would be elevated to go over the railway or the road would remain at-grade and the railway would be depressed.
- **Relocation:** Existing road would be relocated to avoid conflict with the railway.
- **Road adjustment:** Existing road would be realigned to avoid conflict with the railway.
- **Reroute:** Public and private roadways, approaching from one or both sides of the railway, would be rerouted on new access roads (maintained by TCRR) to an alternate, nearby crossing.
- **Closure:** Private roadway on either side of the railway would be closed and traffic would be required to use existing alternate routes.

Construction

During construction, there may be disruption to traffic on roadways, transit services, freight or commuter rail services or pedestrian/bicycle facilities. Construction activities could result in construction traffic on nearby and adjacent roads. Construction activities could also result in traffic delays and temporary road closures on roads crossed by the System. Mitigation measures include detours, signage, striping and pavement markings, temporary business access points and public and emergency provider notifications.

3.1.2.12 Elderly and Handicapped

The System would be designed, constructed and operated in compliance with 49 C.F.R. 37 and 38, and the Americans with Disabilities Act of 1990 (ADA), as enforced by the U.S. Department of Justice; therefore, there would be no impacts related to accessibility of the System for the elderly and handicapped as detailed within **Section 3.12, Elderly and Handicapped**.

3.1.2.13 Land Use

As described in **Section 3.1.2.1.4, General Impact Assumptions**, FRA assumes that the System could impact rural and urban areas. The implementation of the System could permanently convert existing land uses to transportation use within the System's footprint. The width of the System footprint would vary and would be influenced by topography and whether the rail infrastructure would be below grade, on embankment or on viaduct. For instance, as defined previously in **Section 3.1.2.1.2, Design and Operating Characteristics Assumptions**, the minimum System footprint could be 100 feet in some areas that are on viaduct.

Operation

HSR stations in urban areas could increase land use densities and accelerate development around the station area in the long term. Between station areas it is unlikely the System would change the pattern or distribution of land use because it is a "closed system" and has a relatively narrow footprint. Project-influenced development would not be expected between stations as there would be no access to the System.

In rural areas, agriculture impacts of the System could include the loss of crops within the footprint and fragmentation of existing fields. Impacts of the System on livestock could include fragmentation of pasturelands and a possible barrier to herd movement. Portions of the System could be constructed on viaduct, allowing for unimpeded movement of herd beneath the tracks in these areas. In areas not on viaduct, herds could be relocated to adjacent or other pasturelands. Security fencing would prevent livestock access to the System in areas not on viaduct.

Identifying the individual circumstances surrounding acquisition of parcels is not possible for this analysis. However, FRA assumes the System could result in the displacement of structures and the acquisition of parcels. Examples of potential acquisitions include businesses, family-owned shops, larger chain or franchise businesses, gas stations, industrial sites, farms, parks, community facilities, residences, churches or apartment complexes. Mitigation for structure and parcel acquisitions would be negotiated with the property owners on a case-by-case basis during the ROW acquisition.

Construction

TCRR would have to secure access from adjacent property owners for construction staging. Construction staging and access areas could be temporary and properties could be returned to the owner upon completion of construction. Agricultural or pasture land under viaduct sections could be temporarily disturbed and taken out of production during the construction period. Following construction, this land could be returned to agricultural use.

3.1.2.14 Socioeconomics and Community Facilities

Operation

The System would likely displace residents and businesses, which could result in localized changes in demographics. Some migration from rural to metropolitan regions could occur as a result of improved transportation conditions. From a community character and cohesion perspective, the impact of converting existing land use to a transportation use is dependent on the System's track configuration (i.e., at-grade, embankment or viaduct), density of the community and location of and access to community facilities. The System's track configuration would be a critical component to maintaining community connectivity. In some locations, the System could create a barrier to community services. Additionally, the reconfiguration and construction of existing and new roadways could minimize connectivity and access impacts.

The System could have positive and negative economic impacts. The System could create new permanent jobs for operations and maintenance and could create tax revenue, which would represent a positive impact to local and state jurisdictions. However, businesses near the System could experience reduced customer access or noise or visual clutter that deters customers. The effect of construction would depend on the nature and market of each potentially affected business. For example, businesses providing food, lodging or personal items that may be used by construction employees may experience a positive impact. Businesses providing specialty or niche services or those that do not interact with customers on-site would unlikely be negatively affected, provided basic access would be maintained. Businesses that rely on a quiet environment (e.g., audio/video production, day care centers) may be negatively impacted by construction.

The area around stations could see accelerated development and changes to property values. Studies have shown a positive effect between residential and commercial property values and rapid rail/commuter transit.[5] Rapid rail and commuter rail systems, which operate at higher speeds and provide a more regionally accessible transit system, have a wider sphere of influence for positive land premiums around stations as compared to light rail transit. The System would operate at even higher speeds and could provide a connection between population centers, so it is assumed that property values around the System's station areas could experience a similar positive impact. Data are less clear regarding the potential effects on property values near rail corridors without nearby station access.

Construction

Construction of the System would include ground clearing, placement of fill material for track temporary staging areas, new, replaced or extended culverts and bridges and temporary access road development. Short-term impacts from increased noise, dust and vehicular congestion resulting from road closures and detours could occur within communities.

[5] The analysis of property premiums around stations relies on a variety of literature documenting the station area effects of mass transit (including light rail, commuter rail and HSR projects) as well as professional judgement. The variety of available studies utilize differing methodology and approaches; however, the primary factors that can influence property values would be of a similar nature for HSR technology as for traditional mass transit. For example, presence of hazardous freight cargo is negatively correlated with property values, but, as for studies of traditional mass transit, the System would not involve the transportation of hazardous materials. Noise and vibration are negatively correlated with property values, but, similar to traditional mass transit, System noise levels are not expected to exceed that of the background environment where stations are planned. Station area activity (the movement of people in and around the stations) is positively correlated with property premiums, and Project ridership estimates indicate higher levels of station area activity than for traditional rail transit projects. As a result, the factors used for this analysis are assumed to be conservative estimates of the potential for property value growth around station areas.

Economic impacts associated with construction could include an influx of capital investment and construction-related job growth. Capital cost estimates for the System can be used to determine employment, earnings, and tax impacts resulting from the capital investment, and include construction labor, materials, indirect costs and the cost of the systems and rolling stock. The injection of capital into the construction and professional industries could lead to direct, indirect and induced employment earnings, spurring an additional state and local tax revenue. These impacts would be generally spread over the pre-operational period, which would include the engineering, acquisition, construction and procurement phases.

3.1.2.15 Electromagnetic Fields

Electric and magnetic fields are commonly referred to as "electromagnetic fields" (EMFs). EMFs are invisible, non-ionizing radiation. EMFs are commonly produced by both natural and man-made sources. Under extreme conditions, such as a lightning strike, EMF health hazards can include shocks and burns, although such conditions are rare.

Operation

During operation, the System could generate EMF/EMI both at 60 Hz and harmonics, as well as at radiofrequencies for HSR signaling and communication equipment. EMF exposure levels within and outside the existing Shinkansen trainsets are reported by Shinkansen to be below International Commission on Non-Ionizing Radiation Protection guidelines;[6] therefore, passengers on the trainsets, 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. Additionally, HSR equipment would comply with FCC requirements and not adversely interfere with other electric or electronic equipment.

Construction

Construction of the System could be periodically subject the construction area to increased EMF during the use of electric and electronic construction equipment, such as two-way communication radios and power equipment. This standard equipment is regulated by the FCC and associated EMFs would be within the FCC regulatory limits. Typical construction equipment is not likely not interfere with the operation of other nearby electric and electronic equipment; therefore, the impacts from construction activities of the System would not be meaningful.

3.1.2.16 Safety and Security

Safety and security issues could result from natural disasters, safety incidents or criminal acts and would have the potential to affect the HSR System and the ability for emergency services to respond to incidents on or off the HSR system. This Final EIS provides details on safety issues for construction and operation of the System, including the measures and regulations currently in place, or that would be implemented to protect communities through which the System would pass. The potential impacts and compliance measures identified to avoid, minimize, or mitigate those impacts that are described in **Section 3.16.6.1, Safety and Security, Compliance Measures,** and discussed below, would apply independent of where TCRR implements the HSR system.

[6] Central Japan Railway Company, "Environmental Report," *Global Environmental Committee*, 2000, http://jr-central.co.jp.

Operations

TCRR proposes to implement an HSR system based on the Tokaido Shinkansen system, including its design safety elements, systems approach, culture of safety and accident avoidance principles. Accident avoidance principles covering all aspects of system design, operations, inspection, testing and maintenance, and training are the foundations for the Tokaido Shinkansen's proven safety record. These key elements of accident avoidance have been monitored and refined over five decades to result in an expert level of understanding of the principles necessary for safe design and operation of an HSR system. These principles led to HSR system operations and design features (detailed as avoidance measures in **Section 3.16.6, Safety and Security, Avoidance, Minimization and Mitigation**) that would eliminate or highly mitigate the risk of trainset-to-motor vehicle collisions and trainset-to-trainset collisions.

Impacts related to collisions could occur if an HSR vehicle were to strike a person, animal, vehicle or other object, either on the HSR track or as a result of an HSR derailment. The potential for derailment would be mitigated through the measures previously described. To minimize the potential for collisions within the ROW, the System must be built within a dedicated ROW that is completely grade separated from freight, automobile, truck and pedestrian traffic. Additionally, by avoiding bi-directional service on the same track, TCRR would mitigate the risk of head on collisions as trainsets would never need to travel through the same section of track in opposite directions. Further, TCRR's automatic train control system would control trainset movements at all locations, further mitigating the potential for trainset-to-trainset collisions.

Mechanical failure could pose some risk to passengers or employees if confined on a non-operational vehicle and could introduce safety hazards for employees performing emergency maintenance. Additionally, mechanical failure of the doors could impact the safety of boarding or alighting passengers. TCRR's Inspection, Testing and Maintenance Program (see **SS-CM#3: Inspection, Testing, and Maintenance**) would minimize the occurrence of mechanical failure. TCRR's Emergency Preparedness Plan (see **SS-CM#1: Emergency Preparedness Plan**) would specify safe evacuation routes and emergency procedures. The HSR trainset design would include emergency exit path markings and signage; emergency lighting; emergency egress and rescue access windows in every car. In addition the HSR ROW would include walkways along elevated and at-grade sections with vertical access provided in compliance with applicable Occupational Safety and Health Administration (OSHA), and ADA standards for emergency access and egress (see **SS-CM#7: Compliant Facility Design,** and **EH-CM#1: Compliance with ADA and TAS).**

FRA proposes in the NPRM a requirement that TCRR shall not conduct scheduled ROW maintenance on a section of the ROW prior to that section of the ROW being cleared of all revenue service trainsets, and proper action is taken by the general control center staff to protect incursion into established maintenance zones by revenue trainsets. Additionally, the railroad shall not commence revenue service prior to completion of the maintenance activities and that section of the ROW being cleared of all MOW equipment. To further mitigate risks associated with emergency maintenance activities and passenger evacuation activities, employees would receive safety training in compliance with **SS-CM#2: System Safety Program**. FRA has proposed in the NPRM a requirement that TCRR shall have station platform attendants on the platform in close proximity to the trainset protection switches and shall have operating rules requiring coordination between on-board crew and station platform attendants to ensure safety during passenger boarding and alighting from trainsets at stations. The N700-Series trainset doors are equipped with interior manual release mechanisms, exterior door indicator lights that can be seen by the platform attendant and a manual door override located on the exterior of each car.

Fire on the HSR trainset or at facilities could represent an impact to the safety of passengers or employees. Impacts related to fire on the trainset would be mitigated through adherence to the guidelines described under **SS-CM#5: Fire Safety**. Design of the guideway would follow codes and standards deemed applicable to the operation of the railroad and would be advanced in consultation and coordination with key stakeholders along the corridor**.** For stations, applicable fire and life safety standards would be applied in conjunction with applicable building codes, including but not limited to, the International Building Code, to provide for fire and life safety. During more detailed design, TCRR would coordinate with applicable regulatory bodies to incorporate requirements as required. In compliance with federal OSHA standards and as described under **SS-CM#7: Compliant Facility Design,** station areas would include emergency access and egress plans designed to increase the effectiveness and timeliness of emergency response. TCRR's Emergency Preparedness Plan (see **SS-CM#1: Emergency Preparedness Plan**) would specify safe evacuation routes and emergency procedures in the event of an HSR trainset emergency.

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 provide for Emergency Response Staging Areas (ERMSAs) that a trainset could quickly arrive at to allow emergency response teams to access the HSR ROW and trainset. The System has been designed to deter and provide early detection of criminal or terrorist activity with perimeter fencing, closed circuit television, security lighting and private security department to monitor safety and security on vehicles and at facilities, as well as coordinate with local city and county law enforcement. The HSR System's design features work to minimize potential operational safety impacts.

As described in **SS-CM#4**: **Perform Hazard Analysis**, TCRR would be required to establish a risk-based hazard management program and conduct hazard analyses. Any natural hazards identified through this process would be addressed with appropriate hazard controls and procedures. TCRR's operating plan would specify the conditions under which the system would be suspended, such as during or in preparation for extreme weather events. Procedures for communication and responding during an emergency situation involving an HSR trainset, including communication protocols, would be detailed through TCRR's Emergency Preparedness Plan (see **SS-CM#1: Emergency Preparedness Plan**).

The HSR system's intrusion detection system, embedded throughout the HSR rail corridor, would detect large objects, such as vehicles, that break through the barrier and suspend HSR service until the tracks could be inspected and cleared, and if necessary repaired. FRA has proposed in the NPRM a requirement that TCRR conduct special inspections of the track and ROW in the event of fire, flood, severe storm, temperature extremes or other conditions that may damage track infrastructure. Sweeper vehicles, which inspect the ROW for obstacles, could be deployed following any service disruption or severe weather event.

Construction

Any large infrastructure investment has the potential to impact health and safety as a result of construction-related activities. If not properly operated, secured and maintained, construction equipment could create a risk to the physical safety of employees, contractors or other individuals present on construction sites. In addition, movement of vehicles or equipment to a site or between sites could present additional hazards to nearby traffic or pedestrian movements. FRA assumed that TCRR would limit construction site access to authorized personnel, secure the construction site and implement a traffic control plan to address traffic safety.

FRA assumed the System would require construction of roadways to 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. Closures and reroutes could be mitigated with traffic control measures and coordination with local jurisdictions.

3.1.2.17 Recreational Facilities

Recreational facilities include public parklands, off-street trails and other recreational facilities that may serve a public use as well as private recreational facilities, such as driving ranges, mini-golf or go-cart tracks, businesses.

Operations

Operational impacts could be long-term and permanent. These would represent direct changes that could permanently alter the use, character or setting of the recreational facility. This could include full or partial acquisition of any recreational facility and changes in use, access or visual quality, or noise impacts to recreational facilities or parklands.

Construction

Temporary construction impacts could include air quality (emissions from the use of heavy equipment), noise and vibration (from the use of heavy equipment), visual (changes in viewshed) and access (changes or reduced access) impacts. Noise and visual impacts represent the largest distances for potential indirection impacts. As noted in **Section 3.1.2.4, Noise and Vibration,** daytime construction noise impacts could extend 40 to 200 feet from the noise source and nighttime construction noise impacts could extend 125 to 200 feet from the noise source. Noise impacts from construction can be mitigated using a number of methods, such as installing temporary sound barriers, limiting or avoiding nighttime construction near residential neighborhoods, locating stationary construction equipment as far as possible from noise-sensitive sites and re-routing construction-related truck traffic along roadways that will cause the least disturbance to residents.

3.1.2.18 Environmental Justice

Environmental Justice impacts analysis focuses on those impacts that could be determined to be predominantly borne by minority or low-income populations, adverse and/or beneficial based on their location, type or severity. Guidance by the Federal Council on Environmental Quality and the EPA Office of Environmental Justice states that, "… a minority population may be present if the minority population percentage of the affected area is 'meaningfully greater' than the minority population percentage in the general population or other 'appropriate unit of geographic analysis'."[7] It is not possible for this analysis to examine demographic characteristics without specific locations.

As described in **Section 3.1.2.1.4, General Impact Assumptions**, FRA assumed the System would impact urban and rural areas. Given the nature of urban areas and the long distances over which the System could be implanted, FRA assumed that the System could cross communities defined as minority or low-income populations.

The System could bisect, cut through, displace or isolate a community or large numbers of residential units within a minority or low-income community. Community cohesion is a function of density and can be a concern, particularly in urban and suburban areas where a project can create a localized barrier

[7] CEQ, *Environmental Justice: Guidance Under the National Environmental Policy Act*, Washington, D.C., December 10, 1997.

between a residential community and social or commercial resources. In rural areas that are less dense, there would be more flexibility to maintain connectivity, especially to community facilities.

Outreach to specific impacted communities, such as listening sessions, could provide opportunities for meaningful participation throughout System development, help to better understand the precise nature of impacts, and identify appropriate mitigation. Examples of mitigation from the Dallas to Houston HSR Project include relocation assistance, financial planning and budgeting services, and packing assistance.

3.1.2.19 Cultural Resources

FRA assumes that due to the linear nature of the System and the curvature restrictions associated with the operation of the HSR system, impacts to cultural resources would be unavoidable. The term cultural resources includes any prehistoric or historic structures, buildings, objects, sites, districts (a collection of related structures, buildings, objects and/or sites), landscapes, natural features, traditional cultural properties and cemeteries. Permanent impacts could include the complete removal of the resource or indirect impacts to the visual setting. Minimization and avoidance of impacts could include the early consultation with local historical societies and relevant agencies during conceptual design of the System.

3.1.2.20 Soils and Geology

Risk factors that should be considered in the design of the System as a result of soil conditions include unstable soils, highly-expansive soils, low soil bearing strength, corrosive soils, slope failures and settlement. These conditions would present a lower risk to the System with the incorporation of standard engineering design features such as avoiding deep slopes to the maximum extent practicable, stockpiling topsoil for reclamation and incorporating lime stabilization. The ultimate design of the System could include structure types such as HSR bridges, roadway bridges, crash walls, retaining walls, noise walls, fences and utilities. In addition, some portions of the System could require the construction of embankments, which includes cutting, excavation and grading into existing subsurface materials at varying depths, as well as vegetation removal. All structures, embankments and cut slopes should incorporate engineering design features to minimize short- and long-term impacts to System.

__Operation__

Unstable soils could cause impacts during operations due to the potential for failures as a result of exposure to groundwater creep or heavy precipitation events, which are typically more likely to occur in proximity to water resources and other areas containing loose or soft deposits of sand, silts and clays. Soils with high shrink-swell potential shrink during dry conditions and expand when wet. Impacts as a result of a high shrink-swell potential could be greater in areas along the System that are at-grade, such as facilities and structures, rather than elevated structures on deep foundation, retained fill or retained cuts. Loads associated with at-grade construction may not be sufficient to handle the shrink-swell variability of those soils resulting in movement of structures or track sections if design measures, such as minimizing moisture content changes or soil improvement, are not incorporated. Construction of the System on soft or loose soils could result in slope failures at water resources crossings, instability of cut and fill slopes or collapse of retaining structures. Slope failures could also cause increased load to structures or blockage in the pathway of the slope failure. In addition to slope failures, settlement could occur during construction and operation if underlying materials become compressed under large loads, with placement of new fill material and groundwater withdrawal in areas where high groundwater exists. Settlement is more likely to occur in areas of soft deposits of silty or clay soils that have not been previously compressed by loads of similar size. Portions of the System that could be at higher risk of impacts as a result of settlement during operation include approach fills for viaducts, embankments and other areas where retained fill are planned. Settlement can be mitigated through standard engineering design measures such as site stabilization to improve unstable and settlement-prone soils.

Construction

Potential impacts to the System as a result of soil erosion could occur during construction and after construction in areas that require grading and vegetation removal until these areas are reclaimed through implementation of long-term soil stabilization such as with revegetation or other ground covering. In areas where construction activities occur along slopes that vary in height and steepness, localized failures of these slopes could occur with increasing risk as the slope steepness and height increases. Soil and geological impacts on the System are generally mitigated with standard engineering design measures such as geotechnical inspections, slope monitoring and site stabilization to improve unstable and settlement-prone soils.

During construction of the System, impacts to geology could include ground-disturbing activities, such as cutting and grading, which could permanently modify the local topography. The System would be designed to follow local topography, where practicable, in order to minimize impacts.

3.1.2.21 Greenhouse Gas Emissions

Operation

Long-term induced activities that could contribute to GHG emissions from the System include increased vehicle and bus travel on roadways for passengers to access stations and power generation for the electricity consumed by the HSR trainsets, 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 by those passengers using electric trainsets instead of cars and buses to travel between terminal stations. FRA assumed that the magnitude of GHG emissions reduced by this change in mode of travel would be greater than GHG emissions generated by the trainset and station power consumption and passenger travel to and from stations, because future year VMT and vehicle GHG emissions reductions would be greater than GHG emissions from power plants that would be anticipated to steadily decrease due to more stringent standards and improvements in emission controls. In addition, future power plant GHG emissions would be anticipated to decrease due to an increasing percentage of power generated by non-combustion sources. The design, construction, maintenance and inspection actions proposed for the HSR system would provide management of risks introduced from climate change

Construction

During construction of the System, GHG emissions could be generated by non-road construction equipment, on-road vehicles and freight rail hauling activities.

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3.2 Air Quality

3.2.1 Introduction

This section describes the air quality impacts of the Build Alternatives through an analysis of emissions from various sources during the construction and operation of the Project. The purpose of the analysis is to identify potential air quality impacts for the Project, 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_2) and sulfur dioxide (SO_2), and other regulatory requirements applicable to the Project; describe the methodology used to calculate pollutant emissions; describe airborne pollutants of interest and their impact on health; summarize existing regional and local air quality conditions; discuss regional attainment and transportation and general conformity (GC) requirements; reference the State Implementation Plan (SIP) and explain its relevance; quantify construction period and long-term operational pollutant emissions; discuss potential mobile source air toxics impacts; provide a GC analysis within applicable nonattainment areas; recommend mitigation measures and provide a comparative analysis of potential air quality impacts from the Build Alternatives.

The Project would be partially located within nonattainment areas for O_3 and SO_2; therefore, a determination of applicability to demonstrate GC is necessary. The air quality impact analysis aggregates NO_x and volatile organic compounds (VOC) emissions (O_3 precursor pollutants) that occur within the separate O_3 nonattainment areas and SO_2 emissions within Freestone County. NO_x and VOC emissions are included from Dallas and Ellis Counties in the DFW O_3 nonattainment area, and Waller and Harris Counties in the Houston-Galveston-Brazoria (HGB) O_3 nonattainment area, as explained in detail in **Section 3.2.3, Methodology**. The Project does not pass through any of the other HGB or DFW nonattainment area counties. SO_2 emissions from Freestone County are included 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 Project. 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 and 2015 NAAQS for O_3. The O_3 NAAQS was revised in 2015, with nonattainment designations effective August 3, 2018. This is discussed in more detail in **Section 3.2.4, Air Quality Trends and Monitoring**.

3.2.2 Regulatory Context

Federal

<u>Clean Air Act of 1970 and Clean Air Act Amendments of 1990</u>

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.

[1] Clean Air Act, 42 U.S.C. 7401 et seq. (1970).

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. EPA regulates air quality in accordance with the primary and secondary NAAQS. The NAAQS regulate six criteria pollutants under the primary standards. These are carbon monoxide (CO), nitrogen dioxide (NO_2), O_3, lead, 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 (µg/m^3). **Table 3.2-1** shows the NAAQS for the six criteria pollutants.[3]

Table 3.2-1: National Ambient Air Quality Standards for Criteria Pollutants

Pollutant	Primary Standards	Averaging Times[a]	Secondary Standards
CO	9 ppm (10 mg/m^3)	8-hour[b]	None
	35 ppm (40 mg/m^3)	1-hour[b]	None
Lead	0.15 µg/m^3	Rolling 3-Month Average	Same as Primary
NO_2	100 ppb (0.100 ppm)	1-hour[c]	None
	53 ppb (0.053 ppm)	Annual (Arithmetic Mean)	Same as Primary
PM_{10}	150 µg/m^3	24-hour[d]	Same as Primary
$PM_{2.5}$	12 µg/m^3	Annual[e]	15 µg/m^3
	35 µg/m^3	24-hour[c]	Same as Primary
O_3	0.070 ppm (2015 std)	8-hour[f]	Same as Primary
	0.075 ppm (2008 std)	8-hour[f]	Same as Primary
SO_2	75 ppb (0.075 ppm)	1-hour[g]	None
	None	3-hour[g]	0.5 ppm (1,300 µg/m^3)

Source: EPA National Ambient Air Quality Standards Table, 2016

[a] The time period for which compliance with the standard is measured.
[b] Not to exceed more than once a year.
[c] 98th percentile, averaged over 3 years.
[d] Not to be exceeded more than once per year on average over 3 years.
[e] Annual mean, averaged over 3 years.
[f] To attain this standard, the 3-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).
[g] 99th percentile of 1-hour daily maximum concentrations, averaged over 3 years.

Ground-level O_3 is created by chemical reactions between NO_x and VOCs in the presence of sunlight.[4] Ground-level O_3 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

[2] Texas Administrative Code [TAC], Title 30, Part 1, Chapter 101, Subchapter A, Rule 101.21.
[3] EPA, NAAQS Table, accessed May 8, 2016, https://www.epa.gov/criteria-air-pollutants/naaqs-table.
[4] TCEQ, "Ozone: The Facts," January 8, 2016, accessed January 25, 2016, https://www.tceq.texas.gov/airquality/monops/ozonefacts.html.

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[5] 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, Transportation Conformity currently does not apply. However, planning and engineering for HSR between Dallas and Fort Worth is currently a project in the NCTCOG transportation improvement program. If the Project becomes a listed project of either the NCTCOG (the Dallas area MPO) or the H-GAC (the Houston area MPO), then Transportation Conformity would apply. The GC regulations apply to all other federal actions. Therefore, under the GC regulations,[6] FRA must make a determination that a federal action conforms to the SIP pertaining to the Project.

In addition to the NAAQS, EPA regulates mobile source air toxics(s) (MSAT). 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 EPA identified a group of 21 MSATs and further identified a subset of 9 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.[7]

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, Operational Emissions Methodology,** to calculate the difference in emissions from future passenger VMT that would have occurred in the absence of HSR use and 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 trainset 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, No Build Alternative,** and is the same magnitude, but opposite in sign, as the Project emissions. The Project emissions are the net change in emissions between the emissions due to trainset power consumption required minus the vehicle emissions that are avoided due to trainset travel. In this case, the change is a net decrease (except for NO_x and SO_2) as discussed in **Section 3.2.5.2.4, Operational Emissions**.

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

[5] 40 C.F.R. 93(A).
[6] 40 C.F.R. 93(B).
[7] FHWA, *Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents,* October 2016, accessed September 27, 2017, http://www.fhwa.dot.gov/environment/air_quality/air_toxics/policy_and_guidance/msat.

procedures used to calculate emissions to estimate impacts for determining environmental consequences and applicability of GC 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 O_3 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 the MOVES (Motor Vehicle Emission Simulator) emissions 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 Build Alternative C as a proxy for all Build Alternatives because this alternative is comprised of the longest track distance; 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 as detailed in **Appendix F, TCRR Final Constructability Report**. The equipment and workforce schedules were then used with MOVES2014b emission factors to calculate construction period emissions, as discussed in **Sections 3.2.3.1.3, Non-Road Equipment Construction Emissions,** and **3.2.3.1.4, On-Road Vehicle and Material Hauling Emissions**, respectively.

For the purposes of this analysis, Project mobilization was assumed to occur over a 3-month period in 2020. Regional building demolition and land grubbing for the embankment, elevated (viaduct) and retained-fill segments was anticipated to begin in 2020 and conclude in December 2021. The major construction activities were anticipated to occur between 2020 and 2024, with construction of the trainset maintenance facilities (TMFs), maintenance-of-way (MOWs) facilities and stations completed between 2022 and 2024. Project demobilization would occur from September 2024 to December 2024. The years shown can be considered representative years for the purpose of the construction emissions analysis as detailed in the summary schedule in **Appendix F, TCRR Final Constructability Report**. Calculated construction emissions would be valid over any 5-year construction timeframe.

3.2.3.1.2 Construction Activities

Construction period emissions within the DFW and HGB O_3 nonattainment areas and SO_2 nonattainment area were quantitatively estimated for the construction activities associated with the Project, including:

- Mobilization at 56 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 emissions from these activities would account for the majority of the emissions generated by the construction of the Project. The estimated construction emissions from these activities were then used to estimate the regional air quality impacts within the DFW and HGB O_3 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 forklifts and sweepers
- Locomotive equipment, such as trainset engines
- Aircraft, such as jets and prop airplanes

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

NO_x, VOC, SO_2 and greenhouse gas (GHG) emissions from regional building demolition and construction of the embankment, elevated (viaduct) and retained-fill rail segments, traction power substations (TPSSs), industrial buildings at the TMFs, MOW facilities and stations, including parking garages and platform facilities, were calculated using emission factors derived from the MOVES2014b emissions model (see also **Section 3.21, Greenhouse Gas Emissions and Climate Change**). The MOVES2014b model provides the latest emission factors for construction off-road equipment. The use of emission rates from the MOVES2014b model accounts for the latest exhaust emission standards and reflects the recommendation of EPA to capture the latest off-road construction assumptions.

The annual emissions for each specific type of non-road equipment were estimated by multiplying the MOVES2014b-predicted emission factors with the following:

- Average load factor expressed as the average fraction of equipment rated power
- Available power in horsepower
- Activity in hours of use per year

In order to estimate emissions for the Project, 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 Project. The non-road equipment spreadsheets are included in **Appendix E, Air Quality Technical Memorandum**.

Non-road emissions were quantified for the construction of the track (including demolition and road crossings), stations, TMFs and MOW facilities. Emissions were determined using emission factors estimated from MOVES2014b associated with national default model input data for the nonattainment counties. For track construction, total emissions within the DFW and HGB O_3 nonattainment areas and SO_2 nonattainment area were obtained by multiplying the total construction emissions by the fraction of the Project 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 Project and that all equipment would be used based on forty-eight 50-hour work weeks over a 60-month construction period. **Appendix E, Air Quality Technical Memorandum,** provides the full details of construction assumptions provided by TCRR.

Station construction emissions were determined assuming one terminal station located at each end of the Project,[8] a TMF located at each end of the Project, and one MOW facility each located in Dallas, Ellis and Harris Counties. All stations and the TMF and MOW facilities would be constructed between 2020 and 2024 as shown in the summary schedule in **Appendix F, TCRR Final Constructability Report.** The Brazos Valley Intermediate Station would be located within an attainment area for all NAAQS pollutants and is not required to be included in the GC air quality analysis.

3.2.3.1.4 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 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 MOVES2014b emission factors for each nonattainment area county. The on-road vehicles that would be used for the Project 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 MOVES2014b model output and anticipated travel distances of trucks operating within the DFW and HGB O_3 nonattainment areas and SO_2 nonattainment area. The analysis assumed that 80 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, Freight Rail Material Hauling Emissions**. 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 Project. 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. **Appendix E, Air Quality Technical Memorandum,** provides the full details of construction assumptions provided by TCRR.

For truck emissions, NO_x and VOC emission factors were estimated using MOVES2014b in association with national default model input data applicable to each county within the DFW and HGB nonattainment areas. An urban restricted roadway category and average truck speed of 30 mph were assumed in the emission factor modeling. SO_2 emission factors were also developed for Freestone County using a rural restricted roadway category and average truck speed of 30 mph. Annual emissions were calculated using year 2020 emission factors. Year 2020 emission factors would be conservative within any future 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

[8] The equipment and layout of the Houston Terminal Station options are similar; therefore, power consumption at these sites would only differ by a minimal amount.

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

Emission Factor	NO_x Emission Factor (g/mi)		VOC Emission Factor (g/mi)		CO_2e Emission Factor (g/mi)		SO_2 Emission Factor (g/mi)
2020 DFW[a] Emission Factors							
Truck Category	Dallas Co.	Ellis Co.	Dallas Co.	Ellis Co.	Dallas Co.	Ellis Co.	--
Passenger Truck	0.169	0.172	0.062	0.065	435	433	--
Light Commercial Truck	0.169	0.172	0.060	0.063	438	437	--
Single Unit Short-Haul Truck	1.964	1.969	0.239	0.239	1,333	1,327	--
Single Unit Long-Haul Truck	1.620	1.625	0.208	0.208	1,235	1,229	--
2020 HGB[b] Emission Factors							
Truck Category	Harris Co.	Waller Co.	Harris Co.	Waller Co.	Harris Co.	Waller Co.	--
Passenger Truck	0.165	0.205	0.063	0.078	440	438	--
Light Commercial Truck	0.166	0.194	0.062	0.073	444	442	--
Single Unit Short-Haul Truck	1.884	1.885	0.239	0.239	1,352	1,344	--
Single Unit Long-Haul Truck	1.555	1.556	0.208	0.208	1,254	1,246	--
2020 Freestone Co. SO_2 Emission Factor							
	--	--	--	--	--	--	Freestone Co.
All Vehicles	--	--	--	--	--	--	0.009

Source: AECOM 2020

[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 Project using freight rail. A majority of the aggregates used for ballast, sub-ballast and aggregates for concrete would come from quarries from within Texas as detailed in **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports**. These aggregates would be transported to construction sites using existing railroad infrastructure as much as possible. It was assumed, and included in **Section 3.2.6.2, Mitigation Measures,** in **AQ-MM#7: Construction Materials Transport,** that 20 percent of the aggregates, 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, On-Road Vehicle and Material Hauling Emissions**. Rail, reinforcement steel and structural steel would also be transported to the site via rail. **Appendix E, Air Quality Technical Memorandum,** provides the full details of construction assumptions provided by TCRR.

Diesel locomotives are subject to air quality regulations under 40 C.F.R. 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, 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.[9] Engine manufacturers will produce new diesel engines with advanced emission-control technologies similar to those already expected for other transportation sources. 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 emission standards.[10] According to TCRR engineers, existing diesel locomotive engine technology would continue to be used for the HSR Project.[11] 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 FRE 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 Project would occur from power plants supplying electricity to operate the HSR system (trainset 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. Although power generation emissions were estimated and discussed in the following sections, they are technically exempt from a GC analysis since power generation facilities would already be permitted for those emissions, as explained in detail **Section 3.2.5.2.6, Compliance with the GC Rule**. The following subsections describe the methods to estimate trainset and vehicle operation emissions.

3.2.3.2.1 Trainset Operation Emissions

Power Consumption

Emissions due to power consumption, trainsets and stations were calculated using power consumption estimates supplied by TCRR. Daily power consumption information was provided for the initial service level at an initial level of ridership, assumed to occur in 2026, and the future service level 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 trainset 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 the full-service operations scenario, the power generation emissions factors could be higher in the earlier initial service level year

[9] EPA Office of Transportation and Air Quality, *Emission Factors for Locomotives*, April 2009, https://nepis.epa.gov/Exe/ZyPDF.cgi/P100500B.PDF?Dockey=P100500B.PDF.
[10] EPA Office of Transportation and Air Quality, *Control of Emissions from Idling Locomotives*, December 2013, https://nepis.epa.gov/Exe/ZyPdf.cgi?Dockey=P100HP4Q.pdf.
[11] Personal communication, Colleen Zwiebel and Chris Taylor, ARUP, phone call with Bill Tillar, AECOM, May 2016.

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 Trainset Emissions Adjustment** below. Therefore, the initial service level scenario emissions were estimated to investigate whether 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 trainset activity and associated emissions.

Trainset 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 trainset's power demand and accounted for in the power consumption provided. Emissions were calculated using the trainset 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 16 percent less power and would produce fewer emissions initially. Trainset traction power was estimated accordingly with the slower initial operating speed in year 2026 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 among the Build Alternatives, although the difference with the alternative estimated to consume the least power (Alternative E) is negligible at less than 1 percent.

Table 3.2-3: Total Trainset Operations Power Consumption

Power Demand	Year 2026 (Initial Service Level)	Year 2040 (Future Service Level)
Total daily trainset power demand (MWh)	511.3	726.5
Total Daily Station and Facility Consumption (MWh)	661	661
Total Daily Operating Power Consumption (MWh)	1,173	1,388
Transmission and Transformer Losses		
Percentage lost	5%	5%
Power lost (MWh)	58	69
Total Daily Power + Losses (MWh)	1,231	1,457
Operating days/year	365	365
Total Electric Power Consumed per Year (MWh)	**447,250**	**531,867**

Source: TCRR, 2019 for all power demand, consumption and operating days assumptions. EIA, 2015 for percentage of power lost.

The power grid in Texas is interconnected throughout the state to meet demand. The Electric Reliability Council of Texas (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. [12] Power is lost in transmission as heat generated by the resistance of power line conductors, and in transformers mainly

[12] EIA, Table 10. Supply and disposition of electricity, 1990 through 2014, *Texas Electricity Profile,* accessed December 4, 2018, https://www.eia.gov/electricity/state/Texas/.

as heat also due to conductor resistance and due to other electrical effect losses. Annual loss data for Texas from 1996 to 2016 (latest available) was reviewed and used to calculate an average rate of loss of 5 percent.

Emission Factors

There is no certain set of power plants designated or dedicated to providing electricity to the Project, and power generation and distribution are interconnected statewide and primarily controlled by ERCOT. Therefore, emissions from power supplied to the Project were determined using ERCOT data. 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.[13] 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.[14, 15] 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 were available. However, the use of earlier year factors is conservative, because emissions factors have been decreasing as time progresses, as discussed in the following section. These factors only reflected combustion generation and not the portion of power generated by non-combustion (e.g., wind or nuclear), which does not contribute pollutants. This was adjusted using the percentage 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.

Future Year Trainset Emissions Adjustment

Because the available power generation and emissions factor data used to calculate trainset 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), which does not produce criteria pollutants. The State of Texas also set renewable energy generating capacity goals in TAC 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

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

[14] Christophe Maris, 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, accessed May 10, 2016, http://www.arb.ca.gov/research/seminars/paulson/paulson.htm.

[15] U.S. Department of the Interior Bureau of Ocean Energy Management (BOEM), 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, 2015.

2011 target of 4,264 and exceeds the 2025 target.[16] EIA state-level data for the non-combustion portion of power were examined and indicated an increasing trend between 1990 and 2016 from 6 percent to 17 percent.[17] **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 22 percent non-combustion power in 2026 and 30 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.[18,19] Historical combustion emission rates data also indicated that combustion emission factors (EF) also had decreasing trends (e.g., -6 percent per year for NO_x).[20] Available eGRID information was used to project the change in combustion emission rates of NO_x, SO_2 and the GHGs (CO_2, methane [CH_4], nitrous oxide [N_2O]) using the average percent change, shown in **Appendix E, Air Quality Technical Memorandum** (**Figure E3.2-2** through **Figure E3.2-6).**[21] The projected $EF_{combust}$ was then used in Equation 5 to calculate the overall EF_{total} for power generation in ERCOT in the years 2026 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 EPA's National Emissions Inventory show gradual downward trends.[22] These state-level emissions rates were not used directly for EF calculations and projections, but to estimate rates of improvement in emissions rates of these pollutants in Texas and ERCOT. The most current year ERCOT emission factors 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 2026 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 2026 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 2026 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 2026 and 2040 EF_{total} for all

[16] EIA, "Summary Renewable Electric Power Industry Statistics (2010)," State Renewable Electricity Profiles, 2010, accessed October 7, 2016, https://www.eia.gov/renewable/state/Texas/.

[17] EIA, "Table 5. Electric power industry generation by primary energy source, 1990 through 2016," Texas Electricity Profile, 2018, accessed December 4, 2018, https://www.eia.gov/electricity/state/Texas/.

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

[19] Abt Associates, *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, 2015.

[20] EPA, eGRID Online database, accessed December 4, 2018, https://www.epa.gov/energy/egrid.

[21] Ibid.

[22] EPA, "Air Pollutant Emissions Trends Data," accessed May 30, 2016, https://www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data.

pollutants were then multiplied by the trainset operations annual power consumption to calculate the trainset operations emissions in tons per year.

3.2.3.2.2 Vehicle Emissions Reductions

The shift in travel mode from passenger vehicles to HSR use that would occur with the operation of the Project would result in some passenger vehicles no longer making the 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 in the **TCRR Draft Conceptual Engineering Report** during the development of the Draft EIS was used to derive the expected numbers of cars no longer making the trip between Dallas and Houston. The long-term forecast in that report for annual ridership in 2040 was 7.2 million passengers per year. Since the Draft EIS, TCRR has continued to refine their ridership projections. As a result, TCRR's projected ridership numbers have increased since the publication of the Draft EIS. However, for purposes of this Final EIS, FRA continues to use the original ridership projections from the Draft EIS as this represents a more conservative estimate of impacts to air quality. A higher ridership value would result in a greater emissions reduction due to shifting travel from automobiles to HSR. TCRR estimates that 94 percent of the existing travel in 2017 for the Dallas-Houston corridor occurred by car (private vehicle), while the remaining 6 percent occurred by air or bus **(Appendix E, Ridership Technical Memorandum).** 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 94 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 5,640,000 cars per year. The occupancy of 1.2 passengers per car was estimated by TCRR in their conceptual engineering report (**Appendix F, TCRR Final Conceptual Engineering Report**) and reflects the average number of trainset passengers expected to arrive at the station by passenger car. Conceptually the occupancy of 1.2 passengers per car would also reflect the numbers of passengers dropped off that would otherwise be using cars without the HSR. Because the occupancy of 1.2 passengers per car was a project-specific projection, it was used to help derive the number of car trips from ridership passenger numbers.[23] More detail on the occupancy factor and the corresponding sensitivity analysis are discussed at the end of **Section 3.2.5.2.4, Operational Emissions**, and in **Appendix E, Air Quality Technical Memorandum** (under Vehicle Emissions Reduction). The number of vehicles that would no longer travel IH-45 between Houston and Dallas would equate to 15,452 vehicles per day, or about 14.5 percent of the 2035 annual average daily traffic of 106,475 vehicles per day projected in transportation planning documents for this corridor.[24] Therefore, the mode shift would not be assumed to constitute the majority of travel along IH-45. An annual passenger

[23] In response to public comments on the occupancy factor used in the Draft EIS, a sensitivity analysis was performed with a factor more recently used in state transportation planning to test the sensitivity of the conclusion of air quality environmental impacts to a change in the factor. This sensitivity analysis is detailed in **Appendix E, Air Quality Technical Memorandum, Sensitivity of Operational Emissions to Vehicle Occupancy**, p. 61. The analysis did not change the conclusion.

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

ridership of 4.4 million was projected by TCRR for the initial service (2026) level. Using the same 94 percent assumption for travel by car and the occupancy of 1.2 passengers per car, the number of annual car trips per year was estimated at 3,446,667 cars.

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. Ridership passenger numbers projected by TCRR were for one-way trips.[25] Therefore, the one-way trip distance and calculated cars per year were used to calculate the VMT that would have been traveled in the absence of the Project, as shown in **Table 3.2-4**.

Round trip distance X cars/year = VMT

Table 3.2-4: Calculated VMT

Metro Share of VMT	2026 VMT	2040 VMT
Dallas VMT	385,535,754	630,876,628
Houston VMT	438,217,659	717,083,372
Total VMT avoided	823,753,413	1,347,960,000

Source: AECOM 2019

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**).

Emission Factors

The MOVES2014b model was used to derive emissions factors.[26] 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 with MOVES2014b to define vehicle characteristics. National default data for the nonattainment area counties available in MOVES2014b were used to estimate the county specific vehicle emission factors. Emissions were estimated for the years 2026 and 2040 to match the initial service level and future service level years. 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 HSIPR Program.[27] This speed reflects the increasing traffic volume trend observed in traffic data, and the exceedance of the highway's design capacity in future years.

[25] Because the average length of stay assumed in TCRR planning was between 1 and 3 days, analysis in the Draft EIS incorrectly assumed that the ridership passenger numbers were based on round trips. The estimates have been updated for this Final EIS to reflect one-way trips.
[26] EPA, MOVES (Motor Vehicle Emission Simulator), Air quality emissions modeling system, accessed: March 2020, available: https://www.epa.gov/moves/latest-version-motor-vehicle-emission-simulator-moves
[27] TxDOT, Section 5: Planning Documentation, TxDOT Narrative Application Form for the High-Speed Intercity Passenger Rail (HSIPR) Program March 2011 Notice of Funding Availability (NOFA).

Because the 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), emission 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 Final Conceptual Engineering Design and Constructability Reports**). 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 NAAQS 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 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 on **Figure 3.2-1**.[28]

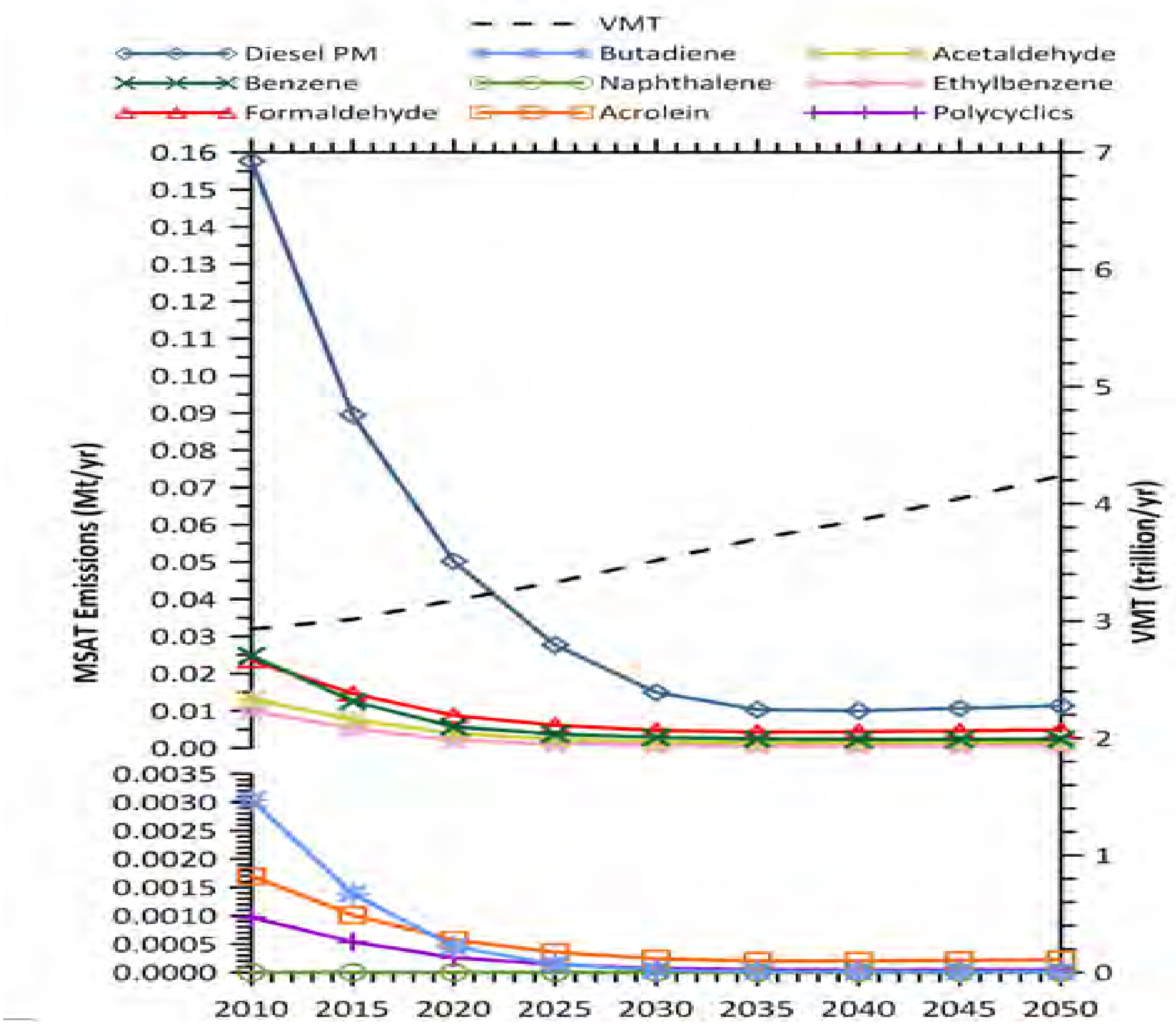
On February 3, 2006, FHWA released *Interim Guidance on Air Toxic Analysis in NEPA Documents*. This guidance was updated on October 18, 2016, by FHWA's *Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents*.[29] The purpose of FHWA's guidance is to advise on when and how to 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

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

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 in September 2016 by FHWA.
Note: Trends for specific locations may be different, depending on locally derived information representing VMT, vehicle speeds, vehicle mix, fuels, emission control programs, meteorology and other factors.

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 Project 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*.[30]

3.2.3.2.4 *General Conformity Emissions Methodology*

Because the Dallas and Houston Terminal Station options would be in nonattainment areas for O_3, and a small section of the Project would be located within the SO_2 nonattainment area in Freestone County, it is necessary to determine whether a GC determination is required. The GC rules prescribe *de minimis* emissions levels dependent on the nonattainment classification of the nonattainment area, below which conformity analysis is not required.[31] The applicable *de minimis* levels are those for serious O_3 and SO_2 nonattainment areas. For VOC or NO_x (the precursor pollutants for O_3), the GC *de minimis* level for either pollutant in a serious O_3 nonattainment area in Texas is 50 tons/year.[32] The GC *de minimis* level for SO_2 is 100 tons/year.[33] The estimate of emissions used to determine whether a formal GC 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 O_3 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, Affected Environment**.

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 EPA.[34] As shown, the only air quality study area counties which are nonattainment for either the 2008 or 2015 8-hour O_3 standard are the counties associated with the terminating ends of the Build Alternatives. The nonattainment designation for SO_2 involves a portion of Freestone and Anderson Counties. Freestone County is within the air quality Study Area. The maintenance designation for lead in the DFW nonattainment area only involve a portion of Collin County, which is not in the air quality Study Area.

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

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[30] FHWA, *A Methodology for Evaluating Mobile Source Air Toxic Emissions Among Transportation Project Alternatives,* July 6, 2011, accessed February 4, 2016, https://www.fhwa.dot.gov/environment/air_quality/air_toxics/research_and_analysis/mobile_source_air_toxics/msatemissions.cfm.

[31] 40 C.F.R. 93.153.

[32] The NO_x and VOC *de minimis* level of 50 tons per year has been updated from the Draft EIS since the DFW and HGB metropolitan areas are now designated as serious nonattainment areas for the 2008 8-hour ozone standard. TCEQ, Dallas-Fort Worth: Current Attainment Status, October 11, 2019, https://www.tceq.texas.gov/airquality/sip/dfw/dfw-status. TCEQ, Houston-Galveston-Brazoria: Current Attainment Status, October 18, 2019, https://www.tceq.texas.gov/airquality/sip/hgb/hgb-status.

[33] EPA, *General Conformity De Minimis Levels,* September 10, 2015, accessed February 4, 2016, http://www3.epa.gov/airquality/genconform/deminimis.

[34] EPA, Texas Nonattainment/Maintenance Status for Each County by Year for all Criteria Pollutants*,* December 31, 2018, accessed January 24, 2019, https://www3.epa.gov/airquality/greenbook/anayo_tx.html .

Table 3.2-5: Current Attainment Status by County

County	NAA	Status	Criteria Pollutant[a]
Dallas	DFW	Serious Nonattainment	Ozone (2008 8-hour standard)
		Marginal Nonattainment	Ozone (2015 8-hour standard)
		Attainment/Unclassifiable	All other pollutants
Ellis	DFW	Serious Nonattainment	Ozone (2008 8-hour standard)
		Marginal Nonattainment	Ozone (2015 8-hour standard)
		Attainment/Unclassifiable	All other pollutants
Navarro	-	No designation until 2020	Sulfur Dioxide
	-	Attainment/Unclassifiable	All Pollutants
Freestone	FRE	Nonattainment (partial county)	Sulfur Dioxide
		Attainment/Unclassifiable	All other pollutants
Limestone	-	Attainment/Unclassifiable	All Pollutants
Leon	-	Attainment/Unclassifiable	All Pollutants
Madison	-	Attainment/Unclassifiable	All Pollutants
Grimes	-	Attainment/Unclassifiable	All Pollutants
Waller[b]	HGB	Serious Nonattainment	Ozone (2008 8-hour standard)
		Attainment/Unclassifiable	Ozone (2015 8-hour standard)
		Attainment/Unclassifiable	All other pollutants
Harris	HGB	Serious Nonattainment	Ozone (2008 8-hour standard)
		Marginal Nonattainment	Ozone (2015 8-hour standard)
		Attainment/Unclassifiable	All other pollutants

Source: TCEQ 2019

[a] Regulated pollutants: ozone, lead, carbon monoxide, nitrogen dioxide, particulate matter (10 microns), particulate matter (2.5 microns), sulfur dioxide.

[b] Waller County was designated as attainment/unclassifiable for the 2015 8-hour ozone standard effective August 3, 2018.

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 30°F in January to 96°F in August, with annual average precipitation of approximately 41 inches. Prevailing winds for the DFW area are out of the south.[35] Average temperatures in Houston vary from 44°F in January to 93°F in August, with annual average precipitation of approximately 45 inches. Prevailing winds are from the southeast near Houston.[36] The air quality Study Area weather conditions include extended hot summers and occasional stagnant, foggy conditions during winter with temperature inversions,[37] all of which are conducive to either forming or retaining air pollutants within the lower atmosphere.[38]

With respect to O_3, winter inversions and fog conditions are not as frequent during the year or do not impact O_3 exceedances as much as hot summer conditions do. The highest concentrations of O_3 form

[35] US Climate Data, "Climate - Dallas Texas", accessed May 3, 2016, http://www.usclimatedata.com/climate/dallas/texas/united-states/ustx1575.

[36] US Climate Data, "Climate Houston Texas," accessed May 3, 2016, http://www.usclimatedata.com/climate/houston/texas/united-states/ustx0617.

[37] 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.

[38] TCEQ, "Ozone: The Facts," January 8, 2016, accessed January 25, 2016, https://www.tceq.texas.gov/airquality/monops/ozonefacts.html.

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.[39] The O_3 season in Texas is roughly March through November, and TCEQ forecasts O_3 action days during this period for several regions, including the DFW and HGB metropolitan areas.[40]

3.2.4.3 Air Quality Trends and Monitoring

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. TCEQ and local agencies maintain ambient air monitoring stations for criteria pollutants throughout Texas. Eight monitoring stations located within and closest to the air quality Study Area were selected using a 10-mile buffer around the Project 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 and Fairfield (Freestone County) stations 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 O_3 has exceeded the NAAQS, with recorded exceedances of the 2008 and 2015 8-hour O_3 standard in the DFW and HGB metropolitan areas. Nonattainment areas are required to comply with the 2015 8-hour O_3 standard within 3 to 20 years of being designated as nonattainment areas under the 2015 standard, depending on the severity of nonattainment.[41] EPA formally completed O_3 designations in Texas during July 2018.[42] Since the DFW and HGB nonattainment areas were classified as marginal nonattainment areas for the 2015 O_3 standard, the attainment date for each is 3 years from the date of designation or August 3, 2021.[43] The air quality Study Area is located in areas currently designated as marginal for the 2015 8-hour O_3 standard and serious for the 2008 8-hour O_3 standard and a small section of the Project would be located within Freestone County that is part of the FRE SO_2 nonattainment area. Besides O_3, monitored data for all other NAAQS are below the respective standard. SO_2 monitoring in Freestone County began in 2017 and validated data within the county began in 2018. Except for PM, most of the long-term measures (e.g., 8-hour or 24-hour) for most NAAQS show a steady to general decreasing trend.

[39] Ibid.
[40] Ibid.
[41] EPA, "Final Updates to National Ambient Air Quality Standards for Ozone," October 21, 2015, accessed January 24, 2019, https://www.epa.gov/sites/production/files/2016-02/documents/20151021webinar.pdf.
[42] EPA, "Additional Air Quality Designations for the 2015 Ozone National Ambient Air Quality Standards," August 3, 2018, accessed January 24, 2019, https://www.federalregister.gov/documents/2018/06/04/2018-11838/additional-air-quality-designations-for-the-2015-ozone-national-ambient-air-quality-standards.
[43] EPA, "Final Updates to National Ambient Air Quality Standards for Ozone," October 21, 2015, accessed January 24, 2019, https://www.epa.gov/sites/production/files/2016-02/documents/20151021webinar.pdf.

Table 3.2-6: DFW Area Ambient Monitoring Results

Criteria Pollutant	Site:	Executive Airport				Fairfield				Dallas Hinton				Corsicana Airport			
	Concentration/ Exceedance	2015	2016	2017	2018	2015	2016	2017	2018	2015	2016	2017	2018	2015	2016	2017	2018
Carbon Monoxide (CO)	Maximum 1-hour (ppm)	-	-	-	-	-	-	-	-	1.8	1.4	1.7	1.5	-	-	-	-
	Maximum 8-hour (ppm)	-	-	-	-	-	-	-	-	1.7	1.2	1.1	1.2	-	-	-	-
	Days >35 ppm 1-hour NAAQS	-	-	-	-	-	-	-	-	0	0	0	0	-	-	-	-
	Days >9 ppm 8-hour NAAQS	-	-	-	-	-	-	-	-	0	0	0	0	-	-	-	-
Lead	Maximum 24-hour (μg/m^3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Days >0.15 μg/m^3 3-month rolling average NAAQS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen Dioxide (NO_2)	Maximum 1-hour (ppb)	56	55	46	50	-	-	-	-	58	76	48	52	35	36	30	37
	Annual Mean (ppb)	6	6	5	6	-	-	-	-	10	9	8	9	2	2	2	4
	Days >100 ppb 1-hour NAAQS	0	0	0	0	-	-	-	-	0	0	0	0	0	0	0	0
	Days >53 ppb Annual Mean NAAQS	0	0	0	0	-	-	-	-	0	0	0	0	0	0	0	0
Ozone (O_3)[a]	Maximum 8-hour (ppb)	74	81	67	81	-	-	-	-	84	82	82	83	72	64	73	73
	Annual fourth-highest concentration (ppb)	68	62	63	75	-	-	-	-	80	69	75	80	64	60	65	67
Particulate Matter, 10 microns (PM_{10})	Maximum 24-hour Concentration (μg/m^3)	-	-	-	-			-	-	75	77	60	108	-	-	-	-
	Days >150 μg/m^3 24-hour average NAAQS	-	-	-	-	-	-	-	-	0	0	0	0	-	-	-	-
Particulate Matter, 2.5 microns ($PM_{2.5}$)	Maximum 24-hour Concentration (μg/m^3)	-	-	-	-	-	-	-	-	28	28	27	41	-	-	-	-
	Annual Mean (μg/m$_3$)	-	-	-	-	-	-	-	-	8.8	8.3	9.0	10.9	-	-	-	-
	Days >35 μg/m^3 24-hour average	-	-	-	-	-	-	-	-	0	0	0	3	-	-	-	-
	Days >12.0 μg/m^3 annual mean	-	-	-	-	-	-	-	-	0	0	0	0	-	-	-	-
Sulfur Dioxide (SO_2)	Maximum 1-hour (ppb)	-	-	-	-	-	-	-	-	6	4	18	11	85	38	86	72
	99th percentile of 1-hour daily max (ppb)	-	-	-	-	-	-	-	56	4	4	4	4	46	20	51	51
	Days >75 ppb 1-hour daily max 99th percentile NAAQS	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0

Source: TCEQ 2016, EPA 2015

(-) = Data not monitored

[a] The current standard is the 2015 8-hour standard of 70 ppb with an attainment date of August 3, 2021. The previous standard was the 2008 8-hour standard of 75 ppb with an attainment date of July 20, 2018.

Table 3.2-7: Houston Area Ambient Monitoring Results

Criteria Pollutant	Site:	NW Harris County				Lang				Bunker Hill Village				Houston SW Freeway			
	Concentration/ Exceedance	2015	2016	2017	2018	2015	2016	2017	2018	2015	2016	2017	2018	2015	2016	2017	2018
Carbon Monoxide (CO)	Maximum 1-hour (ppm)	-	-	-	-	1.7	1.7	-	-	-	-	-	-	-	-	-	-
	Maximum 8-hour (ppm)	-	-	-	-	1.5	1.3	-	-	-	-	-	-	-	-	-	-
	Days >35 ppm 1-hour NAAQS	-	-	-	-	0	0	-	-	-	-	-	-	-	-	-	-
	Days >9 ppm 8-hour NAAQS	-	-	-	-	0	0	-	-	-	-	-	-	-	-	-	-
Lead	Maximum 24-hour (µg/m^3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Days >0.15 µg/m^3 3-month rolling average NAAQS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen Dioxide (NO_2)	Maximum 1-hour (ppb)	43	95	34	37	65	52	53	63	-	-	-	-	61	59	58	56
	Annual Mean (ppb)	5	4	3	4	11	11	11	10	-	-	-	-	13	11	13	12
	Days >100 ppb 1-hour NAAQS	0	0	0	0	0	0	0	0	-	-	-	-	0	0	0	0
	Days >53 ppb Annual Mean NAAQS	0	0	0	0	0	0	0	0	-	-	-	-	0	0	0	0
Ozone (O_3)[a]	Maximum 8-hour (ppb)	91	79	80	98	95	80	77	100	85	86	34	66	-	-	-	-
	Annual fourth-highest concentration (ppb)	78	67	74	77	91	69	70	74	74	71	31	62	-	-	-	-
Particulate Matter, 10 microns (PM_{10})	Maximum 24-hour Concentration (µg/m^3)	-	-	-	-	78	87	-	-	-	-	-	-	-	-	-	-
	Days >150 µg/m^3 24-hour average NAAQS	-	-	-	-	0	0	0	0	-	-	-	-	-	-	-	-
Particulate Matter, 2.5 microns ($PM_{2.5}$)	Maximum 24-hour Concentration (µg/m^3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Annual Mean (µg/m$_3$)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Days >35 µg/m^3 24-hour average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Days >12.0 µg/m^3 annual mean	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfur Dioxide (SO_2)	Maximum 1-hour (ppb)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	99th percentile of 1-hour daily max (ppb)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Days >75 ppb 1-hour daily max 99th percentile NAAQS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Source: TCEQ 2016, EPA 2015

(-) = Data not monitored

[a] The current standard is the 2015 8-hour standard of 70 ppb with an attainment date of August 3, 2021. The previous standard was the 2008 8-hour standard of 75 ppb with an attainment date of July 20, 2018.

Data for PM_{10} have reached almost 72 percent of the 24-hour average standard at the Hinton site in Dallas, while data from the same site for $PM_{2.5}$ have exceeded the 24-hour average standard on three occasions and reached almost 90 percent of the annual mean primary standard. The Dallas Hinton air quality monitoring station is located near the northern terminus of the Project. Statewide, the average 24-hour $PM_{2.5}$ value fluctuates but slightly improved by 3 percent from 2002 to 2014, while the longer-term average annual value decreased 18 percent, signaling a steady decline.[44] As a long-term trend, Texas air quality has improved markedly, especially in Dallas and Houston. In the DFW area, 8-hour O_3 levels improved by 21 percent during the last 15 years, at the same time the population grew by more than 29 percent. The Houston-area 8-hour O_3 levels improved 29 percent between 2000 and 2014, at the same time the population increased over 34 percent.[45] 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 O_3 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.[46]

3.2.5 Environmental Consequences

3.2.5.1 No Build Alternative

In the No Build Alternative, the HSR system would not be constructed or operated. 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 HSR 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 Project 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. Impacts to air quality would be expected as a result of other planned projects, such as the Tenaska Power Plant Expansion project in Grimes County and the terminal expansions at George Bush International Airport in Harris county. The impacts of these projects are discussed in **Section 4.4, Indirect and Cumulative Impacts, Cumulative Impacts**.

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.[47] 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-

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[44] EPA, *America's Children and the Environment: Criteria Pollutants*, October 21, 2015, accessed November 2019, https://www.epa.gov/sites/production/files/2015-10/documents/ace3_criteria_air_pollutants.pdf.
[45] TCEQ, "Texas Air Quality Continues to Improve," *National Outlook*, April 1, 2015, accessed November 2019, https://www.tceq.texas.gov/assets/public/comm_exec/pubs/pd/020/2015/Outlook-Apr-2015-x.pdf.
[46] Ibid.
[47] FHWA, *Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents,* October 18, 2016, accessed September 27, 2017, http://www.fhwa.dot.gov/environment/air_quality/air_toxics/policy_and_guidance/msat.

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

The construction emissions analysis quantifies NO_x and VOC air emissions within the relevant DFW and HGB O_3 nonattainment counties for use in the GC analysis. Construction-period SO_2 emissions were quantified 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. 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 43.8 miles would occur within the DFW O_3 nonattainment counties, and approximately 46.9 miles would occur within the HGB O_3 nonattainment counties. In addition, approximately 32.6 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 from 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 for each Build Alternative is not provided in **Section 3.2.5, Environmental Consequences**.

Operation of the Project would provide a net regional air quality benefit. Operation of the Project would generally reduce regional criteria and GHG pollutants (see also **Section 3.21, Greenhouse Gas Emissions and Climate Change**). The exception would be NO_x emissions and SO_2 emissions, 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 GC applicability as discussed in detail in **Section 3.2.5.2.6, Compliance with the GC Rule**.

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**, **Methodology,** were used to estimate construction period emissions for the Build Alternatives. Construction period 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 in **Table 3.2-8** would be the maximum emissions within the respective nonattainment area during the construction period. The specific construction equipment, including the rated horsepower, utilization, and total number of equipment for each major construction activity, are provided in **Appendix E, Air Quality Technical Memorandum**.

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

Construction Activity	Construction Year	DFW NAA[b]		HGB NAA[c]		FRE NAA
		NO_x (tons)	VOC (tons)	NO_x (tons)	VOC (tons)	SO_2 (tons)
Track[d]	1	7.18	0.68	7.36	0.70	0.001
	2	7.18	0.68	7.36	0.70	0.001
	3	7.18	0.68	7.36	0.70	0.001
	4	7.18	0.68	7.36	0.70	0.001
	5	7.18	0.68	7.36	0.70	0.001
Stations[e]	1	0	0	0	0	0
	2	0	0	0	0	0
	3	3.94	0.40	3.94	0.40	0
	4	3.94	0.40	3.94	0.40	0
	5	3.94	0.40	3.94	0.40	0
TMFs[f]	1	0	0	0	0	0
	2	0	0	0	0	0
	3	6.80	0.64	6.79	0.64	0
	4	6.80	0.64	6.79	0.64	0
	5	0	0	0	0	0
MOWs[g]	1	0	0	0	0	0
	2	0	0	0	0	0
	3	4.28	0.42	2.14	0.21	0
	4	7.92	0.76	3.96	0.38	0
	5	0	0	0	0	0
Total	**1**	**7.18**	0.68	7.36	0.70	**0.001**
	2	**7.18**	0.68	7.36	0.70	**0.001**
	3	**22.20**	**2.14**	**20.23**	**1.95**	**0.001**
	4	**25.84**	**2.48**	**22.05**	**2.12**	**0.001**
	5	**11.12**	**1.08**	**11.30**	**1.10**	**0.001**

Source: AECOM 2020

[a] These construction emissions were estimated for 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 Build Alternative C by less than 1.9 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 facility each in Dallas, Ellis and Harris Counties. No MOW facility would be constructed in Waller or Freestone Counties.

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, Construction Emissions Methodology**. 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 NO_x, VOC and SO_2 emissions resulting from all on-road construction period vehicle operations within the DFW and HGB O_3 nonattainment areas and SO_2 nonattainment area are shown in **Table 3.2-9**.

Table 3.2-9: On-Road Construction Period Vehicle Emissions (tons/year)[a]						
Construction Activity	Construction Year	DFW NAA[b]		HGB NAA[c]		FRE NAA
		NO_x (tons)	VOC (tons)	NO_x (tons)	VOC (tons)	SO_2 (tons)
Truck Hauling	Year 1 – 5 (per year)	6.53	0.84	4.56	0.61	0.005
On-Road Vehicles – Track	Year 1 – 5 (per year)	3.32	1.15	3.42	1.22	0.002
On-Road Vehicles – Station	1	0	0	0	0	0
	2	0	0	0	0	0
	3	0.63	0.22	0.62	0.23	0
	4	0.63	0.22	0.62	0.23	0
	5	0.63	0.22	0.62	0.23	0
On-Road Vehicles – TMF	1	0	0	0	0	0
	2	0	0	0	0	0
	3	0.34	0.12	0.33	0.12	0
	4	0.34	0.12	0.33	0.12	0
	5	0	0	0	0	0
On-Road Vehicles – MOW	1	0	0	0	0	0
	2	0	0	0	0	0
	3	0.36	0.13	0.35	0.13	0
	4	0.67	0.23	0.64	0.23	0
	5	0	0	0	0	0
Total	**1**	**9.85**	**1.99**	**7.98**	**1.83**	**0.007**
	2	**9.85**	**1.99**	**7.98**	**1.83**	**0.007**
	3	**11.19**	**2.46**	**9.28**	**2.30**	**0.007**
	4	**11.49**	**2.57**	**9.57**	**2.41**	**0.007**
	5	**10.48**	**2.22**	**8.59**	**2.06**	**0.007**

Source: AECOM 2020

[a] These construction emissions were estimated for Build 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 Build Alternative C by less than 1.9 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 locomotive line-haul emissions of NO_x and VOC within the DFW and HGB O_3 nonattainment areas and SO_2 nonattainment area during the construction period. 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 existing Tier 2 locomotive emission factors as described in **Section 3.2.3.1.5, Freight Rail Material Hauling Emissions**. Year 2020 would be the first year that ballast and aggregate materials would be required for construction, and therefore existing emission factors would be the most conservative within the construction schedule because future emissions would be expected to be lower as rail vehicle technology improves and as rail companies introduce newer, cleaner burning locomotives into the fleet. The detailed results from the locomotive emission calculations are provided in **Appendix E, Air Quality Technical Memorandum**.

Table 3.2-10: Locomotive Line-Haul Emissions from Construction Activities (tons/year)[a]						
Construction Activity	Construction Year	DFW NAA[b]		HGB NAA[c]		FRE NAA[d]
		NO_x (tons)	VOC (tons)	NO_x (tons)	VOC (tons)	SO_2 (tons)
Material Hauling	Year 1 – 5 (per year)	1.68	0.09	2.52	0.13	0

Source: AECOM 2019

[a] These construction emissions were estimated for 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 Build Alternative C by less than 1.9 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 NOx, VOC and SO_2 emissions within the nonattainment areas. Maximum construction period 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 Construction Period Emissions (tons/year)[a]						
Construction Activity	Construction Year	DFW NAA[b]		HGB NAA[c]		FRE NAA
		NO_x (tons)	VOC (tons)	NO_x (tons)	VOC (tons)	SO_2 (tons)
Off-Road Construction Equipment	1	7.18	0.68	7.36	0.70	0.001
	2	7.18	0.68	7.36	0.70	0.001
	3	22.20	2.14	20.23	1.95	0.001
	4	25.84	2.48	22.05	2.12	0.001
	5	11.12	1.08	11.30	1.10	0.001
On-Road Construction Vehicles	1	9.85	1.99	7.98	1.83	0.007
	2	9.85	1.99	7.98	1.83	0.007
	3	11.19	2.46	9.28	2.30	0.007
	4	11.49	2.57	9.57	2.41	0.007
	5	10.48	2.22	8.59	2.06	0.007
Locomotive Hauling	Year 1 – 5 (per year	1.68	0.09	2.52	0.13	0
Total	**1**	**18.71**	**2.76**	**17.86**	**2.66**	**0.008**
	2	**18.71**	**2.76**	**17.86**	**2.66**	**0.008**
	3	**35.07**	**4.69**	**32.03**	**4.38**	**0.008**
	4	**39.01**	**5.14**	**34.14**	**4.66**	**0.008**
	5	**23.28**	**3.39**	**22.41**	**3.29**	**0.008**

Source: AECOM 2020

[a] These construction emissions were estimated for 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 Build Alternative C by less than 1.9 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 and VOC emissions during the construction period in the DFW and HGB nonattainment areas and an increase of SO_2 emissions in the Freestone County nonattainment area as a result of the Project. Therefore, an adverse short-term (60 month) impact would occur.

3.2.5.2.4 Operational Emissions

For future trainset operation emissions, Build Alternative A power consumption was used, as TCRR estimated it to have the highest power consumption among 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 power consumption between the least to the most power consuming Build Alternative only varied by 1.2 percent. The methods described in **Section 3.2.3.2, Operational Emissions Methodology,** were used to estimate operational emissions. The results for trainset operation emissions are shown in **Table 3.2-12**.

Table 3.2-12: Trainset Operations Emissions

Emissions (tons per year)								
NO_x	VOC	PM_{10}	SO_2	CO	CO_2	CH_4	N_2O	CO_{2eq}
Year 2026 (Initial Service Level)								
67.2	6.4	6.8	61.0	45.9	172,035	15.8	1.7	172,941
Year 2040 (Future Service Level)								
30.1	4.8	3.3	9.7	32.7	121,329	14.6	1.1	122,032

Source: AECOM 2019

For vehicle emissions reductions, the resultant 2026 and 2040 emission factors generated for the DFW and HGB nonattainment area counties in the air quality Study Area were used to determine criteria pollutant emissions, expressed as grams per mile (g/mile) and converted to pounds per mile (lb/mile) as shown in **Appendix E, Air Quality Technical Memorandum (Table E3.2-12** and **Table E3.2-13)**. The total annual VMT avoided and emission factors were used to calculate the emissions that would have occurred in the absence of the Project, as shown in **Table 3.2-13**.

Table 3.2-13: Passenger Vehicle Emissions Reduction

Emissions (tons per year)							
VMT	CO	NO_x	VOC	PM_{10}	$PM_{2.5}$	SO_2	CO_{2eq}
Year 2026 (Initial Service Level)							
Houston Trip Emissions							
438,217,659	635.4	19.8	10.1	16.9	3.4	1.0	125,988
Dallas Trip Emissions							
385,535,754	559.0	16.6	8.1	14.9	3.0	0.9	109,492
TOTAL	1,194.4	36.4	18.2	31.8	6.3	1.8	235,480
Year 2040 (Future Service Level)							
Houston Trip Emissions							
717,083,372	537.8	13.4	10.3	27.7	4.7	0.8	158,834
Dallas Trip Emissions							
630,876,628	441.6	10.9	8.3	24.4	4.2	0.7	138,162
TOTAL	979.4	24.3	18.6	52.0	8.9	1.5	296,996

Source: AECOM 2020

The trainset operation emissions represent increases in emissions due to the Project. The vehicle emissions reduction represents emissions reduced by the Project. Vehicle VMT reduction emissions were subtracted from the trainset operation emissions to calculate net emissions due to implementation of the Project. **Table 3.2-14** shows the results using the 2026 and 2040 trainset operations emissions and 2026 and 2040 passenger vehicles emissions reductions calculated above.

Table 3.2-14: Net Operational Emissions (tons per year)

NO_x	VOC	PM_{10}	SO_2	CO	CO_{2eq}	CO_{2eq} Metric Tons
Year 2026 (Initial Service Level)						
30.8	(11.8)	(25.0)	59.2	(1,148)	(68,937)	(62,539)
Year 2040 (Future Service Level)						
5.8	(13.8)	(48.7)	8.2	(947)	(192,865)	(174,964)

Source: AECOM 2020

( ) 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 NO_x and SO_2. The SO_2 emission increase is consistent with the analysis of other HSR projects proposed in California, comparing trainset power consumption emissions versus vehicle emissions.[48, 49] The 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.[50] 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 the GC *de minimis* level as discussed in **Section 3.2.5.2.6**, **Compliance with the GC Rule**. For NO_x, VOC and CO, the net reductions in 2026 are equal to or 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 2026, making the potential emissions that would be reduced by taking cars off the road smaller. For example, the NO_x emission factor drops by approximately one-third from 2026 to 2040, countering the effects of more ridership. By contrast, the trainset NO_x emissions factor only drops by roughly one-half. For the other pollutants, the relative drop in emissions rates from 2026 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 Project.

3.2.5.2.5 Mobile Source Air Toxics

The Project has 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 Project would provide another option for intercity travel between Dallas and Houston that would emit air pollutants, including MSATs, into the atmosphere. However, the Project 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.

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

[48] California High-Speed Rail Authority and USDOT FRA, *FINAL California High-Speed Train Project Environmental Impact Report/Environmental Impact Statement, Merced to Fresno Section Project EIR/EIS*, 2012.

[49] USDOT FRA, *Final Environmental Impact Statement and Final Section 4(f) Evaluation for the Proposed DesertXpress High-Speed Passenger Train Victorville, California to Las Vegas, Nevada*, 2011.

[50] California High-Speed Rail Authority and USDOT FRA, *FINAL California High-Speed Train Project Environmental Impact Report/Environmental Impact Statement, Merced to Fresno Section Project EIR/EIS*, 2012.

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 Duel (TxLED) 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 Project would have minimal impact on total MSAT emissions in the air quality Study Area.

The operation of the trainset propulsion technology used by the Project would not have combustion emissions, so no direct MSAT emissions would occur during operation. The potential MSAT emission sources during operation of the Project 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 compared to the total vehicle activity on nearby roadways. Future use of electric or alternative fuel types are potential considerations for DART.

This evaluation includes a basic analysis of the likely MSAT emission impacts of the Project. 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 Project.[51] 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 Project.[52] As reductions in regional MSAT emissions are predicted with the Project, further MSAT analysis would not be suggested even if it were practicable to accomplish.

3.2.5.2.6 Compliance with the GC Rule

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

To determine whether projects are subject to the GC determination requirements, EPA has established GC applicability levels (in tons per calendar year) for each of the criteria pollutants for each type of designated nonattainment and maintenance area. Project emissions of criteria pollutants are compared to the GC *de minimis* levels. If the annual emissions generated by construction or operation of the Project are less than the GC *de minimis* level, then a GC determination is not required. If annual project-related pollutant emissions generated in a nonattainment or maintenance area exceed the GC *de minimis* level, compliance with the GC Rule must be demonstrated and a GC determination is required. In addition, the Project emissions may not cause new violations or exacerbate an existing violation of the NAAQS.

[51] FHWA, *Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents*, 2016, http://www.fhwa.dot.gov/environment/air_quality/air_toxics/policy_and_guidance/msat.
[52] Ibid.

As discussed in **Section 3.2.4.3, Air Quality Trends and Monitoring,** the air quality Study Area is located in both the DFW and HGB nonattainment areas that are currently designated as marginal for the 2015 8-hour O_3 standard and serious for the 2008 8-hour O_3 standard, and a small section of the Project would be located within Freestone County that is part of the FRE SO_2 nonattainment area. The GC *de minimis* level for both the DFW and HGB areas are 50 tons per year NO_x and 50 tons per year for VOC, and the GC *de minimis* level for the FRE nonattainment area is 100 tons per year for SO_2. The NO_x and VOC level of 50 tons per year are lower than the respective NO_x and VOC level of 100 tons per year as reported in the Draft EIS since the DFW and HGB metropolitan areas are designated as serious nonattainment areas for the 2008 8-hour O_3 standard.

GC 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, MOW facilities, bridges and roadway crossings, would occur over a 60-month construction period from 2020 to 2024. Subsequent years would realize only indirect emissions resulting from the operation of the Project and reduction of passenger vehicle emissions within the DFW and HGB O_3 nonattainment areas and the FRE SO_2 nonattainment area. GC 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 2020 to 2024 construction period. Total indirect emissions would be greatest once the Project achieves the maximum service level with the greatest amount of ridership and trainset operations, which is assumed to occur by 2040. According to TCEQ, the 2008 8-hour O_3 standard attainment date as specified in the latest DFW and HGB SIP is July 20, 2021.[53] The 2015 8-hour O_3 standard attainment date as specified in the latest DFW and HGB SIP is August 3, 2021.[54] Because the latest SIP attainment dates occur during the construction period, only emissions generated during the construction phase and emissions associated with maximum operational conditions were compared to the GC *de minimis* level to determine whether the GC 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 Project. As shown, maximum annual direct (construction-related) NO_x, VOC and SO_2 emissions within the DFW and HGB O_3 nonattainment areas and the FRE SO_2 nonattainment area during the 5-year construction period would be less than the respective GC *de minimis* level.

The emissions shown in **Table 3.2-15** are the maximum construction-related emissions occurring during any year of construction. Annual construction-related emission calculations are provided in **Table E3.1-1** of **Appendix E, Air Quality Technical Memorandum**.

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[53] TCEQ, "Dallas-Fort Worth: Current Attainment Status," https://www.tceq.texas.gov/airquality/sip/dfw/dfw-status, and Houston-Galveston-Brazoria: Current Attainment Status, accessed December 27, 2019, https://www.tceq.texas.gov/airquality/sip/hgb/hgb-status.

[54] Ibid.

Table 3.2-15: Maximum Annual Construction-Related Emissions[a,b] by Nonattainment Area

Emission Source	NO_x (tons)	VOC (tons)	SO_2 (tons)
DFW NAA[c]			
Non-Road Vehicles and Activities	25.84	2.48	--
On-Road Vehicles	11.49	2.57	--
Locomotive Hauling	1.68	0.09	--
Total	39.01	5.14	--
GC *de minimis* level	50	50	--
Exceeds GC *de minimis* level?	No	No	--
HGB NAA[d]			
Non-Road Vehicles and Activities	22.05	2.12	--
On-Road Vehicles	9.57	2.41	--
Locomotive Hauling	2.52	0.13	--
Total	34.14	4.66	--
GC *de minimis* level	50	50	--
Exceeds GC *de minimis* level?	No	No	--
FRE NAA			
Non-Road Vehicles and Activities	--	--	0.001
On-Road Vehicles	--	--	0.007
Locomotive Hauling	--	--	0
Total	--	--	0.008
GC *de minimis* level	--	--	100
Exceeds GC *de minimis* level?	--	--	No

Source: AECOM 2020

[a] These construction emissions were estimated for Build 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 are lower and estimated to differ from Build Alternative C by less than 1.9 percent.
[b] The construction-related emissions are lower than emissions reported in the Draft EIS based on updated material quantity estimates for Build Alternative C and lower locomotive emissions since locomotives would haul less aggregate materials.
[c] The applicable DFW NAA counties are Dallas and Ellis Counties.
[d] The applicable HGB NAA counties are Harris and Waller Counties.

Indirect (Operational) Emissions in the Nonattainment Areas

Because not all the Projects' 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 trainset 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 Project. These emissions would occur at the power plants meeting the operational demand at any particular time that the trainsets 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 Projects' 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 Project 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.[55]

The first assumption was that the Project 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 2026 and 2040 emission factors for NO_x, VOC and SO_2 and applying the resultant percentages for DFW (8 percent), HGB (21 percent) and FRE

[55] EPA, eGRID, 2016, accessed February 2016,https://www.epa.gov/energy/egrid.

(3 percent) to the total trainset power consumption. The second assumption was that traction, switching and signaling power for the trainsets would draw uniformly from plants along the Project evenly, but stations and TMFs were assumed to draw from plants in their respective locations. The emissions were calculated using the same methods described above using the projected 2026 and 2040 emission factors for NO_x, VOC and SO_2 and applying the trainset power consumptions equally to plants along the Project, 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**. The full details of calculations for both assumptions are provided in **Appendix E**, **Air Quality Technical Memorandum** (**Table E3-17)**.

Table 3.2-16: Maximum Indirect (Operational) NAA Emissions

NAA	Trainset Operation Emissions (tons per year)			Vehicle Emissions (tons per year)			Net Emissions (tons per year)		
	NO_x	VOC	SO_2	NO_x	VOC	SO_2	NO_x	VOC	SO_2
***de Minimis* Levels**									
GC *de minimis* level	50	50	100	50	50	100	50	50	100
Emissions for Year 2026 (Initial Service Level)									
DFW	23.2	2.2	-	−6.1	−3.0	-	17.1	−0.8	-
HGB	16.0	1.5	-	−8.5	−4.4	-	7.5	−2.9	-
FRE	-	-	6.5	-	-	−0.24	-	-	6.3
Exceeds GC *de minimis* level?	No	No	No	No	No	No	No	No	No
Emissions for Year 2040 (Future Service Level)									
DFW	10.3	1.7	-	−4.1	−3.1	-	6.2	−1.4	-
HGB	6.8	1.1	-	−5.8	−4.4	-	1.0	−3.3	-
FRE	-	-	1.1	-	-	−0.20	-	-	0.9
Exceeds GC *de minimis* level?	No	No	No	No	No	No	No	No	No

Source: AECOM 2020

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 the nonattainment area, and visiting cars arriving to the nonattainment area through the associated lengths of IH-45. In the case of the FRE 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 VMT. The same 2026 and 2040 emission factors and methodology described above were then used to calculate the emissions. **Table 3.2-16** 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 E3-18)**.

The 2026 and 2040 trainset 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**. Net reductions are shown for all pollutants except NO_x in the DFW and HGB NAAs, and SO_2 in the FRE NAA. The increase in NO_x is comparatively negligible and well below the current GC serious nonattainment level of 50 tons per year.

The increase in SO_2 would also be comparatively negligible and well below the current nonattainment level of 100 tons per year. Operational emissions of the regulated pollutants from the Project in nonattainment areas, while not considered under the GC analysis, are below GC *de minimis* levels.

GC Applicability Determination and Impact

As shown in **Table 3.2-15**, maximum annual construction period NO_x and VOC emissions within the DFW and HGB O_3 nonattainment areas and the FRE SO_2 nonattainment area would be less than the respective GC pollutant levels 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 GC 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 GC *de minimis* levels. However, operational analysis included the power plant emissions for demonstration, even though they do not technically apply to determining GC applicability. **Table 3.2-16** shows that maximum annual operational indirect emissions within the DFW, HGB and FRE nonattainment areas would be less than the respective GC *de minimis* level for NO_x, VOC and SO_2.

Therefore, a formal conformity determination would not be necessary for construction-related or operational NO_x or VOC emissions within the DFW and HGB nonattainment areas and SO_2 emissions within the FRE nonattainment area for the Project and no additional NO_x, VOC and SO_2 analyses would be required.

3.2.6 Avoidance, Minimization and Mitigation

Operation of the Project 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 Project 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 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

TCRR would be required to comply with the following Compliance Measures (CM).

AQ-CM#1: Texas Low Emission Diesel Fuel (TxLED) Program. The TxLED Program was implemented to reduce emissions of NO_2 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.[56] TCRR shall adhere to the TxLED Program for all diesel fueled on-road motor vehicles and non-road construction equipment.

WQ-CM#3: Stormwater Management/Stormwater Pollution Prevention Plan that would minimize fugitive dust are discussed in **Section 3.3.6.1, Water Quality, Compliance Measures**.

[56] 30 TAC 114.312–114.319 — Low Emission Diesel.

3.2.6.2 Mitigation Measures

TCRR would be required to implement the following Mitigation Measures (MM).

AQ-MM#1: Dust Suppression Techniques. During the construction period, TCRR shall cover and/or treat disturbed areas where practicable 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 techniques during all clearing, grubbing, scraping, excavation, grading, cut and fill and demolition activities.

AQ-MM#2: Materials Transport. During construction, TCRR shall cover or effectively wet all materials transported offsite. Additionally, TCRR shall cover or effectively wet materials transported within the construction site when within 120 feet of adjacent homes or businesses to limit visible dust emissions.

AQ-MM#3: Construction Off-Road Vehicle Speed Limitations. During construction, TCRR shall limit vehicle travel speeds to minimize dust generation.

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

AQ-MM#5: Construction Equipment. During construction, TCRR 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 shall phase ground disturbing activities to the greatest extent possible to reduce the amount of disturbed surfaces at any one time.

AQ-MM#7: Construction Materials Transport. During construction, TCRR shall transport a minimum of 20 percent of the Project-wide construction materials (i.e., sand, gravel, cement, ballast, sub-ballast, steel and rail pieces used for concrete) using existing freight rail lines in an effort to minimize road vehicle emissions and construction period traffic impacts in nonattainment counties (Harris, Waller, Dallas, Ellis, and Freestone). Construction emissions are calculated by county in nonattainment areas and for the Project as discussed in **Section 3.2.3.1, Construction Emissions Methodology**.

Implementation of the above mitigation measures during the 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.

3.2.7 Build Alternatives Comparison

The lengths of the Build Alternatives vary by no more than approximately 4.69 miles; therefore, the differences in criteria pollutant emissions produced from power consumption to propel trainsets those extra distances would be minimal. Also, the equipment and layout of the Houston Terminal Station options are similar; therefore, power consumption at these sites would only differ by a minimal amount. In fact, the maximum power consuming Build Alternative and the least consuming Build Alternative vary by approximately 1 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 location areas, 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 among 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 trainset 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 HSR 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, the maximum annual construction period NO_x, VOC and SO_2 emissions within the DFW, HGB and FRE nonattainment areas would be less than the respective GC *de minimis* level for all years of construction. Construction-related emissions would be lower for all other Build Alternatives. All Build Alternatives and Houston Terminal Station options would have a construction period impact for NO_x, VOCs, SO_2 and MSATs; however, these impacts would be short-term and localized.

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] Poor water quality in a waterbody has the potential to influence the quality of other waterbodies throughout the watershed. For the purpose of this analysis, waterbodies include rivers, streams, canals, lakes, drinking water reservoirs and retention or detention basins, including waterbodies that drain to a certain point and the connected groundwater features.

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 CWA is the primary federal law that protects the nation's waters.[3] Section 303 and 501 of the CWA give 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 CWA Section 305(b). Through a data sharing process, TCEQ monitors data from total maximum daily load (TMDL)[4,5] and nonpoint source programs; EPA; United States Geologic Survey (USGS); and the Clean Rivers Program collected by river authorities and local partner agencies. The data are used to evaluate compliance with Texas Surface Water Quality Standards.[6]

Sections 303(d) and 305(b) of the CWA require states to identify waterbodies that do not meet federal water quality standards. States must develop TMDLs for pollutants that exceed water quality standards in those waterbodies. TCEQ routinely monitors surface water quality in the state and conducts biannual

[1] USGS, "Dictionary of Water Terms," last updated November 6, 2015, accessed December 2019, http://water.usgs.gov/edu/dictionary.html.
[2] Ibid.
[3] 33 U.S.C. 1251-1387.
[4] EPA, "Impaired Waters and TMDLs," last updated September 13, 2018, accessed December 2019, http://www.epa.gov/tmdl/impaired-waters-and-tmdls-program-overview-introduction.
[5] 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.
[6] TCEQ, "Texas Surface Water Quality Monitoring and Assessment Strategy FY 2012-2017, Rev. 1," Austin, TX: TCEQ Water Quality Planning Division, December 2013, accessed December 2019, https://www.tceq.texas.gov/assets/public/waterquality/swqm/monitor/swqm_strategy.pdf.

assessments to comply with Section 305(b) of the CWA. The status of 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 2 years. The biennial 305(b) assessment identifies those surface water resources not meeting their designated uses. According to the CWA, waters not meeting their intended use are listed as impaired waterbodies in reference to Section 303(d) of the CWA.[7] The 2014 report was approved by EPA on November 19, 2015.[8] Coordination with TCEQ would be required for impacts to impaired waterbodies listed in the 305(b) report.

Section 404 of the CWA 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.[9] The Project 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 CWA regulates the discharge of pollutants into waters of the United States 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 BMPs and Tier II projects require the use of TCEQ-approved BMPs and an individual certification review by TCEQ.[10]

The Texas Water Code[11] 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.[12] In accordance with Section 402 of the CWA, 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.[13] 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.[14] The TCEQ TPDES General Construction Permit (TXR150000) applies to small construction activities that disturb between 1 and 5 acres and large construction activities that disturb 5 or more acres. In addition, the Multi-Sector General Permit (TXR050000) authorizes stormwater discharges from industrial facilities associated with manufacturing, processing, material storage and waste material disposal areas.[15] Under Section 402 of the CWA, local responsibility and authority for compliance may be delegated through an appropriate TPDES Permit to a local Municipal Separate Storm Sewer System

[7] TCEQ, "2014 Texas Integrated Report of Surface Water Quality for the Clean Water Act Sections 305(b) and 303(d)," last updated September 3, 2019, accessed December 2019, https://www.tceq.texas.gov/waterquality/assessment/14twqi/14txir.

[8] TCEQ, "2014 Texas Integrated Report Index of Water Quality Impairments," November 19, 2015, accessed December 2019, https://www.tceq.texas.gov/assets/public/waterquality/swqm/assess/14txir/2014_imp_index.pdf.

[9] Clean Water Act, Title 33, Part 1251 et seq., U.S. Government Publishing Office, 1972.

[10] Water Pollution Prevention and Control Title 33 C.F.R. Section 1341, U.S. Government Publishing Office, 1994.

[11] Water Quality Control, *Texas Water Code*, Title II, Subtitle D, Chapter 26, accessed December 2019, http://www.statutes.legis.state.tx.us/Docs/WA/htm/WA.26.htm.

[12] TCEQ, "Stormwater Discharges Associated with Construction Activities - TXR150000," March 5, 2018, accessed December 2019, https://www.tceq.texas.gov/assets/public/permitting/stormwater/txr150000-cgp.pdf.

[13] TCEQ, "What Is The 'Texas Pollutant Discharge Elimination System (TPDES)'?," last updated August 29, 2019, accessed December 2019, https://www.tceq.texas.gov/permitting/wastewater/pretreatment/tpdes_definition.html.

[14] TCEQ, "Fact Sheet and Executive Director's Preliminary Decision, Stormwater Discharges from Construction Activities - TXR150000," June 7, 2017, accessed December 2019, https://www.tceq.texas.gov/assets/public/permitting/wastewater/general/2018-CGP/2018-TXR150000-CGP-Fact-Sheet.pdf.

[15] TCEQ, "Stormwater Multi-Sector General Permit for Industrial Facilities," last updated. October 28, 2019, accessed December 2019, https://www.tceq.texas.gov/permitting/stormwater/industrial.

(MS4) operator such as the City of Dallas. Also, construction sites that disturb less than 1 acre also need to be permitted if they are located within 1/4 mile of other construction work.

Safe Drinking Water Act

The Safe Drinking Water Act of 1974, amended in 1986 and 1996,[16] is a federal law that sets drinking water quality standards for public water systems in the United States.[17] 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. 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.[18]

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.[19] 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.[20] 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 5 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.[21]

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.[22] Texas has 100 established GCDs that 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. TWDB provides assistance to GCDs in the development of management plans and provides final approval of plans. Other than coordinating with

[16] 42 U.S.C. 300f et seq.
[17] 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.
[18] TCEQ, "Rules and Regulations for Public Water Systems," last updated November 4, 2019, accessed December 2019, https://www.tceq.texas.gov/drinkingwater/pdw_rules.html.
[19] TCEQ, "Source Water Protection," May 30, 2019, accessed December 2019, https://www.tceq.texas.gov/drinkingwater/SWAP.
[20] TWDB, "2017 State Water Plan," Austin, TX, May 2016.
[21] Ibid.
[22] Groundwater Conservation Districts, Texas Water Code, Title II, Subtitle E, Chapter 36, accessed December 2019, http://www.statutes.legis.state.tx.us/Docs/WA/htm/WA.36.htm.

regional planning groups to develop groundwater management plans, the primary duties of each GCD include permitting and registering groundwater wells and adopting and enforcing rules to implement the plan.[23]

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.[24] This code was developed to ensure the quality of the state's groundwater for the safety and welfare of the public.

Local

The 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. 122.[25]

3.3.3 Methodology

3.3.3.1 Water Quality Study Area

The limit of disturbance (LOD) of the Project was the basis for identifying watersheds and groundwater aquifers that could be directly impacted by the Project; 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 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 subwatersheds were selected as they reflect a scale that best represents direct, indirect and cumulative effects.

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.[26] 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 Project 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 in the following sections.

[23] TCEQ, "What is a Groundwater Conservation District (GCD)?," Groundwater Conservation Districts, accessed December 2019, https://www.tceq.texas.gov/assets/public/permitting/watersupply/groundwater/maps/gcd_text.pdf.
[24] Water Well Drillers and Water Well Pump Installers, Texas Administrative Code, Title 16. Chapter 76.
[25] Protection of the Environment, Title 40 C.F.R. Section 122, U.S. Government Publishing Office, 2011.
[26] TCEQ, "How to Interpret SWSA Maps," Last updated August 22, 2018, accessed December 2019, 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 Project. 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.[27] A subwatershed is defined as smaller drainage areas, such as a tributary of a creek, that drain into watersheds, larger streams or lakes. Hydrologic units are used to classify water systems. A Hydrologic Unit Code (HUC) identifies unique hydrologic unit drainage areas, ranging from larger, multi-state basins to small watersheds.[28] In Texas, water quality management is typically conducted at the watershed level with influence from local subwatershed management.[29] Watersheds are assigned 8-digit identification codes (HUC8) and encompass multiple subwatersheds, which are assigned 12-digit identification codes (HUC12).

To assess potential impacts to surface water quality, watershed information was obtained from TCEQ, USGS, EPA and TWDB for watersheds within the water quality Study Area defined in **Section 3.3.3.1, Water Quality Study Area**. In addition, the *2014 Texas Integrated Report Index of Water Quality Impairments* was reviewed to identify threatened or impaired waterbodies in the Study Area.[30] 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 Project with analysis of data obtained from 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, TWDB's well data were reviewed within the Study Area. Potential direct impacts to groundwater quality were identified by comparing HSR design elements of the Project (e.g., pier construction and location) with analysis of data obtained from TCEQ, TWDB and EPA, such as locations of groundwater wells and aquifer boundaries.

3.3.3.4 Water Supply

Geographic Information System (GIS) data were obtained from TCEQ and queried to locate public water supplies within the Study Area. In addition, the Texas Source Water Protection Program participants list was reviewed, and public water systems located within the Study Area were identified based on mapped public water systems. The Texas Source Water Protection Program is a program ran by TCEQ and is used to help protect the drinking water sources for public water systems. Potential direct impacts to water supply, including reservoirs and public supply wells, were identified by comparing HSR design elements of the Project (e.g., construction methodology and/or pier placement) with analysis of data obtained from TCEQ, TWDB and EPA, such as locations of public water supplies and drinking water reservoirs.

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[27] Purdue University, "What is a Watershed?" *Know Your Watershed,* 2005, accessed December 2019, https://engineering.purdue.edu/watersheds/resources/Academy/Building_Local_Partnerships_KYW.pdf.

[28] U.S. Geological Survey, "Hydrologic Unit Maps," Water Resources of the U.S., October 21, 2019, accessed December 2019, http://water.usgs.gov/GIS/huc.html.

[29] Texas A&M University, "Watershed approach to water quality management," accessed December 2019, http://texaswater.tamu.edu/surface-water/watershed-water-quality-management.htm.

[30] TCEQ, "2014 Texas Integrated Report of Surface Water Quality for the Clean Water Act Sections 305(b) and 303(d)," last updated September 3, 2019, accessed December 2019, https://www.tceq.texas.gov/waterquality/assessment/14twqi/14txir.

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 (HUC8) are intersected by the water quality Study Area and described in the following sections. 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 (HUC 12030105) is part of the Upper Trinity River Basin and is 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 the Lower Trinity-Tehuacana Watershed. Eight waterbodies contribute to the Upper Trinity Watershed, including the Trinity River.[31] 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 (HUC12) contained within the Upper Trinity Watershed that underlie the water quality Study Area:

- Coombs Creek-Trinity River (Segment 1– Dallas County
- Deep Branch-Tenmile Creek (Segment 1 – Dallas County)
- Five Mile Creek-Trinity River (Segment 1 – Dallas County)
- Middle Red Oak Creek (Segments 1, 2A and 2B – Dallas/Ellis Counties)
- Prairie Creek-Trinity River (Segment 1 – Dallas County)
- Turtle Creek (Segment 1 – Dallas County)
- Lower Grove Creek (Segments 2A and 2B – Ellis County)
- 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 (HUC 12030109) and Richland (HUC 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.[32] 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 Trinity-

[31] EPA, "Upper Trinity Watershed -- 12030105," last updated January 7, 2016, Accessed January 7, 2016, http://cfpub.epa.gov/surf/huc.cfm?huc_code=12030105.
[32] EPA, "Richland Watershed -- 12030108," accessed January 7, 2016, http://cfpub.epa.gov/surf/huc.cfm?huc_code=12030108.

Tehuacana Watershed.[33] 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 (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
  - 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 <u>Navasota Watershed</u>

The Navasota (HUC 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 (HUC 12070101).[34] 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 County)
- 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)

[33] EPA, "Lower Trinity-Tehuacana Watershed -- 12030201," accessed January 7, 2016, http://cfpub.epa.gov/surf/huc.cfm?huc_code=12030201.
[34] EPA, "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 (HUC 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 (HUC 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.[35] 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 and 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 (HUC 12040101), Spring (HUC 12040102) and Buffalo-San Jacinto (HUC 12040104), are part of the San Jacinto River Basin and underlie Segment 5 in Grimes County. 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 continues to the Buffalo-

[35] EPA, "Lower Trinity-Kickapoo Watershed -- 12030202," accessed January 7, 2016, http://cfpub.epa.gov/surf/huc.cfm?huc_code=12030202.

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 Station options in Harris County.[36] 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 all Terminal Options – Harris County)
  - City of Houston-Buffalo Bayou (Segment 5: Northwest Transit Center Terminal and Segment 5: Northwest Mall Terminal Options – 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**.

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.[37]

[36] EPA, "Spring Watershed -- 12040102," accessed January 7, 2016, http://cfpub.epa.gov/surf/huc.cfm?huc_code=12040102; EPA, "West Fork San Jacinto Watershed -- 12040101," accessed January 7, 2016, http://cfpub.epa.gov/surf/huc.cfm?huc_code=12040101.

[37] TCEQ, "Texas Watershed-Based Plans," Watershed Protection Plans for Nonpoint Source Water Pollution, October 2019, accessed December 2019, available: https://www.tceq.texas.gov/assets/public/waterquality/nps/watersheds/wbp-listforweb.pdf.

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

Watershed	Build Alternative Segment	County	Watershed Area (acres)[a]
Upper Trinity	Segment 1	Dallas	822.4
	Segment 1	Ellis	69.1
	Segment 2A	Ellis	445.2
	Segment 2B	Ellis	497.3
Chambers	Segment 2A	Ellis	507.2
	Segment 2B	Ellis	484.5
	Segment 3A	Ellis	57.7
	Segment 3B	Ellis	59.3
	Segment 3C	Ellis	57.7
	Segment 3A	Navarro	187.2
	Segment 3B	Navarro	248.7
	Segment 3C	Navarro	187.2
Richland	Segment 3A	Navarro	840.6
	Segment 3B	Navarro	957.7
	Segment 3C	Navarro	930.3
Navasota	Segment 4	Freestone	316.0
	Segment 4	Limestone	336.1
	Segment 3C	Leon	1.6
	Segment 4	Leon	677.5
	Segment 5	Grimes	564.3
Lower Trinity-Tehuacana	Segment 3A	Navarro	21.7
	Segment 3B	Navarro	20.5
	Segment 3C	Navarro	25.8
	Segment 3A	Freestone	0.73
	Segment 3B	Freestone	1.4
	Segment 3C	Freestone	1,407.8
	Segment 4	Freestone	577.9
	Segment 3C	Leon	254.3
Lower Trinity-Kickapoo	Segment 3C	Leon	1,143.7
	Segment 4	Leon	526.1
	Segment 3C	Madison	611.3
	Segment 4	Madison	596.4
	Segment 3C	Grimes	102.4
	Segment 4	Grimes	68.7
	Segment 5	Grimes	170.3
West Fork San Jacinto	Segment 5	Grimes	433.6
Spring	Segment 5	Grimes	358.1
	Segment 5	Waller	332.1
	Segment 5	Harris	902.3
Buffalo-San Jacinto	Segment 5	Harris	362.2
	Segment 5: Industrial Site Terminal Option	Harris	92.3
	Segment 5: Northwest Mall Terminal Option	Harris	103.9
	Segment 5: Northwest Transit Center Terminal	Harris	99.0

Source: TWDB 2016
[a] Acreages reflect both temporary and permanent impacts.

3.3.4.1.6 Impaired Waterbodies

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 whether 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 CWA Section 303(d). Impaired waters are identified in the *Texas Integrated Report Index of Water Quality Impairments.*[38] 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 TCEQ as outlined in Chapter 307 of the TAC.[39] The reviews would determine whether degradation is authorized by the state and may affect permit approval or result in TPDES permit requirements.

As identified in **Table 3.3-2**, bacteria is the only surface water parameter that has TMDLs completed and approved by EPA (Category 4a) in Harris County (AU 1017A_01; 1017_01; 1009_04). These AUs correspond to five subwatersheds within the water quality Study Area: Five Mile Creek-Trinity River, Cryer Creek-Chambers Creek, Mims Creek-Upper Keechi Creek, Cole Creek-Whiteoak Bayou, and Dry Creek-Cypress Creek subwatersheds, respectively.

Table 3.3-2 also identifies impairments that may be suitable for development of a TMDL (Category 5) that do not have regulated TMDLs at this time (Section 303[d] list). These include dioxins and polychlorinated biphenyls (PCBs) in edible tissue for Dallas County (AU 0805_03), chloride in Navarro County (Segments 3A, 3B and 3C) (AU 0814_03) and depressed dissolved oxygen (DO) in Freestone County (Segment 3C) (AU 0804H_01).

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.[40] 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 United States. Dioxins are also formed as by-products of other industrial operations, such as the incineration of municipal wastes and the bleaching of wood pulp.

PCBs are synthetic chemicals that are no longer produced in the United States 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.[41]

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[38] TCEQ, *2014 Texas Integrated Report Index of Water Quality Impairments*, November 19, 2015, accessed December 2019, https://www.tceq.texas.gov/assets/public/waterquality/swqm/assess/14txir/2014_imp_index.pdf.

[39] Antidegradation, Texas Administrative Code, Title 30, Chapter 307, accessed December 2019, 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.

[40] Science Clarified, "Dioxin," accessed December 2019, http://www.scienceclarified.com/Di-El/Dioxin.html#ixzz4BQsz5GZS.

[41] EPA, " Polychlorinated Biphenyl (PCB) Question and Answer Manual and Response to Comment Documents," accessed December 2019, https://www.epa.gov/pcbs/polychlorinated-biphenyl-pcb-question-and-answer-manual-and-response-comment-documents.

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
Chambers/Cryer Creek-Chambers Creek	Chambers Creek Above Richland-Chambers Reservoir	0814/0814_03	General	Chloride/5c	Navarro	3A, 3B, 3C
Lower Trinity-Tehuacana/Mims Creek-Upper Keechi Creek	Upper Keechi Creek	0804H/0804H_01	Aquatic Life	Depressed Dissolved Oxygen/5b	Freestone	3C
Buffalo-San Jacinto/Cole Creek-Whiteoak Bayou	Brickhouse Gully/Bayou	1017A/1017A_01	Recreation	Bacteria/4a	Harris	5
Buffalo-San Jacinto/Cole Creek-Whiteoak Bayou	Cole Creek	1017B/ 1017_01	Recreation	Bacteria/ 4a	Harris	5
Spring/Dry Creek-Cypress Creek	Cypress Creek	1009/ 1009_04	Recreation	Bacteria/ 4a	Harris	5

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 4a:TMDLs have been completed and approved by EPA for the surface water parameter bacteria only.

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.

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 DO, resulting in insufficient amounts of DO available for fish and other aquatic life. Die-off and decomposition of submerged plants also contribute to insufficient DO levels.[42]

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 9 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

[42] 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.

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 in the following sections and depicted in **Appendix D, Groundwater Resources Mapbook**.[43]

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**). 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])[44] requires EPA to review any project receiving federal funds that is located over a sole source aquifer or its recharge zone.[45] 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 Aquifer
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)
	Gulf Coast	Queen City Aquifer (subcrop)
		Yegua Jackson Aquifer (outcrop)
Waller	Gulf Coast	None
Harris	Gulf Coast	None

Source: George, Mace, and Petrossian 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.[46] Saturated thickness of an aquifer is the vertical measurement of the space filled with water. The top of the saturated layer is

[43] Peter G. George, Robert E. Mace, and Rima Petrossian, "Aquifers of Texas Report 380," Austin, Texas: Texas Water Development Board, 2011.
[44] EPA, "My WATERS Mapper: Drinking Water Information," October 9, 2015, accessed December 3, 2015, http://watersgeo.epa.gov/mwm/?layer=LEGACY_WBD&feature=12030102&extraLayers=null.
[45] Ibid.
[46] Ibid.

known as the water table and is 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.[47]

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.[48] 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.[49] Compaction of subsurface clay layers due to the loss of supporting pressure caused by water level declines has 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 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 with water levels appearing to be stable.[50]

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

[47] M.D. Campbell 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.
[48] Peter G. George, Robert E. Mace, and Rima Petrossian, "Aquifers of Texas Report 380," Austin, Texas: Texas Water Development Board, 2011.
[49] Ibid.
[50] USGS, " Dictionary of Water Terms," last updated November 6, 2015, accessed December 2019, http://water.usgs.gov/edu/dictionary.html.

of sand, silt, clay and gravel that was left by flowing water.[51] Freshwater saturated thickness averages about 50 feet in the Nacatoch Aquifer.[52] 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 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. However, Due to droughts since 2010, water levels have been declining.[53]

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 1,000 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 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.[54]

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 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 TWDB.[55]

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 TWDB. Groundwater for domestic and livestock purposes is typically extracted from shallow wells throughout the aquifer. Water is also used for some

[51] Peter G. George, Robert E. Mace, and Rima Petrossian, “Aquifers of Texas Report 380,” Austin: Texas Water Development Board, 2011.
[52] Ibid.
[53] Ibid.
[54] Peter G. George, Robert E. Mace, and Rima Petrossian, “Aquifers of Texas Report 380,” Austin: Texas Water Development Board, 2011.
[55] Ibid.

municipal, industrial and irrigation purposes. No significant water level declines have been detected throughout the aquifer in wells measured by TWDB.[56]

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).[57] 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 14 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
Navarro	Other	3905703	Unknown	24	3B
Navarro	Woodbine	3360202	Corsicana Water Department	2029	3B
Navarro	Nacatoch	3905103	A. L. Weeks	77	3B
Navarro	Taylor	3351902	Unknown	24	3B
Limestone	Carrizo-Wilcox	3938907	J. Carpenter	290	4
Madison	Carrizo-Wilcox	5908903	Mrs. Merle Prescott	316	4
Grimes	Gulf Coast	6033502	Frank H. Nelson	462	5
Grimes	Gulf Coast	6025201	L. B. Floyd	202	5
Waller	Gulf Coast	6049906	Master Electric	356	5
Harris	Gulf Coast	6503502	Paddock Estate	1170	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 Industrial Site Terminal Station Option

Source: TWDB 2015

A spring is formed when the land surface intersects a flowing body of groundwater at or below the local water table. This can be caused by streams incising so deeply that the aquifer is exposed or when an aquifer is filled to the point where that water overflows onto the land surface.[58] There are no springs located within the Study Area. The closest spring is an unnamed spring located approximately 0.58 mile east of Segment 3C in Freestone County.

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.[59] Three GCDs, Prairielands, Mid-east Texas and Bluebonnet, are established in the Study Area, as is the Harris-Galveston Subsidence District (HGSD).[60] More information on the GCDs is provided in **Section 3.8,**

[56] Ibid.
[57] National Ground Water Association, "Springs," accessed December 2019, https://www.ngwa.org/what-is-groundwater/About-groundwater/springs.
[58] Texas Natural Resource Conservation Commission, "State of Texas Source Water Assessment and Protection Program Strategy," Austin: Public Drinking Water Section, Water Utilities Division, 1999.
[59] TCEQ, "TCEQ Groundwater Conservation Districts," *TCEQ_GCD*, Austin, Texas, 2014.
[60] TWDB, "2017 State Water Plan," Austin, TX. May 2016.

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 an 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 an 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 five MSDs are located within the Study Area (**Appendix D, Natural Resources Mapbook**). Four of the MSDs are located in the City of Dallas within the Trinity and Woodbine Aquifers. Combined, they cover approximately 86 acres of Segment 1 in Dallas County. The two northernmost MSDs cover the majority of the Dallas Terminal Station and approximately 0.64 mile of Segment 1 from 0 to 200 feet below ground surface. This MSD applies to groundwater beneath properties generally located at 318 Cadiz Street, Dallas, Texas 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.

3.3.4.3 Water Supply

3.3.4.3.1 Regional Water Supply Planning

Every 5 years TWDB compiles a comprehensive state water plan from information collected from 16 regions throughout the state.[61] The water quality Study Area spans 3 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: Dallas, Ellis, Freestone and Navarro Counties.[62] 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.[63] 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.[64]

3.3.4.3.2 Reservoirs and Dams

The only major public water supply reservoir identified near the Study Area is Lake Limestone located approximately 0.25 mile from Segment 4 in Limestone County (**Appendix D, Natural Resources Mapbook**).[65] Lake Limestone is owned and operated by the Brazos River Authority and 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.[66] It is located in portions of Limestone and Leon Counties in the

[61] Ibid.
[62] Ibid.
[63] Ibid.
[64] TCEQ, “Source Water Protection,” May 30, 2019, accessed December 2019, https://www.tceq.texas.gov/drinkingwater/SWAP.
[65] Ibid; TWDB, “Lake Limestone (Brazos River Basin),” accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/reservoirs/limestone/index.asp.
[66] EPA, *My WATERS Mapper: Drinking Water Information,* October 9, 2015, accessed December 3, 2015, http://watersgeo.epa.gov/mwm/?layer=LEGACY_WBD&feature=12030102&extraLayers=null.

Navasota Watershed. Other reservoirs in the Study Area, like Lake Bardwell, are primarily used for flood control.

A total of 193 dams are located within the subwatersheds that intersect the Study Area. Twenty-eight of these dams are located within 0.5 mile of the Study Area. The nearest dam, Everett Gss, is located 53 feet west of the Study Area in Ellis County.

3.3.4.3.3 Public Water Supply

The EPA Safe Drinking Water Information System identifies 1,600 public water systems located within the nine watersheds of the water quality Study Area.[67] 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, are non-transient, non-community water systems. A water system that temporarily provides water to changing populations, such as a golf club or campground, is a transient non-community water system.[68] **Table 3.3-5** identifies the type of public water system within the water supply Study Area counties by watershed.

Table 3.3-5: EPA Safe Drinking Water Information System

Watershed	Counties	PWS Source	PWS Type			Total
			CWS	NTNCWS	TNCWS	
Upper Trinity	Dallas	GW	3	0	0	**3**
		SW	8	0	0	**8**
	Ellis	GW	1	0	0	**1**
		SW	5	0	0	**5**
Lower Trinity - Kickapoo	Leon	GW	9	0	0	**9**
	Madison	GW	6	0	2	**8**
	Grimes	GW	5	1	0	**6**
Lower Trinity-Tehuacana	Freestone	GW	22	2	4	**28**
		SW	1	0	0	**1**
	Limestone	GW	1	0	0	**1**
	Leon	GW	7	0	0	**7**
Chambers	Ellis	GW	13	0	1	**14**
		SW	9	0	0	**9**
	Navarro	SW	4	0	0	**4**
Richland	Navarro	GW	0	0	1	**1**
		SW	6	0	0	**6**
	Freestone	GW	1	0	0	**1**
Navasota	Freestone	GW	3	1	0	**4**
	Limestone	GW	8	1	3	**12**
		SW	2	0	0	**2**
	Leon	GW	6	2	0	**8**
	Grimes	GW	4	0	1	**5**
	Madison	GW	1	0	0	**1**
West Fork San Jacinto	Grimes	GW	4	1	1	**6**
	Harris	GW	18	2	3	**23**

[67] Ibid.
[68] TCEQ, "Texas Surface Water Quality Monitoring and Assessment Strategy FY 2012-2017, Rev. 1," Austin, TX: TCEQ Water Quality Planning Division, December 2013, accessed December 2019, https://www.tceq.texas.gov/assets/public/waterquality/swqm/monitor/swqm_strategy.pdf.

Table 3.3-5: EPA Safe Drinking Water Information System						
Watershed	Counties	PWS Source	PWS Type			Total
			CWS	NTNCWS	TNCWS	
		SW	5	0	0	**5**
East Fork San Jacinto	Harris	GW	6	0	4	**10**
East Fork Trinity	Dallas	SW	5	0	0	**5**
Elm Fork Trinity	Dallas	SW	4	0	0	**4**
Lower Brazos	Waller	GW	11	2	5	**18**
Lower Brazos-Little Brazos	Grimes	GW	7	1	1	**9**
Lower West Fork Trinity	Dallas	GW	1	2	2	**5**
		SW	4	0	0	**4**
	Ellis	GW	2	1	0	**3**
		SW	2	0	0	**2**
North Galveston Bay	Harris	GW	20	2	8	**30**
		SW	1	0	0	**1**
West Galveston Bay	Harris	GW	2	6	6	**14**
		SW	18	3	3	**24**
Spring	Grimes	GW	4	0	1	**5**
	Waller	GW	15	4	0	**19**
	Harris	GW	170	51	70	**291**
		SW	24	0	0	**24**
Buffalo-San Jacinto	Waller	GW	2	10	2	**14**
	Harris	GW	247	200	119	**566**
		SW	96	8	0	**104**
TOTALS			**793**	**300**	**237**	**1,330**

Source: EPA 2015

CWS – Community Water System
GW – Groundwater
SW – Surface Water
NTNCWS – Non-Transient Non-Community Water System
PWS – Public Water System
TNCWS – Transient Non-Community Water System

Two public water system wells are located in the Study Area (**Table 3.3-6**). In addition to wells, which pump water from underground sources, public water systems may be supplied by surface water intakes (i.e., where water is pumped from surface water for use in the public water system). The nearest surface water intake is approximately 0.10 mile from the water quality Study Area.[69]

Table 3.3-6: Public Water System Wells Within the Study Area						
County	Aquifer	Source ID	PWS Name/ID	Well Depth (feet)	Segment	Status
Freestone	Carrizo-Wilcox	TX0810015	Pleasant Grove	411	3C	Active
Harris	Gulf Coast	TX1010013	City of Houston	450	5	Unused

Source: TCEQ 2012

Any public water system is eligible to participate in the voluntary Texas Source Water Protection Program. The public water system identified on the Participants in the Source Water Protection Program list within the LOD is the City of Houston.[70] Locally controlled and implemented, the City of Houston's Source Water Protection Program implements measures to protect their source water from contamination. Additional requirements and/or restrictions to construction and operations may apply

[69] TCEQ, "Texas Source Water Protection Program Participants," TCEQ: Participants in the Source Water Protection Program, May 30, 2019, accessed December 2019, https://www.tceq.texas.gov/assets/public/permitting/watersupply/pdw/swap/SWP%20PARTICIPANTS%202017.pdf.
[70] City of Houston, "Drinking Water Operations," accessed December 2019, https://www.publicworks.houstontx.gov/pud/drinkingwater.html.

within the City of Houston to maintain water quality. Water wells account for approximately 14 percent of the City of Houston's water supply.[71]

3.3.5 Environmental Consequences

This section provides an analysis of the potential water quality impacts of the No Build Alternative, each Build Alternative, and the Houston Terminal Station options. Potential stream and wetland impacts are discussed in **Section 3.7.5, Waters of the U.S., Environmental Consequences,** and floodplains and bridge crossings are discussed in **Section 3.8.5, Floodplains, Environmental Consequences**. Potential impacts from existing contamination and hazardous materials are discussed in **Section 3.5.5, Hazardous Materials and Solid Waste, Environmental Consequences.** Since MSDs are state designations to restrict contaminated groundwater usages, the consequences are the same as those discussed in **Section 3.5.5, Hazardous Materials and Solid Waste, Environmental Consequences**.

3.3.5.1 No Build Alternative

In the No Build Alternative, the HSR system would not be constructed or operated. Existing surface water, groundwater and water supply resources would not be disturbed as a result of the HSR Project. Potential impacts could occur as a result of continued natural growth as well as other planned projects, such as the IH-35 East roadway improvement project in Dallas County, Waxahachie Line rail project in Dallas and Ellis Counties and Integrated Pipeline Project in Navarro and Ellis Counties. These projects are either planned or currently under construction and would increase the amount of impervious cover, thus increasing the amount of stormwater runoff. Potential impacts of these Projects are discussed in **Table 4-9** in **Chapter 4, Indirect and Cumulative Impacts**.

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.[72] 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 TCEQ and the USACE under the CWA (**Section 3.3.2, Regulatory Context**). As discussed in **Section 3.3.6, Avoidance, Minimization and Mitigation**, TCRR, in coordination with TCEQ and the USACE, would avoid and minimize impacts to surface water quality, groundwater quality and water supply, as practicable, and obtain the appropriate permits.

Potential impacts would occur to surface water quality, groundwater quality and water supply during construction and operation of the Project. 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 Project 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 Project Study Area (**Section 3.13,**

[71] TCRR, *Texas Central Partners Texas High-Speed Rail Final Conceptual Engineering Report-FCERv2*, July 1, 2019.
[72] Ibid.

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 result in total suspended solids (TSS) such as rock, soil and debris fragments entering downstream water resources. These TSS may also contain bacteria, nutrients, particles and other constituents attached to sediment or carried separately by stormwater that contribute to pollutant loading. Increased pollutant loading in runoff may impact surface water, groundwater quality and water supply. While this could impact waterbodies, threatened or impaired waterbodies and reservoirs or other public water supplies would be more sensitive to construction stormwater runoff. A discussion of these potential construction impacts by surface water quality, groundwater quality and water supply is provided in the following sections.

Surface Water Quality

Construction of the Project would result in temporary impacts to surface water quality. Stormwater runoff from construction activities could increase TSS that may contain various substances known to contribute to pollutant loading, such as nitrogen, phosphorus and bacteria. Potential impacts to water quality would consist of altering the concentration of one or more of these substances within a waterbody, causing a waterbody to no longer meet a designated use, such as recreation and the ability to support aquatic life, or further degrading an already impaired waterbody (**Table 3.3-7**). 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 waterbody where pollutant concentration is historically low. See **Section 3.3.4.1.6, Impaired Waterbodies,** for more information.

Table 3.3-7: Length of 303(d) Listed Streams that would Potentially be Impacted by the Build Alternatives

Basin/Alternative Segment	Length (feet) of 303(d) Listed Streams per Alternative						County
	A	B	C	D	E	F	
Upper Trinity							
Segment 1	209.0	209.0	209.0	209.0	209.0	209.0	Dallas
Segment 2A	--	--	--				Ellis
Segment 2B				--	--	--	Ellis
Chambers							
Segment 2A	--	--	--				Ellis
Segment 2B				--	--	--	Ellis
Segment 3A	135.7			135.7			Navarro
Segment 3B		308.4			308.4		Navarro
Segment 3C			135.7			135.7	Navarro
Richland							
Segment 3A	--			--			Navarro
Segment 3B		--			--		Navarro
Segment 3C			--			--	Navarro
Lower Trinity-Tehuacana							
Segment 3A	--			--			Navarro
Segment 3B		--			--		Freestone
Segment 3C			--			--	Navarro Leon
Segment 3C			151.3			151.3	Freestone
Segment 4	--	--		--	--		Freestone

Table 3.3-7: Length of 303(d) Listed Streams that would Potentially be Impacted by the Build Alternatives

Basin/Alternative Segment	Length (feet) of 303(d) Listed Streams per Alternative						County
	A	B	C	D	E	F	
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	--	--	--	--	--	--	Waller
Segment 5	93.0	93.0	93.0	93.0	93.0	93.0	Harris
Buffalo-San Jacinto							
Segment 5	392.3	392.3	392.3	392.3	392.3	392.3	Harris

Source: AECOM 2019

TMDL implementation plans have been developed by TCEQ for waterbodies impaired with bacteria within the Study Area. Stormwater runoff mitigation measures are outlined in TMDL implementation plans for these waterbodies and are summarized in **Section 3.3.6, Avoidance, Minimization and Mitigation.**[73, 74, 75] For bacteria, the TMDL implementation plans collectively conclude that for construction sites, compliance with the TCEQ General Construction Permit is an adequate measure to contain stormwater runoff within the TMDLs.[76] The General Construction Permit is further described in **Section 3.3.6, Avoidance, Minimization and Mitigation.**

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 Project could result in the introduction of nitrogen and phosphorus to listed waterbodies. 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 an SWPPP and sedimentation controls, as discussed below, to prevent nitrogen and phosphorus from entering waterbodies. None of the Build Alternatives would directly introduce dioxins or PCBs to the environment and further contribute to impairment of 303(d) listed waterbodies within the water quality Study Area. As discussed in **Section 3.5, Hazardous Materials and Solid Waste**, industrial sites that could possibly contain dioxins or PCBs would be investigated and remediated in accordance with federal, state and local standards prior to construction.

[73] 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.

[74] TCEQ, "Implementation Plan for Dallas and Tarrant counties Legacy Pollutant TMDLs for Segment 0805, 0841, and 0841A," Austin, Texas, August 2001.

[75] TCEQ, "Implementation Plan for Seventy-Two Total Maximum Daily Loads for Bacteria in the Houston-Galveston Region," Austin, Texas, January 2013.

[76] Drainage design details for each crossing are included in **Appendix E, Waters of the U.S. Technical Memorandum** and **Appendix G, TCRR Final Conceptual Engineering Plans and Details.**

Erosion and sedimentation BMPs **(WQ-MM#1: Maintenance and Inspection of Temporary Erosion and Sediment Controls),** SWPPP controls and other requirements would be implemented to avoid and minimize impacts caused by soil erosion and sedimentation during construction as a result of stormwater runoff. Due to potential discharge of pollutants to surface water, a TPDES permit, issued by TCEQ, would be required to comply with CWA Section 402. By implementing avoidance, minimization and mitigation measures and complying with permits, as described in **Section 3.3.6, Avoidance, Minimization and Mitigation**, sedimentation and runoff would be controlled.

Groundwater Quality

Sedimentation and runoff from construction of the Project could result in potential temporary impacts to groundwater quality due to the 14 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 potential contamination of soils exists. Construction in these areas would provide a path for contaminants to be transported via sedimentation and stormwater runoff. Hazardous materials, such as petroleum and oil products used for fueling and maintenance of construction equipment, could also impact groundwater quality if spilled near waterbodies or wellheads, or if they are spilled near a shallow aquifer, potentially leaching through soil into groundwater. **Table 3.3-8** identifies the number of groundwater wells that would potentially be impacted by the Build Alternatives.

Table 3.3-8: Groundwater Wells that would Potentially be Impacted by the Build Alternatives

Alternative Segment	Number of Groundwater Wells per Alternative					
	A	B	C	D	E	F
Segment 3B		4			4	
Segment 4	2	2		2	2	
Segment 5	8	8	8	8	8	8
Total Per Build Alternative	**10**	**14**	**8**	**10**	**14**	**8**

Source: AECOM 2019

Build Alternatives B and E would potentially impact the greatest number of groundwater wells (14) and Build Alternatives C and F would potentially impact the least amount of groundwater wells (8). One groundwater well would be located within the LOD of the Houston Industrial Site Terminal Station and Houston Northwest Mall Terminal Station options.

As discussed in **Section 3.5.5, Hazardous Materials and Solid Waste, Environmental Consequences**, BMPs 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.

By implementing BMPs and mitigation discussed in **Section 3.3.6, Avoidance, Minimization and Mitigation**, the pathway for contamination to reach groundwater would be reduced.

Water Supply

As stated in **Section 3.3.4, Affected Environment**, Lake Limestone Reservoir is located approximately 0.25 mile from Segment 4 of the Study Area. Lake Limestone would experience potential indirect, temporary 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, one tributary to Lake Limestone Reservoir intersects Segment 4 at Sanders Creek. The Brazos River

Authority was contacted to determine whether 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 Reservoir during construction (**Appendix C, Public and Agency Involvement**). Additionally, the portions of Segment 4 that would intersect the tributary to Lake Limestone Reservoir 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 Build Alternatives C and F would have no impacts to Lake Limestone Reservoir.

A coordination letter regarding the Richland-Chamber Reservoir, which is located approximately 2.5 miles from Segment 3B and 2.1 miles from Segment 3C, 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, Agency Correspondence**).

Potential 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. **Table 3.3-8** includes the number of groundwater wells per Build Alternative. 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, Avoidance, Minimization and Mitigation**.

Increased water demand would occur for the duration of construction. Aside from drinking water for construction crews, water would be used for construction activities such as dust suppression and mixing concrete. Potable and non-potable water for construction would be supplied from existing surface or groundwater supply systems, and would be trucked in, as needed. Therefore, water demand during construction would not be anticipated to require construction or expansion of a water treatment facility, or expanded water entitlements. Additional information on water demand during construction and operation is located in **Section 3.9.5.2.1, Utilities and Energy, Utilities**.

3.3.5.2.2 Operational Impacts

Potential operational impacts would result from stormwater runoff and operation activities, such as maintenance of culverts or bridges, fueling and trainset maintenance activities and obtaining water supplies for the operational facilities and trainsets. A discussion of these operational impacts by surface water quality, groundwater quality and water supply is provided in the following sections.

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 Project would be on embankment may also influence drainage patterns, which could potentially affect water resources. Potential long-term impacts to surface water quality from operation and maintenance of the Project would include increased runoff as a result of the new impervious areas. However, overall, the Project 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 Project.

Operation of the railway would have potential permanent impacts on surface water quality including impaired stream segments. TCRR would implement 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 watersheds (**WQ-MM#6. Total Suspended Solids/Stormwater Runoff Control [Permanent]**) to mitigate potential impacts to water quality.

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. The increase in impervious cover may slow the groundwater recharge rate; however, the rate of recharge would not impact groundwater quality.

As discussed in **Section 3.5.5, Hazardous Materials and Solid Waste, Environmental Consequences**, BMPs 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 BMPs and eliminating wellheads as a conduit for pollution by plugging and/or displacement as discussed in **Section 3.3.6.2, Mitigation Measures**, the potential for contaminants entering groundwater sources would be reduced, mitigating potential impacts to groundwater quality.

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 trainset washing. Anticipated water demand during operations is depicted in **Table 3.3-9**.

Table 3.3-9: Build Alternatives Water Demand

County	Facility	Demand (gallons per day)	TOTAL (gallons per day)
Dallas	Dallas Terminal Station	95,100	95,100
Grimes	Brazos Valley Intermediate Station	25,800	25,800
Harris	Houston Terminal Station	73,800	73,800
Dallas and Harris	Two TMFs	64,137 (each)	128,275
Various	Seven MOW Facilities	3,811(each)	26,677
TOTAL		**349,652**	

Source: TCRR 2019

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 Project would include reusing water in innovative ways such as reclaimed wastewater, condensation and rainwater for irrigation or toilet flushing. The MOW facilities would obtain potable water from the local water supply facilities presented in **Table 3.9-3** in **Section 3.9.4, Utilities and Energy, Affected Environment**. Each facility would also generate wastewater. Additional potable water required to supply the Project and wastewater generated by the Project is discussed in **Section 3.9.5, Utilities and Energy, Environmental Consequences**.

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. As groundwater exploration is a large contributor to land subsidence, access to municipal water systems for the Build Alternatives and Houston Terminal Station options would mitigate potential land subsidence in these areas. See also **Section 3.8.5.2.2, Floodplains, Geohydrology**.

As discussed in **Section 3.3.5.2.1, Construction Impacts,** in a response letter dated January 14, 2016, the Brazos River Authority indicated that there would be no potential direct impacts to the operation of Lake Limestone Reservoir during construction (**Appendix C, Agency Correspondence**). The portions of Segment 4 that would intersect the tributary 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.

Overall impacts to water quality would require permits and approvals from TCEQ and the USACE that would include permit provisions to avoid, minimize and mitigate impacts, as detailed in **Section 3.3.6, Avoidance, Minimization and Mitigation**.

3.3.6 Avoidance, Minimization and Mitigation

During construction of the Project, potential impacts to water quality would be minimized by adhering to compliance measures and permitting described in the following sections. TCRR has incorporated drainage features, such as swales, culvert crossings, viaduct sections and detention basins, into the design of the Project to maintain water flow, to provide natural filters for stormwater runoff and to ensure that off-site cross-drainage patterns would not be changed where practicable. In addition, TCRR included design features to avoid and minimize potential impacts to water quality, including placing approximately 55 percent of the Build Alternatives on viaduct to span waters of the U.S. Construction on viaduct would reduce the need for pesticides and fertilizer as there would be no landscaping and/or ground cover to maintain on viaduct sections; therefore, potential influx of pesticides and fertilizers to nearby waterbodies could be minimized. TCRR will acquire necessary permits as described in **Section 3.3.6.1, Compliance Measures**, before initiating construction.

3.3.6.1 Compliance Measures

TCRR would be required to comply with the following Compliance Measures (CM).

WQ-CM#1: Section 401 Water Quality Certification. Prior to construction and concurrent with the Section 404 process described in **Section 3.7, Waters of the U.S.**, TCRR shall complete a Tier II Certification Questionnaire and Alternatives Analysis Checklist for review by TCEQ to obtain a Section 401 Water Quality Certification. TCEQ may request additional information from TCRR.

WQ-CM#2: TPDES General Construction Permit (TXR150000) and Multi-Sector General Permit (TXR050000). Prior to construction, TCRR shall prepare an SWPPP for the Project or for each construction segment and submit a Notice of Intent (NOI) to TCEQ (with the appropriate fees) to obtain coverage under the General Construction Permit. Before starting construction, TCRR shall ensure a copy of the Site Notice is posted at the construction site and the notice will remain posted until construction is completed. Activities conducted during construction must adhere to General Construction permit requirements.

TCRR shall obtain authorization under the Multi-Sector General Permit (TXR050000) to discharge stormwater from the TMFs during operation of the Project. TCRR shall monitor contaminant levels in stormwater discharges annually as set forth in the permit. These results will be maintained onsite with the SWPPP.

WQ-CM#3: Stormwater Management/Stormwater Pollution Prevention Plan. Prior to construction, TCRR shall prepare an SWPPP and submit an NOI to 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 shall be responsible for implementing the SWPPP throughout the construction period. During construction, TCRR shall restrict construction activities to permanent and temporary workspaces and easements.

To address Section 401 Water Quality Certification requirements, TCRR shall identify and implement temporary stormwater controls. TCRR shall implement sediment control measures prior to the start of and during construction and isolate the construction area from waterbodies and wetlands. TCRR shall store dredged and fill material in a way that prevents sedimentation runoff to waterbodies. Control measures may include the following:

- Sandbag berm
- Silt fence
- Triangular filter dike
- Rock berm
- Hay bale dike
- Brush berms
- Stone outlet sediment traps
- Erosion control compost
- Compost filter socks
- Sediment basins
- Mulch filter socks
- Bypass pump-around system, or similar alternative – to be used in conjunction with berms for effective dewatering

TCRR shall stabilize disturbed areas during construction to prevent sediment from entering adjacent waterbodies and wetlands. Stabilization measures may include the following:

- Temporary vegetation
- Blankets/matting
- Mulch
- Sod
- Interceptor swale
- Diversion dike

- Erosion control compost
- Mulch filter socks
- Compost filter socks

WQ-CM#4: Compliance with MS4 Requirements. As part of compliance with TPDES and any MS4 requirements, prior to construction TCRR shall provide MS4 operators (including the City of Houston and the City of Dallas) a copy of the SWPPP and/or NOI, where required by local ordinance. During the construction phase, the MS4 operators may inspect the construction site as regularly as every 14 calendar days. TCRR shall conduct regular inspections, maintenance and recordkeeping to determine whether appropriate controls measures have been installed and implemented in accordance with the SWPPP and General Construction Permit.

3.3.6.2 Mitigation Measures

TCRR would be required to implement the following Mitigation Measures (MM).

WQ-MM#1: Maintenance and Inspection of Temporary Erosion and Sediment Controls. Prior to construction, TCRR shall include maintenance and inspection procedures that comply with BMPs in the SWPPP (**WQ-CM#3: Stormwater Management/Stormwater Pollution Prevention Plan**). Procedures will include the following, at minimum:

- Silt and sediment shall be removed from devices no later than when the design capacity of the device reached 50 percent of the original design capacity.
- Deteriorated materials shall be repaired or replaced when discovered.

TCRR shall regularly inspect the Project area in in compliance with General Construction Permit TXR150000. TCRR shall inspect the Project area, as defined in the SWPPP, to evaluate the condition of erosion and sediment controls. Inspections shall either be conducted every 14 calendar days or within 24 hours of a rain event consisting of greater than or equal to 0.5 inch. An alternative schedule would be that TCRR conduct regular inspections every seven calendar days regardless of whether there has been a rainfall event since the previous inspection.

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 BMPs.

WQ-MM#3: Site Restoration and Revegetation. Upon completing construction activities, TCRR shall restore temporary construction areas to at least the quality of preexisting conditions. Additionally, where feasible, seed mixes approved by the U.S. Department of Agriculture shall be used to minimize the introduction of invasive species. In previously undisturbed areas, TCRR shall work with landowners to determine site restoration and revegetation requirements appropriate for the existing land use (i.e., agriculture, pasture, woodlands). Where native seeding is proposed, TCRR shall verify that seed mixes consist of native species appropriate for the ecoregion. TCRR shall coordinate site-restoration and revegetation requirements, including the control of invasive species, in accordance with other statutory obligations (i.e., Section 404 permit, TPDES, USFWS, Texas Parks and Wildlife Department [TPWD]), landowner agreements, and local site conditions.

WQ-MM#4: Well Modifications. Prior to construction, TCRR shall identify and coordinate well plugging and abandonment activities with the appropriate regulatory agency (TCEQ, Texas Railroad Commission, GCD or TWDB). TCRR shall coordinate any relocations (drilling) with the appropriate regulatory agency.

Additionally, TCRR shall hire licensed drillers in accordance with Texas Department of Licensing specifications.[77]

WQ-MM#5: New Well Permits/Registrations in GCD. Should TCRR relocate groundwater wells within the Bluebonnet, Prairielands and Mid-East Texas GCD, TCRR shall coordinate with the well owner and the appropriate GCD to permit and/or register the relocated wells.

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, Mitigation Measures**.

WQ-MM#6. Total Suspended Solids/Stormwater Runoff Control (Permanent). Once construction is completed, TCRR shall implement final stabilization measures to reduce TSS, soil erosion and sedimentation to protect adjacent waterbodies. Acceptable measures for stabilization include the following:

- Retention/irrigation systems
- Extended detention basin
- Vegetative filter strips
- Grassy swales
- Erosion control compost
- Compost filter socks
- Sedimentation chambers
- Constructed wetlands
- Wet basins
- Compost filter socks
- Vegetation lined drainage ditches
- Sand filter systems
- Mulch filter socks

WQ-MM#7: Wildlife Friendly Control Measures. TCRR shall use soil stabilization materials and techniques that minimize entanglements to snakes and other wildlife.

See also **FP-CM#2, Construction Floodplain Best Management Practices,** in **Section 3.8.6.1, Floodplains, Compliance Measures,** and **Section 3.8.5.2.3, Floodplains, Hydrology,** for discussion of detention basins that would also provide a filter for sedimentation and contaminants from reaching surface water.

3.3.7 Build Alternatives Comparison

Surface water in watersheds and groundwater in aquifers are fluid and connected; therefore, the effects on one could impact the larger system and have been combined in evaluating the Study Area for effects to these systems. In general, the potential impacts to surface water quality, groundwater quality and water supply are similar for all Build Alternatives and Houston Terminal Station options. **Table 3.3-10** provides a summary of the resources analyzed in this section.

Based on the data presented in **Table 3.3-10**, total impaired waterbody impacts among Build Alternatives would be within approximately 173 feet of each other. Build Alternatives B and E would have the most impacts to waterbodies included on the 303(d) List and waterbodies with active TMDLs (1,002.7 feet) and Build Alternatives A and D would have the least total impaired waterbody impacts (830 feet).

[77] 16 TAC 76.

Build Alternatives B and E would potentially impact the greatest number of groundwater wells (13) and Build Alternatives C and F would potentially impact the least number of groundwater wells (7). In addition, one groundwater well would be located within the LOD of the Houston Industrial Site Terminal Station Option, while no groundwater wells would be located within the Houston Northwest Mall Terminal Station Option or Houston Northwest Transit Center Terminal Station Option.

All Build Alternatives (A through F) would impact one active public water system well.

Table 3.3-10: 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)	344.7	517.4	496	344.7	517.4	496	0	0	0
Impaired Waterbodies with TMDLs (feet)	485.3	485.3	485.3	485.3	485.3	485.3	0	0	0
Impaired Waterbodies Total (feet)	830	1,002.7	981.3	830	1,002.7	981.3	0	0	0
Active Public Water System Wells	1	1	1	1	1	1	0	0	0
Groundwater Wells	9	13	7	9	13	7	0	0	1
Reservoir/Dam Crossings	0	0	0	0	0	0	0	0	0

Source: AECOM 2019

Build Alternatives C and F would not be located near any reservoirs or dams. Build Alternatives A, B, D and E would cross a tributary draining to Lake Limestone Reservoir, a water supply reservoir, resulting in potential temporary indirect water quality impacts to Lake Limestone Reservoir.

The increased demand for water supply would be the same for all Build Alternatives and Houston Terminal Station options. Based on the information presented in **Section 3.3.5, Environmental Consequences** and **Table 3.3-9**, there is no notable difference in anticipated potential impacts to surface water quality, groundwater quality and water supply as a result of the Project.

3.4 Noise and Vibration

3.4.1 Introduction

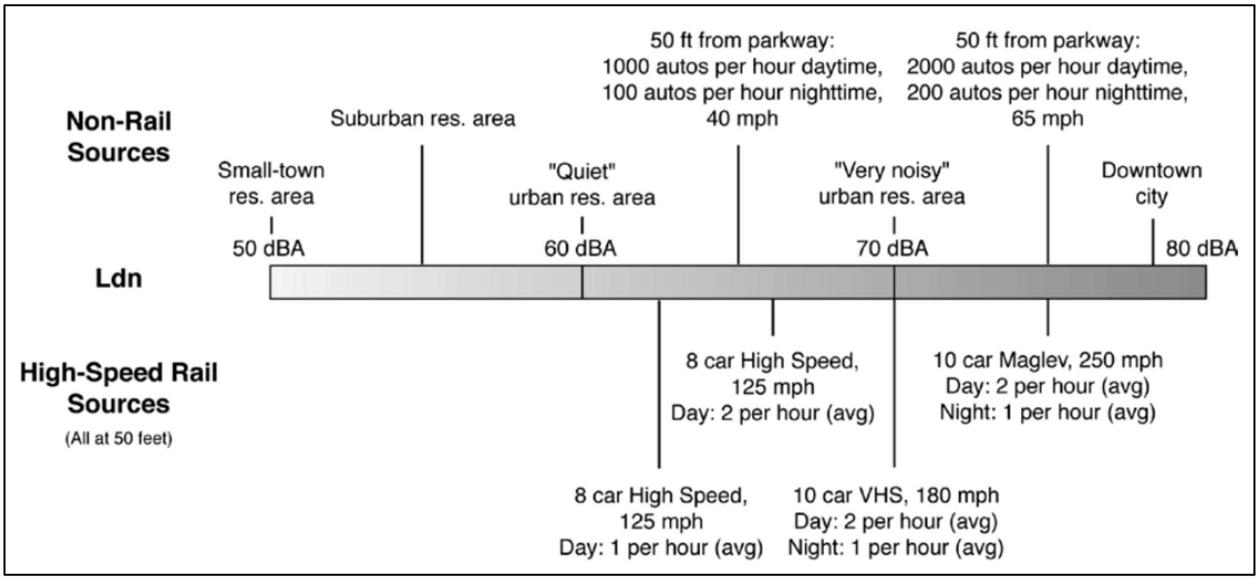
This section describes the assessment of potential noise and vibration impacts from construction and operation of the Project, as well as recommended mitigation measures to eliminate or reduce these impacts.

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 10 similar events during the day. Typical Ldn values for HSR sources and non-rail sources are shown on **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

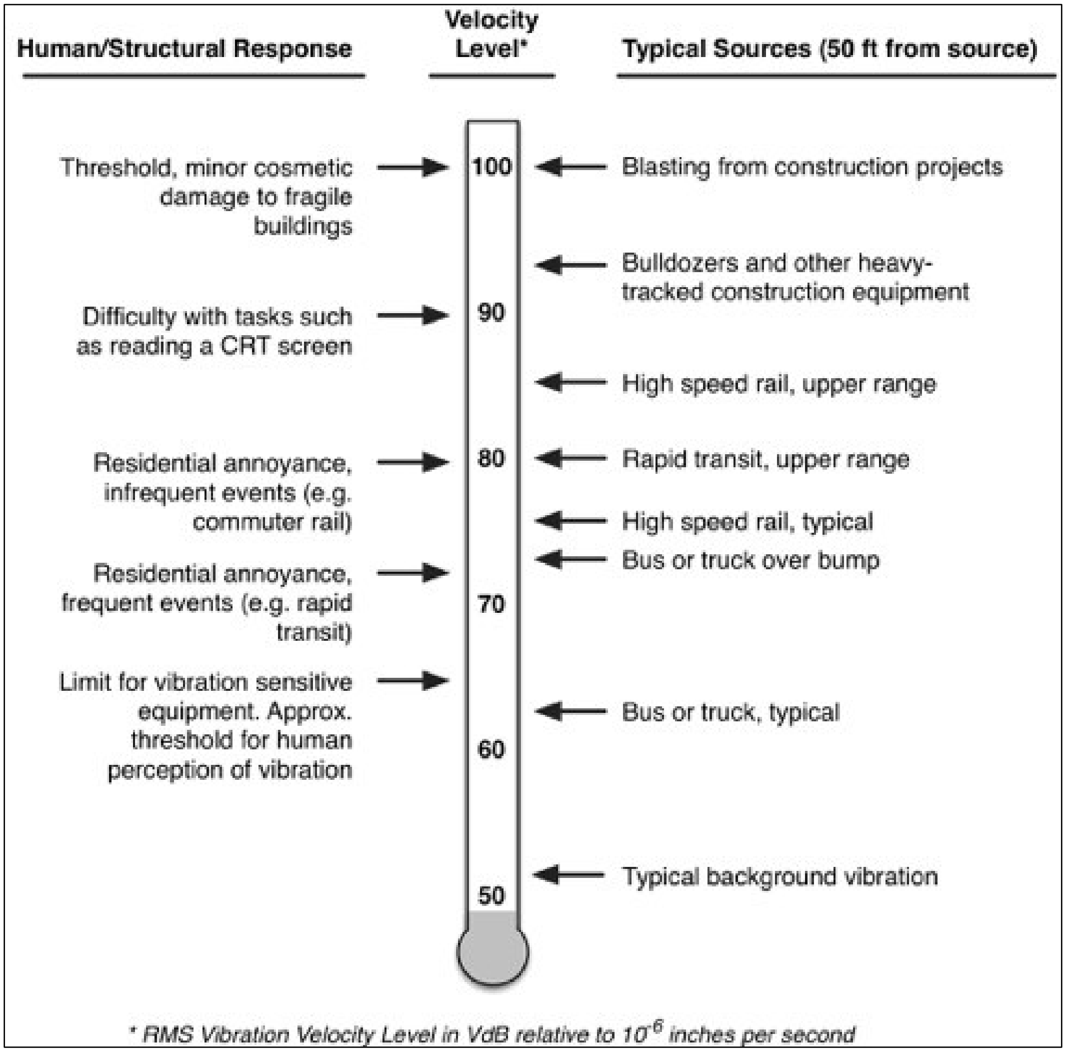
Ground-borne vibration is the motion of the ground transmitted into a building that can be described in terms of displacement, velocity, or acceleration. Vibration velocity is used for rail system projects and is defined by the following:

- **Level:** Vibration is expressed in terms of root mean square vibration velocity level, using vibration decibels (VdB), with a reference value of 1 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 on **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. 210) prescribe minimum compliance regulations for enforcement of the Railroad Noise Emission Standards established by EPA in 40 C.F.R. 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. 51) establishes standards for noise exposure used to assess the suitability of sites for new residential development.

- OSHA Occupational Noise Exposure; Hearing Conversation Amendment (Federal Register 48 (46), 9738—9785) establishes noise exposure limits in the workplace.
- EPA Railroad Noise Emission Standards (40 C.F.R. 201) establish 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)[1].

State

No state-wide noise or vibration regulations apply to transportation systems in Texas. The 2019 TxDOT *Guidance: Traffic Noise Policy Implementation recently replaced TxDOT's Guidelines for Analysis and Abatement of Roadway Traffic Noise*[2] 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., TPSS) shall comply with the following local regulations:

City of Dallas

Ordinance No. 19455 in Part II of the Dallas Development Code (Chapter 51A, Article VI) includes environmental performance standards for both noise and vibration. Section 51A-6.102 of the ordinance specifies noise limits based on zoning district and time of day in terms of Leq averaged over an 8-minute period of time. For residential districts, the limits are 56 dBA during daytime hours (7 AM to 10 PM) and 49 dBA during nighttime hours (10 PM to 7 AM) on the bounding lot line, which would apply to stationary sources. Although construction activities are exempt from these noise limits, Chapter 30 of the Dallas Code of Ordinances restricts construction activity to the hours between 7 AM and 7 PM, Monday through Friday, and between 8 AM and 7 PM on Saturdays and legal holidays. In addition, Section 51A-6.105 of Ordinance 19455 includes property-line vibration standards based on frequency and ground displacement that could be applied to construction activities.

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 to 7 PM) and 49 dBA during nighttime hours (7 PM to 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.

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[1] D. E. Siskind, M. S. Stagg, J. W. Kopp, and C. H. Dowding, *Structure Response and Damage Produced by Ground Vibration From Surface Mine Blasting*, Report of Investigations 8507, 1980.

[2] TxDOT, *Guidance: Traffic Noise Policy Implementation*, December 2019, Available: https://www.txdot.gov/inside-txdot/division/environmental/compliance-toolkits/traffic-noise.html

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 to 10 PM) and 60 dBA and 50 dBA, respectively, during nighttime hours (10 PM to 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 85 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[3] were followed 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 to 300 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 (1-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 the Project 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, Impact Criteria**) 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 Project in each county within the Study Area (see **Figure 3.4-9** through **Figure 3.4-12** for vibration measurement locations). At each location, tests were conducted by impacting the ground with an instrumented weight

[3] FRA, *High-Speed Ground Transportation Noise and Vibration Impact Assessment*, Final Report DOT/FRA/ORD-12/15, September 2012.

and measuring the response of the soil at various distances. The results of the ground vibration tests were combined with vehicle (trainset) 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 **Appendix E, Noise and Vibration Technical Memorandum**.

Project information for use in the analysis was obtained from TCRR[4], consisting of (1) plan and profile maps of the Project 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 trainset. Although the HSR system is based on the Shinkansen N700-Series trainset,, this remodeled trainset is not yet in service and sound data for this trainset is not yet available. However, because the N700-Series will have new features that reduce air resistance and noise compared to the N700-A model, the noise assessment should be conservative (i.e., the noise impacts will not be greater than and are likely to be less than projected). Similarly, because source vibration data are not available for the Shinkansen N700-Series trainset, the projections of vibration are based on measurements of operating Pendolino high-speed trainsets included in the FRA guidance document. The Pendolino and Shinkansen trainsets are both of the electric multiple unit type and should have similar vibration characteristics. The Project information from TCRR and the results of available noise and vibration measurements were used in the prediction and assessment when applying the methodology from the FRA guidance manual.[5]

FRA noise and vibration impact criteria, described in the following sections, 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 trainset. For HSR operations, 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 conducted 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 operational noise and vibration at stations and MOW facilities, the screening procedures described in the FTA guidance manual[6] 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[7] provides noise and vibration criteria for HSR construction and operation as described below.

3.4.3.2.1 <u>Construction Noise Impact Criteria</u>

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 two noisiest pieces of equipment, assuming they would both operate at the same time during a 1-hour period.

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[4] TCRR, *Texas Central Dallas to Houston High Speed Rail Final Conceptual Engineering Report v2 – FCE*, May 9, 2019.
[5] FRA, *High-Speed Ground Transportation Noise and Vibration Impact Assessment*, Final Report DOT/FRA/ORD-12/15, September 2012.
[6] FTA, *Transit Noise and Vibration Impact Assessment Manual*, FTA Report No. 0123, September 2018.
[7] Ibid.

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

The FRA guidance manual[8] 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.

To avoid temporary annoyance to building occupants during construction or construction interference with vibration-sensitive equipment inside special-use buildings, such as recording studios, the long-term vibration criteria were used. These criteria are described in **Table 3.4-5** and **Table 3.4-6** in **Section 3.4.3.2.4, Operational Vibration Impact 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 impacts that would require mitigation during construction.

Table 3.4-2: Construction Vibration Damage Criteria

Building Category	PPV (inch/second)	Approximate L_v[a]
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

Source: FRA, *High-Speed Ground Transportation Noise and Vibration Impact Assessment*, Final Report DOT/FRA/ORD-12/15, September 2012

[a] Root mean square vibration velocity level in VdB relative to 1 micro-inch/second.

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.[9] 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 Project 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.

[8] FRA, *High-Speed Ground Transportation Noise and Vibration Impact Assessment*, Final Report DOT/FRA/ORD-12/15, September 2012.

[9] Ibid.

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 Leq(h)[a]	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 Ldn	Residences and buildings where people normally sleep. This category includes homes, hospitals and hotels where nighttime sensitivity to noise is assumed to be of utmost importance.
3	Outdoor Leq(h)[a]	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.

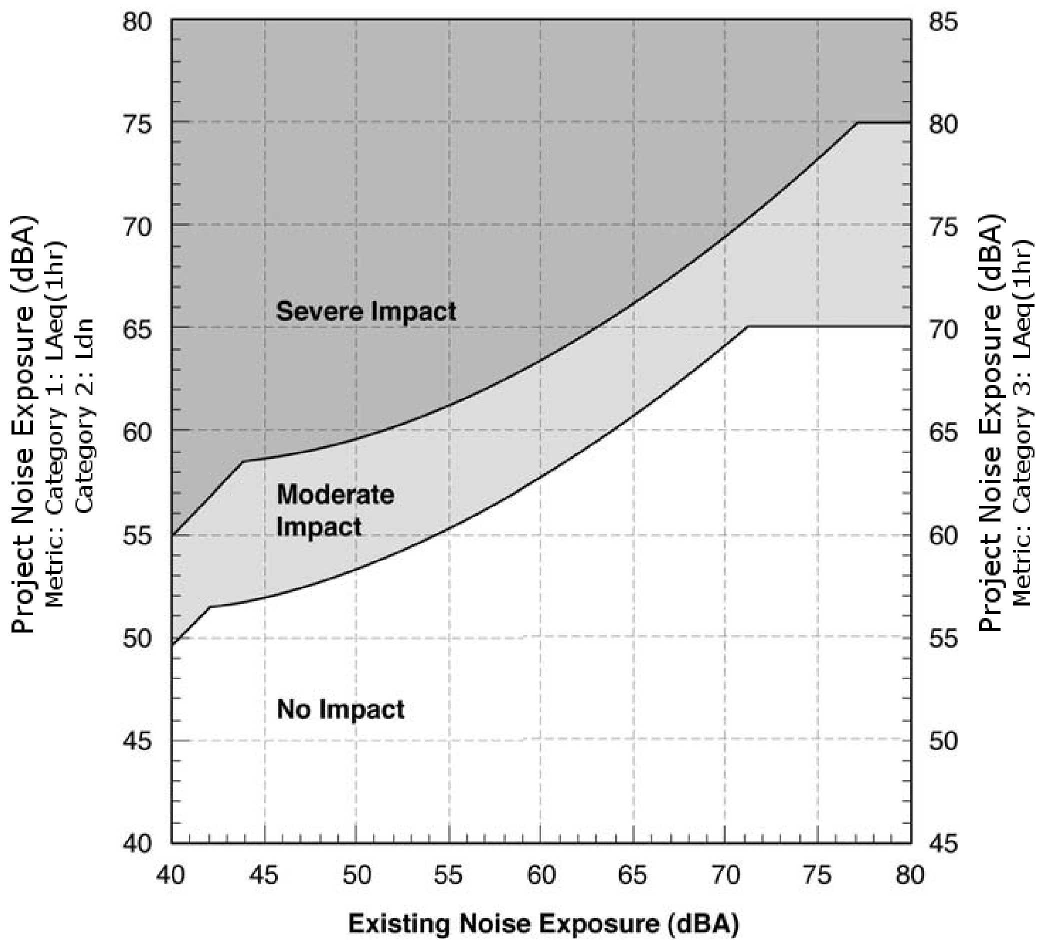
Source: FRA, *High-Speed Ground Transportation Noise and Vibration Impact Assessment*, Final Report DOT/FRA/ORD-12/15, September 2012

[a] 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 on **Figure 3.4-3**. As shown on 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 on **Figure 3.4-3**:

- **No Impact:** In this range, the Project would have no impact since the introduction of the Project 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 on **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 on **Figure 3.4-3**, changes in the noise due to the Project 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.

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 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."

To supplement the noise impact criteria in **Figure 3.4-3**, FRA[10] 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 trainsets. This effect is separate from the impact criteria defined above and is dependent on the trainset speed and trainset and would be confined to an area very close to the tracks. For example, the FRA guidelines indicate that 200 mph trainset operations would have the potential for increased annoyance within about 45 feet of the track centerline. Thus, the area where rapid onset rates of trainset noise may cause startle would typically be within the ROW limits of the rail corridor.

[10] FRA, *High-Speed Ground Transportation Noise and Vibration Impact Assessment*, Final Report DOT/FRA/ORD-12/15, September 2012.

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 (SEL)[11] of 100 dBA from passing trainsets, as shown in **Table 3.4-4**.

Table 3.4-4: FRA Interim Criteria for Trainset 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.[12] The criteria for a general vibration assessment are based on land use and trainset 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.

Table 3.4-5: Ground-Borne Vibration and Noise Impact Criteria

Land Use Category	Ground-Borne Vibration Impact Level (VdB re 1 micro-inch/sec)			Ground-Borne Noise Impact Level (dBA re 20 micro Pascals)		
	Frequent Events[a]	Occasional Events[b]	Infrequent Events[c]	Frequent Events[a]	Occasional Events[b]	Infrequent Events[c]
Category 1: Buildings where vibration would interfere with interior operations	65 VdB[d]	65 VdB[d]	65 VdB[d]	N/A[e]	N/A[e]	N/A[e]
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

[a] *Frequent Events* is defined as more than 70 vibration events of the same kind per day.

[b] *Occasional Events* is defined as between 30 and 70 vibration events of the same kind per day.

[c] Infrequent Events is defined as fewer than 30 vibration events of the same kind per day.

[d] 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.

[e] Vibration-sensitive equipment is generally not sensitive to ground-borne noise.

[11] The SEL describes a receiver's cumulative noise exposure from a single noise event (a passing trainset in this case). It is represented by the total A-weighted sound energy during the event, normalized to a 1-second interval.

[12] FRA, *High-Speed Ground Transportation Noise and Vibration Impact Assessment*, Final Report DOT/FRA/ORD-12/15, September 2012.

Table 3.4-6: Ground-Borne Vibration and Noise Impact Criteria for Special Buildings

Type of Building or Room	Ground-Borne Vibration Impact Level (VdB re 1 micro-inch/sec)		Ground-Borne Noise Impact Level (dBA re 20 micro-Pascals)	
	Frequent Events[a]	Occasional or Infrequent Events[b]	Frequent Events[a]	Occasional or Infrequent Events[b]
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.

[a] *Frequent Events* is defined as more than 70 vibration events per day.

[b] *Occasional or Infrequent Events* is defined as fewer than 70 vibration events per day.

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 aboveground (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.

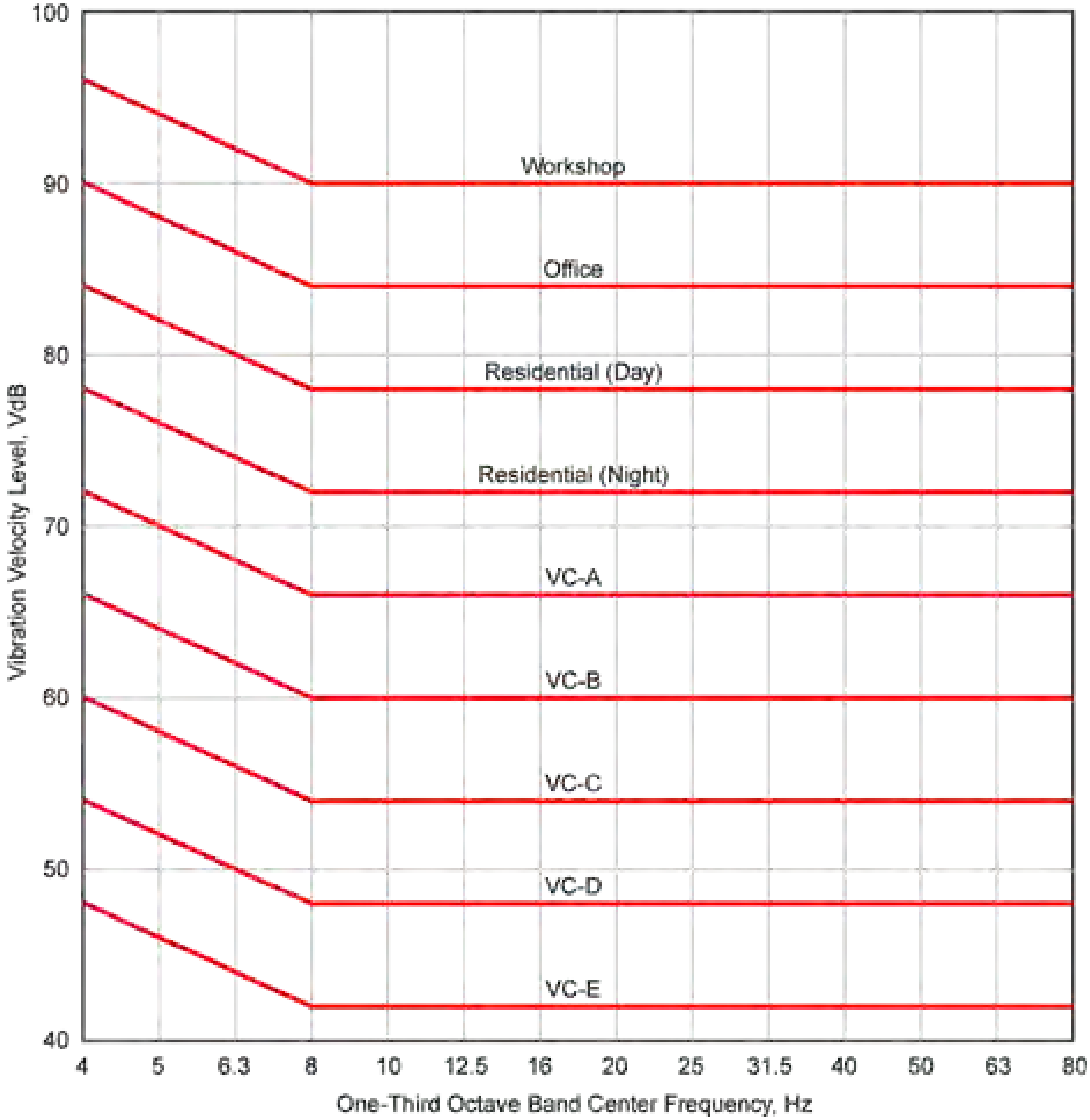
For a detailed vibration analysis, more refined impact criteria are required than for a general assessment. A frequency distribution, or spectrum, of the vibration energy determines whether the vibrations are likely to generate a significant response in a building or structure. Therefore, the criteria 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.[13,14] 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 on **Figure 3.4-4** and descriptions of the curves are shown in **Table 3.4-7**. The curves on **Figure 3.4-4** were applied to the projected vibration spectrum for the Project. If the entire proposed vibration spectrum of the Project would be below the curve, there would be no impact.

[13] 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.

[14] Institute of Environmental Sciences and Technology, "Considerations in Clean Room Design," RR-CC012.1, 1993.

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

Table 3.4-7: Interpretation of Vibration Criteria for Detailed Analysis

Criterion Curve (See Figure 3.4-8)	Max Lv (VdB)[a]	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

[a] 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 Project 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 initially conducted in January 2016 to characterize the existing conditions along the Project. Because some alignment modifications occurred after those measurements were carried out (see **Section 2.5.4, Alternatives Considered, Engineering Refinements**), additional noise measurements were conducted in May 2017 to account for the major new alignment modification in the area just south of Dallas. All the other alignment modifications were relatively small compared to the overall alignment. In the rural areas (outside of Houston and Dallas and their suburbs) the existing noise measurement locations are approximately 8 miles apart, and except for the area just south of Dallas, the modified alignments are approximately 0.6 to 1.2 miles from the original alignments, which is well within the range targeted for the existing measurements. Furthermore, in the rural areas near the modified alignments, no significant sources of existing noise would require additional measurements to characterize the noise environment for those new alignments.

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 (LT) noise monitoring sites and 19 short-term (ST) noise monitoring sites within the Study Area. As previously described, the results of the existing noise measurements at the representative locations in **Table 3.4-8** are sufficient to characterize the existing noise levels at all noise-sensitive locations within the Study Area along the original and modified alternative segments.

Table 3.4-8: Summary of Existing Noise Measurements								
Site No.	Measurement Location	County	Segment	Measurement Start		Measurement Duration (hour)	Noise Level (dBA)	
				Date	Time		Leq	Ldn
LT-1	4019-4099 Bulova Street, Dallas (Residences)	Dallas	1	1/21/2016	14:00	24	75	72
LT-1A	5125 Cleveland Road, Dallas (Residences)	Dallas	1	5/11/2017	11:20	3[a]	50	53
LT-1B	1345 East Belt Line Road, Lancaster (Residences)	Dallas	1	5/12/2017	2:49	3 [a]	68	70
LT-1C	1786 Nail Drive, Lancaster (Residences)	Dallas	1	5/11/2017	14:00	3 [a]	44	45
LT-2	911 FM 813, Palmer (Residence)	Ellis	2A	1/21/2016	9:09	24	62	55
LT-3	508 Old Waxahachie Road, Waxahachie (Residence)	Ellis	2A	1/20/2016	16:00	24	58	53
LT-4	NW CR 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	North Freeway Service Road, 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 Road, Marquez (Residence)	Leon	4	1/18/2016	11:00	24	53	42
LT-11	North Freeway Service Road, 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 West Feeder Road (Residence)	Leon	3C	1/18/2016	16:00	24	53	55
LT-14	7652 Greenbriar Road (Residence)	Madison	3C	1/18/2016	13:00	24	63	65
LT-15	1977 Poteet Road (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[b]
LT-20	21512 Binford Road (Residence)	Harris	5	1/22/2016	10:56	24	49	51 [b]
LT-21	1218 Canyon Arbor Way (Residence)	Harris	5	1/20/2016	19:00	24	67	69 [b]
LT-22	14812 Hempstead Road (Residence)	Harris	5	1/19/2016	21:00	24	44	46 [b]
LT-23	11217 Todd Street, Houston (Residence)	Harris	5	1/21/2016	14:00	24	47	49
ST-1	1213 Coleman Avenue, Dallas (Residence)	Dallas	1	1/22/2016	11:40	1	63	61
ST-2	4412 Kolloch Drive, Dallas (Residence)	Dallas	1	1/21/2016	15:00	1	62	60
ST-3	6350 J. J. Lemmon Road, Dallas (College Park Baptist Church)	Dallas	1	1/21/2016	17:10	1	54	52

Table 3.4-8: Summary of Existing Noise Measurements

Site No.	Measurement Location	County	Segment	Measurement Start		Measurement Duration (hour)	Noise Level (dBA)	
				Date	Time		Leq	Ldn
ST-4	2607 Ferris Road, Lancaster (Residence)	Ellis	2A	1/22/2016	10:00	1	52	50
ST-5	369 Farmer Road, 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	North Freeway Service Road & CR 1090, Streetman (Residential Area)	Freestone	3C	1/19/2016	16:00	1	54	52
ST-9	Old Mexia-Fairfield Road, 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	North Freeway Service Road & CR 306, Buffalo (Parcel Adjacent to Several Hotels)	Leon	3C	1/18/2016	17:00	1	68	66
ST-12	20559 IH-45 Frontage Road (Residence)	Leon	3C	1/19/2016	9:06	1	61	59
ST-13	5192 Dawkins Road (Residence)	Madison	4	1/19/2016	11:12	1	54	52
ST-14	3159 Clark Road (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 Road (Residence)	Waller	5	1/21/2016	9:11	1	47	45
ST-18	6734 Limestone Street (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

[a] Due to limited access, three 1-hour measurements were made at these sites. The Ldn was estimated using methods contained in the FRA guidance manual.

[b] 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.

Figure 3.4-5: Existing Noise Measurement Locations (Sheet 1 of 4)

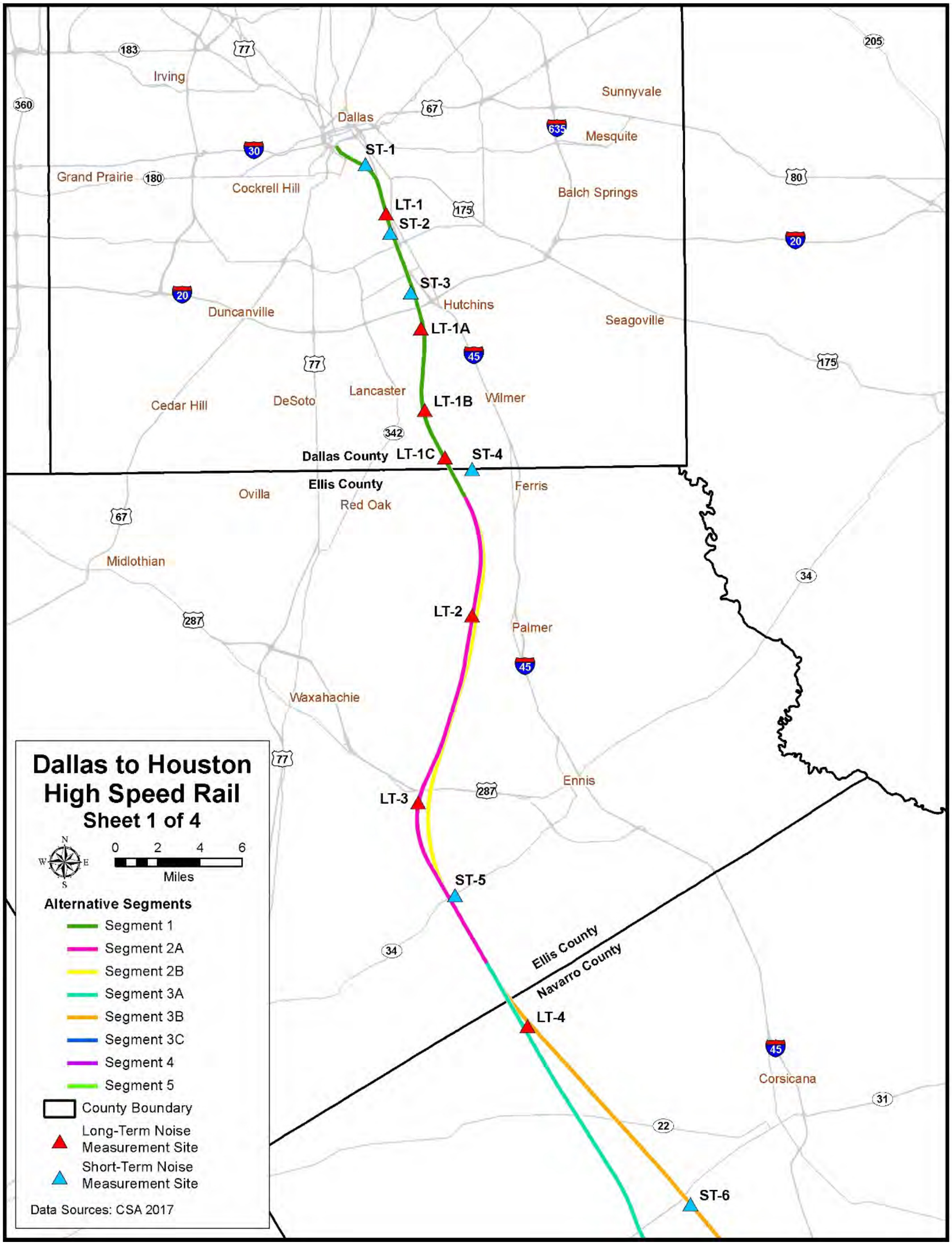


Figure 3.4-6: Existing Noise Measurement Locations (Sheet 2 of 4)

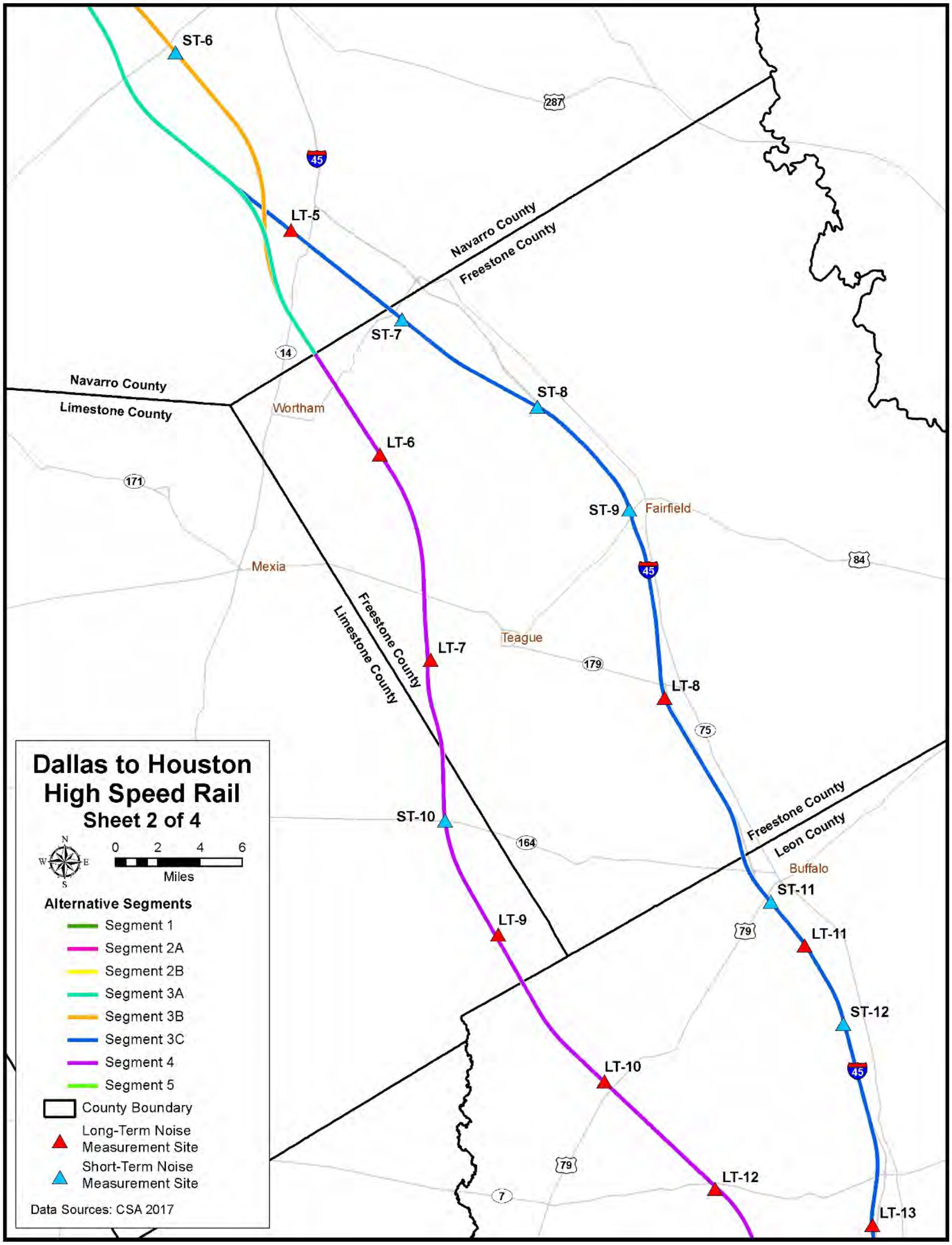


Figure 3.4-7: Existing Noise Measurement Locations (Sheet 3 of 4)

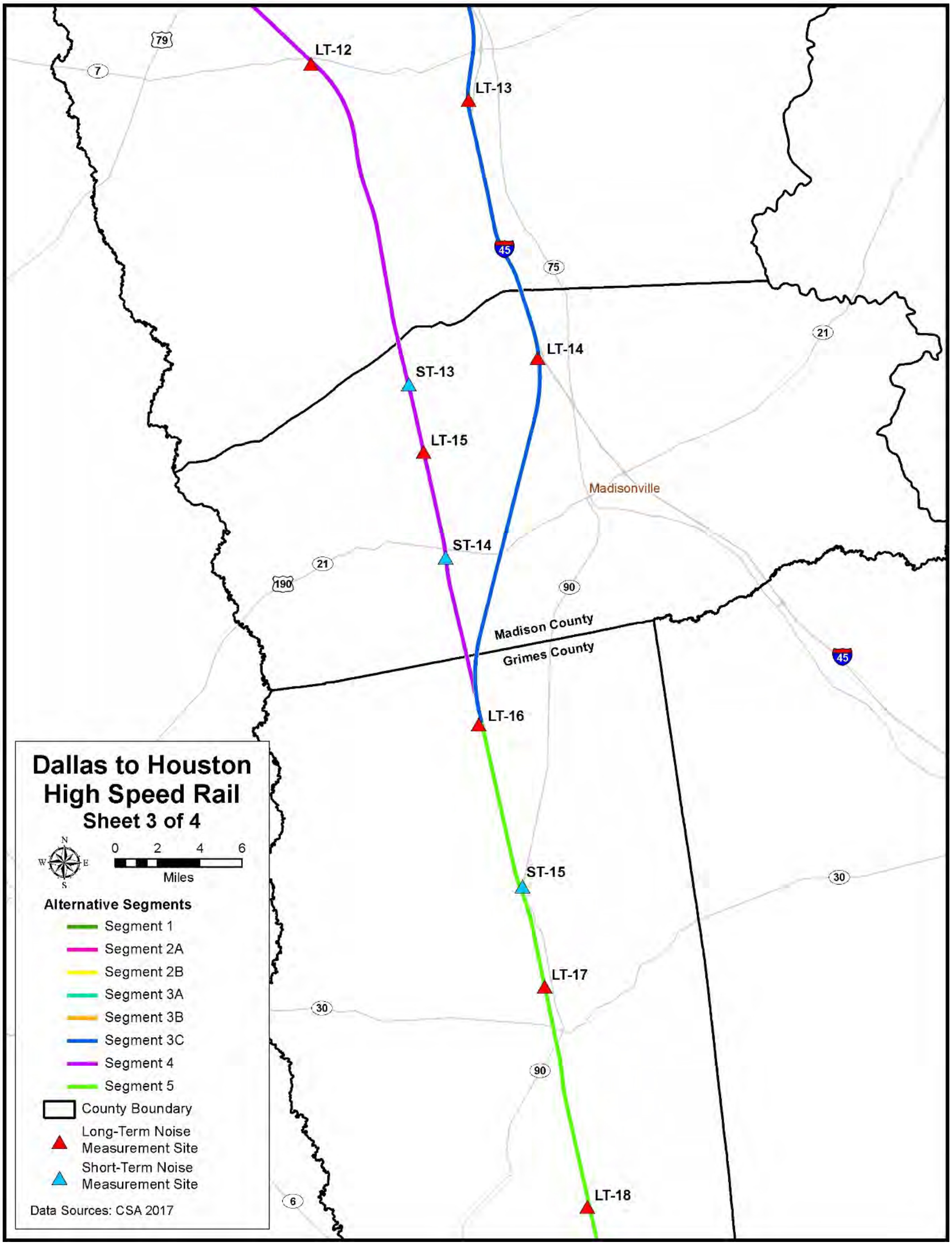
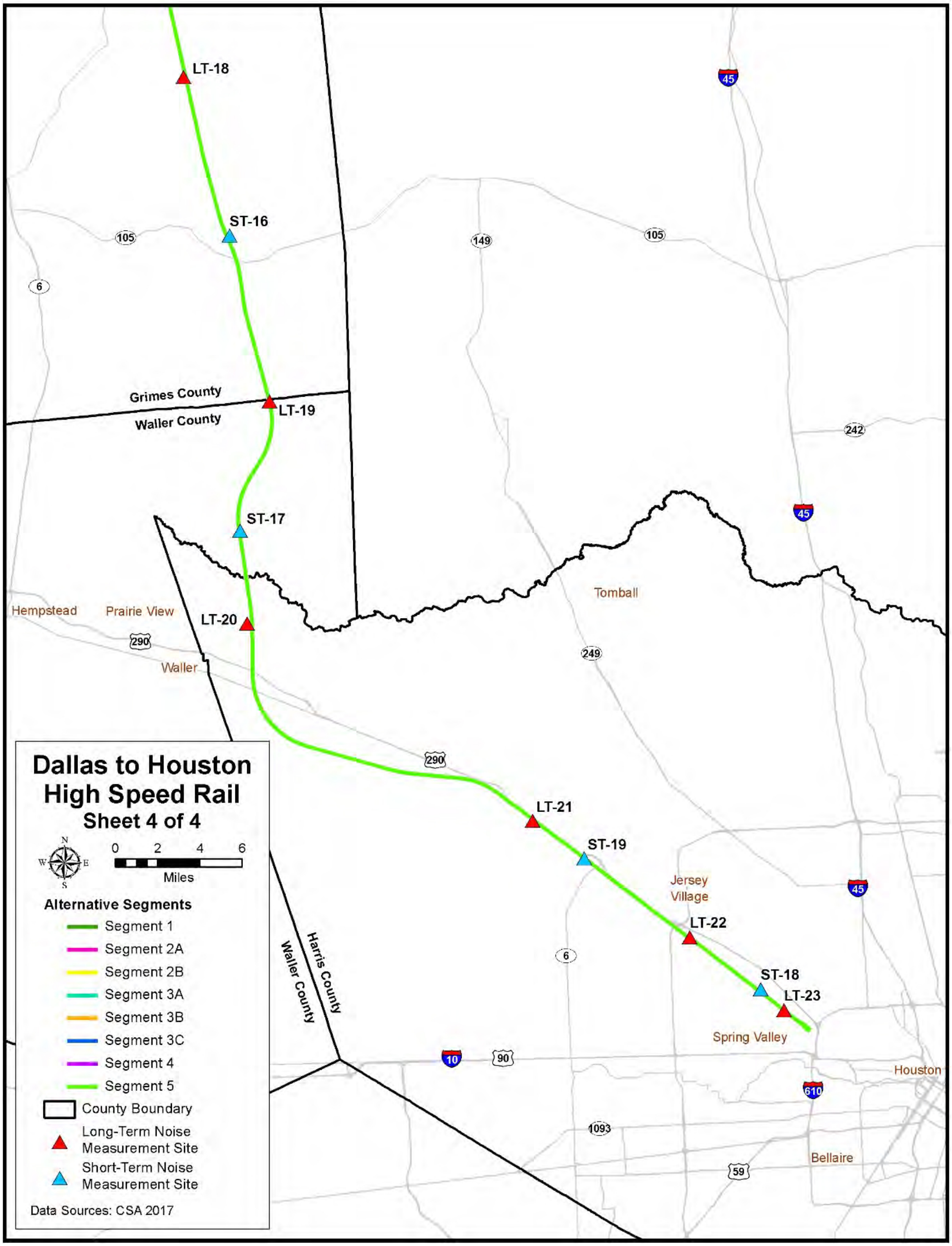


Figure 3.4-8: Existing Noise Measurement Locations (Sheet 4 of 4)



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 **Figure 3.4-9** through **Figure 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	Segment	Date
V-1	4360 Kolloch Drive, Dallas (Church)	Dallas	1	1/18/2016
V-2	103 Coffee Road	Ellis	2A, 2B	1/18/2016
V-3	710 FM 2100	Navarro	3A, 3B, 3C	1/19/2016
V-4	North Freeway Service Road, 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 Road (Residential Parcel)	Madison	3C	1/20/2016
V-8	10063 CR 311 (Residence)	Grimes	5	1/21/2016
V-9	Plantation Drive, Todd Mission	Waller	5	1/21/2016
V-10	Josey Ranch Road, Houston	Harris	5	1/22/2016
V-11	21610 US 290 Frontage Road, Houston	Harris	5	1/22/2016

Source: Cross-Spectrum Acoustics 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 in the following sections 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 Road 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 Project 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 farmland with scattered single-family residences within the Study Area.

Figure 3.4-9: Vibration Propagation Measurement Locations (Sheet 1 of 4)

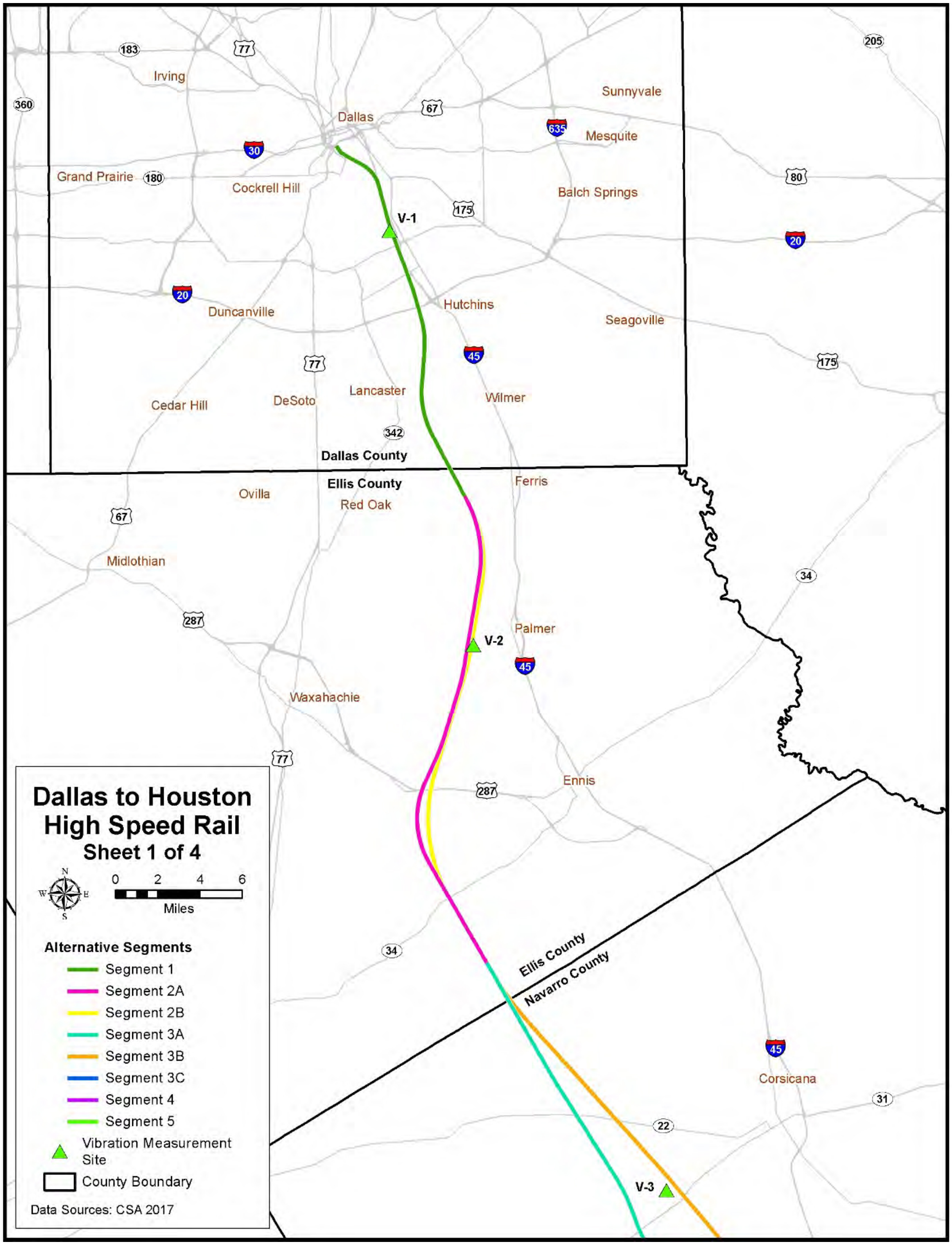


Figure 3.4-10: Vibration Propagation Measurement Locations (Sheet 2 of 4)

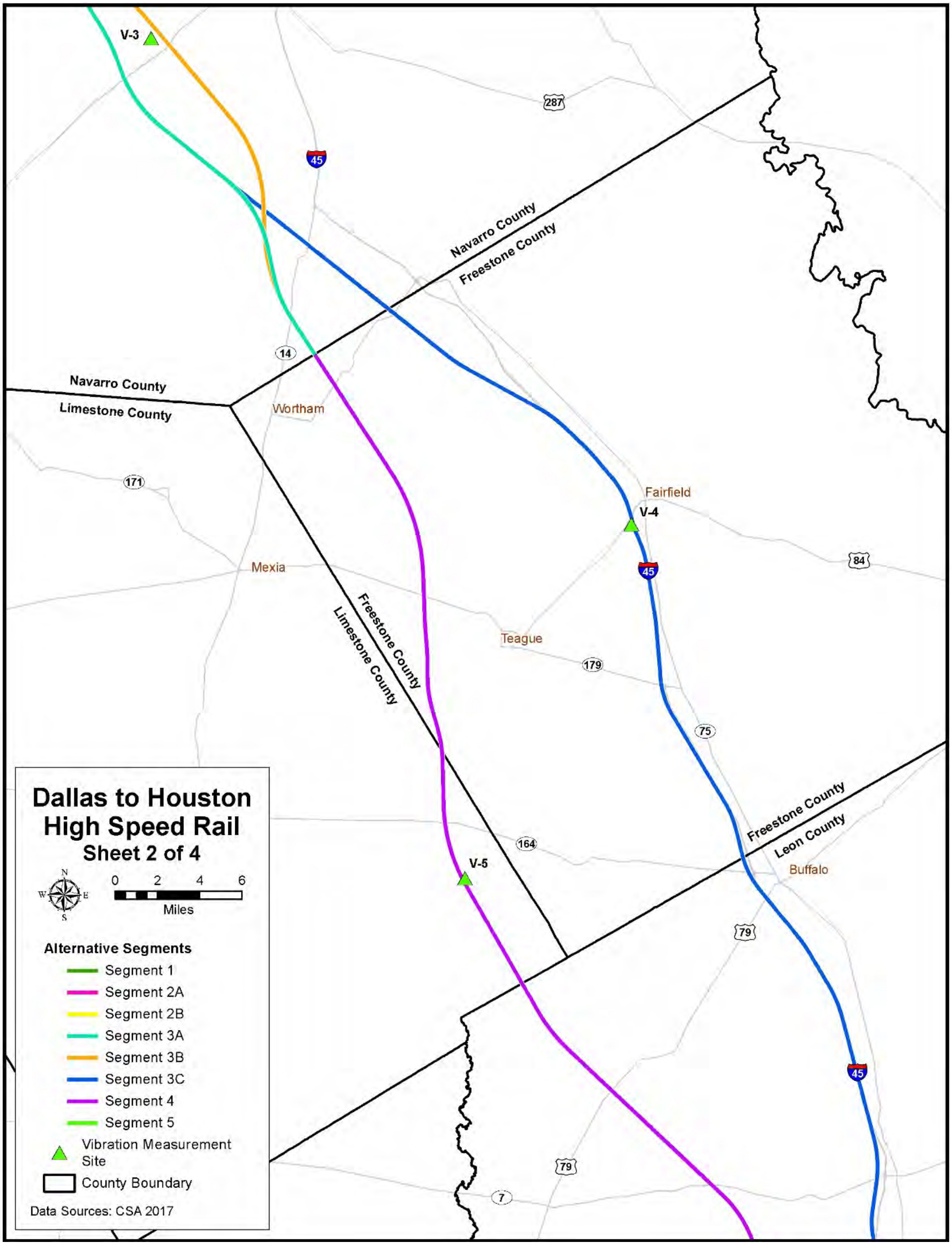


Figure 3.4-11: Vibration Propagation Measurement Locations (Sheet 3 of 4)

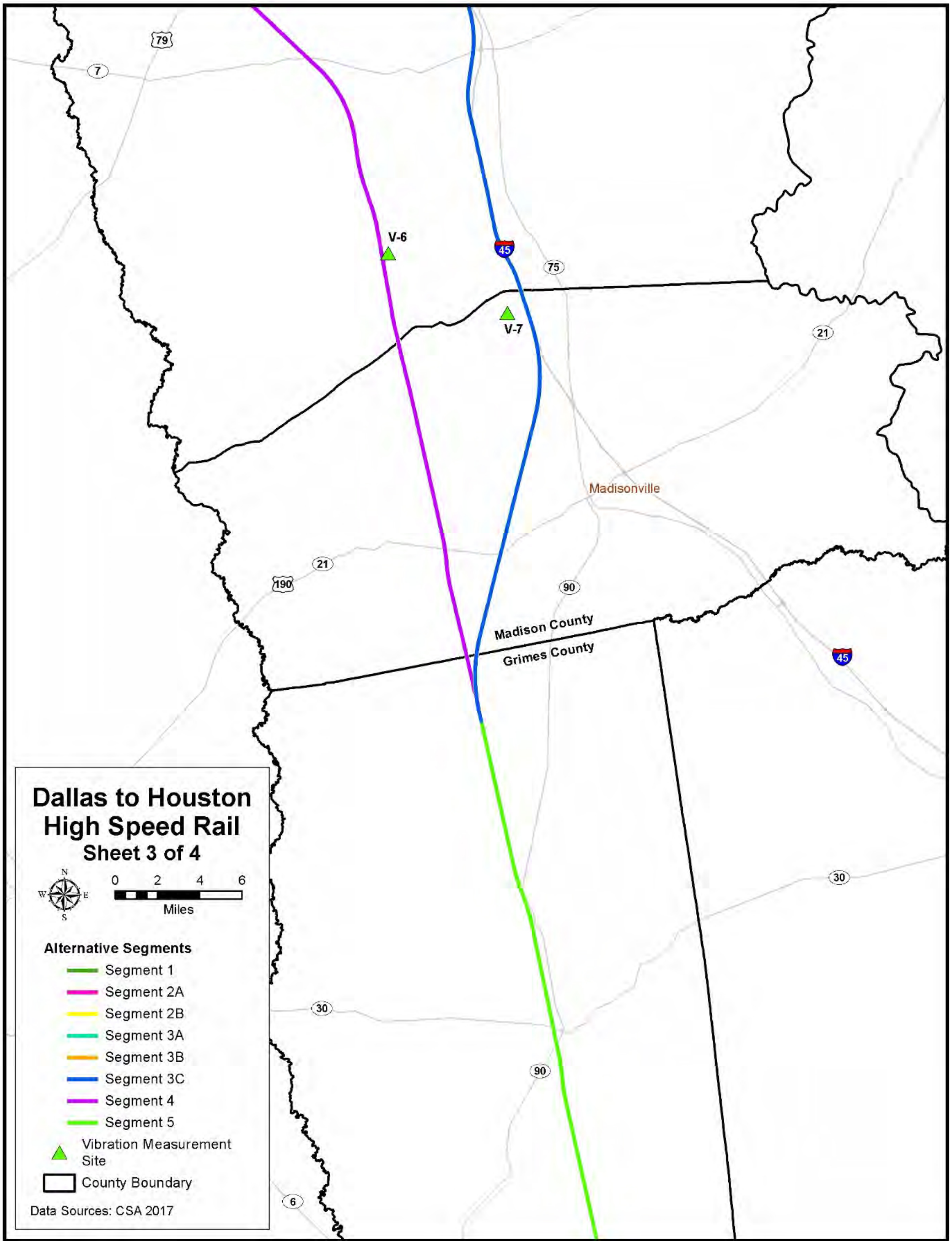
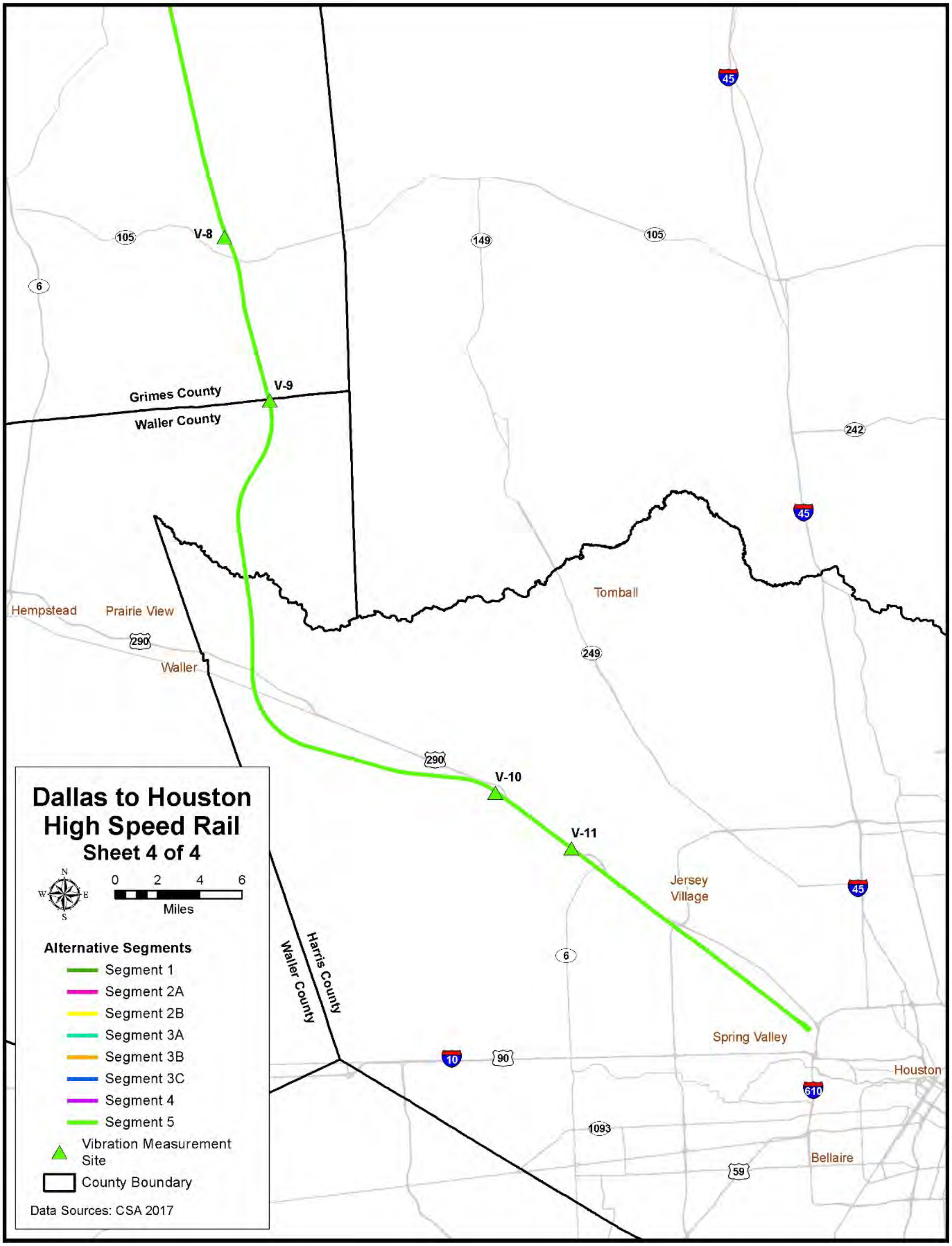


Figure 3.4-12: Vibration Propagation Measurement Locations (Sheet 4 of 4)



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 Road, 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 1-hour periods throughout the day along Cleveland Road in front of the property.

Site LT-1B: 1345 East Beltline Road, Lancaster. The Ldn measured at this location was 70 dBA. The dominant noise source was traffic on East Beltline Road. Noise levels were measured during three separate 1-hour periods throughout the day along East Beltline Road 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 1-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 1 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 1 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 1 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 was 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 farmland with scattered single-family residences.

3.4.4.2.1 Noise Measurements (Segments 2A and 2B)

Site LT-2: Farm to Market (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 1 hour in the field behind the residence.

Site ST-5: 369 Farmer Road, Ennis. The Leq measured at this location was 62 dBA. The dominant noise source was traffic on Route 34. Noise levels were measured for 1 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 Segments 3A, 3B, 3C and 4 in Navarro County is typically rural farmland with scattered single-family residences.

3.4.4.3.1 Noise Measurements (Segment 3A)

Site LT-4: NW County Road (CR) 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 1 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 farmland 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 farmland 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 farmland and oil fields with scattered single-family residences.

3.4.4.4.1 Noise Measurements (Segment 3C)

Site LT-8: North Freeway 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 CR 1041, Wortham. The Leq measured at this location was 31 dBA. The dominant noise source was distant wildlife. Noise levels were measured for 1 hour on the side of the road within the public ROW.

Site ST-8: North Freeway Service Road at CR 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 1 hour on the side of the road within the public ROW.

Site ST-9: North 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 1 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 farmland/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 CR 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 1 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: North 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: North Freeway Service Road at CR 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 1 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 1 hour.

3.4.4.6.2 Vibration Measurements (Segment 3C)

Site V-7: 10290 Greenbriar Road. The vibration propagation measurement was conducted along Greenbriar Road 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 1 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 1 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 1 hour.

Site ST-16: CR 341, Plantersville. The measured Leq at this location was 50 dBA. The dominant noise source was local traffic from CR 341. Noise levels were measured at the back of the property near a shed for a period of 1 hour.

3.4.4.8.4 Vibration Measurements (Segment 5)

Site V-8: 10063 CR 311. The vibration propagation measurement was conducted along CR 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 State Highway (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 1 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 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 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 Union Pacific Railroad (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 UPRR 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 1 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 1 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

In the No Build Alternative, the Project would not be constructed or operated, and no new short-term or long-term noise or vibration impacts would occur. Existing trends affecting noise and vibration would be expected to continue without the contribution of Project. The existing noise and vibration sources throughout the Study Area, which include highways and freight trains, would continue to generate noise and vibration. Existing 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 such as the Waxahachie Line rail project in Dallas and Ellis Counties. The impacts of planned projects are discussed in **Section 4.4, Indirect and Cumulative Impacts, Cumulative 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 were 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 200 feet from nighttime construction. The numbers of residences within 200 feet of the LOD where there is the potential for construction noise impact are included in **Table 3.13-7**.

Table 3.4-10: Construction Noise Impact Screening Distances for Residences			
Construction Activity	1-Hour 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	200[a]
Utility Relocations	88	40	125
Trackwork	88	40	125
Stations	102	200	200[a]
MOW Facilities	102	200	200[a]
Trainset Maintenance	102	200	200[a]

Source: Cross-Spectrum Acoustics 2019

[a] This screening distance accounts for the prohibition of pile driving during nighttime hours as specified in **NV-MM#2: Construction Noise Control Plan**.

During construction, some activities may cause perceptible ground-borne vibration, most notably pile driving for structures and vibratory compaction for ground improvements. Where these activities occur within 50 feet of underground utilities, TCRR would coordinate with the utilities to identify where relocation and/or encasement of pipelines would be needed to avoid vibration damage from nearby construction and compensate the utilities for such work. Potential vibration impacts other than those from pile driving and vibratory compaction within 50 feet of structures would be limited to annoyance effects 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. The numbers of residences within 290 feet of the LOD where there is the potential for construction vibration impact are included in **Table 3.4-12**.

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

Table 3.4-12: Residential Structures within 290 Feet of LOD		
County	**Segment**	**No. of Residential Structures**
Dallas, Ellis	Segment 1	135
Ellis	Segment 2A	51
Ellis	Segment 2B	96
Ellis, Navarro	Segment 3A	22
Ellis, Navarro	Segment 3B	91
Ellis, Navarro, Freestone, Leon, Madison, Grimes	Segment 3C	132
Limestone, Leon, Madison, Grimes	Segment 4	88
Grimes, Waller, Harris	Segment 5	618
Houston Terminal Station Options	Industrial Site	78
	Northwest Mall	0
	Northwest Transit Center	29

Source: Cross-Spectrum Acoustics 2020

Descriptions of the types of equipment that would be used for each construction activity are included in **Appendix E, Noise and Vibration Technical Memorandum,** and potential mitigation measures for construction are included in **Section 3.4.6.1, Compliance Measures,** and in **Section 3.4.6.2, Mitigation Measures**.

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 trainset operations (addressed in the following sections), sources of potential operational noise impacts in the vicinity of stations includes automobile 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 two proposed TMF sites and five MOW sites along each Build Alternative. For the MOW sites, FTA guidance (Chapter 3 of the FTA Guidance Manual)[15] 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 an 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 3.4-13** for FRA Category 2 (residential) land use and in **Table 3.4-14** for FRA 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 Project. The Project Noise Level (not future noise) is the calculation of the noise due to the implementation of the Project – 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.

[15] FTA, *Transit Noise and Vibration Impact Assessment Manual*, FTA Report No. 0123, September 2018.

Table 3.4-13: Summary of Operational Noise Impacts for Residential Land Uses[a]

County/ Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Existing Noise Level (Ldn)	Project Noise Level – 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	225-415	72	53-57	65	71	0	0	--	--	--
				53		54	60	0	0			--
Dallas (1)	Dallas Station to IH-20	SB	348-1001	72	48-54	65	71	0	0	--	--	--
				53		54	60	0	0			--
Dallas (1)	IH-20 to Bluff Springs Road	NB	300-793	53	47-54	54	60	0	0	Single-Family Residences	Operations and Low Existing Noise Levels	--
				70		64	69	0	0			--
				45		52	59	3	0			10-11
Dallas (1)	IH-20 to Bluff Springs Road	SB	223-970	53	46-55	54	60	0	0	Single-Family Residences	Operations and Low Existing Noise Levels	--
				70		64	69	0	0			--
				45		52	59	1	0			11
Ellis (1)	IH-20 to Bluff Springs Road	NB	183-910	45	48-59	52	59	8	0	Single-Family Residences	Operations and Low Existing Noise Levels	11-12
Ellis (1)	IH-20 to Bluff Springs Road	SB	122-914	45	48-61	52	59	10	2	Single-Family Residences	Operations and Low Existing Noise Levels	11-12
Ellis (2A)	Bluff Springs Road to FM 813	NB	176-982	45	46-59	52	59	0	1	Single-Family Residences	Operations and Low Existing Noise Levels	14
				55		55	61	0	0			--
Ellis (2A)	Bluff Springs Road to FM 813	SB	199-777	45	49-58	52	59	2	0	Single-Family Residences	Operations and Low Existing Noise Levels	14-15
				55		55	61	2	0			14-15
Ellis (2A)	FM 813 to TX 287	NB	824-896	55	49	55	61	0	0	--	--	--
				53		55	61	0	0			--
Ellis (2A)	FM 813 to TX 287	SB	163-989	55	47-60	55	61	2	0	Single-Family Residences	Operations and Low Existing Noise Levels	18
				53		55	61	0	0			--
Ellis (2A)	TX 287 to TX 34	NB	712-908	53	47-50	55	61	0	0	--	--	--
				52		54	60	0	0	--	--	--
Ellis (2A)	TX 287 to TX 34	SB	289-957	53	46-56	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	947	53	46	55	61	0	0	--	--	--
				36		50	55	0	0			--
Ellis (2A)	TX 34 to TX 22	SB	No noise sensitive receivers.							--	--	--
Ellis (2B)	Bluff Springs Road to FM 813	NB	338-988	55	46-55	55	61	0	0	Single-Family Residences	Operations and Low Existing Noise Levels	--
				45		52	59	2	0			29
Ellis (2B)	Bluff Springs Road to FM 813	SB	325-901	55	49-55	55	61	0	0	Single-Family Residences	Operations and Low Existing Noise Levels	--
				45		52	59	1	0			30
Ellis (2B)	FM 813 to TX 287	NB	154-947	55	48-60	55	61	2	0	Single-Family Residences	Operations and Low Existing Noise Levels	33
				53		55	61	0	0			--
Ellis(2B)	FM 813 to TX 287	SB	660	55	49	55	61	0	0	--	--	--
				53		55	61	0	0	--	--	--
Ellis (2B)	TX 287 to TX 34	NB	183-757	53	50-59	55	61	4	0	Single-Family Residences	Operations and Low Existing Noise Levels	39-40
				60		58	63	0	0			--
Ellis (2B)	TX 287 to TX 34	SB	191-945	53	48-59	55	61	3	0	Single-Family Residences	Operations and Low Existing Noise Levels	38-40
				60		58	63	0	0			--
Ellis (2B)	TX 34 to TX 22	NB	947	53	46	55	61	0	0	--	--	--
Ellis (2B)	TX 34 to TX 22	SB	No noise sensitive receptors.							--	--	--
Ellis (3A)	TX 34 to TX 22	NB	No noise sensitive receptors.							--	--	--
Ellis (3A)	TX 34 to TX 22	SB	No noise sensitive receptors.							--	--	--
Ellis (3B)	TX 34 to TX 22	NB	857	36	49	50	55	0	0	--	--	--
Ellis (3B)	TX 34 to TX 22	SB	No noise sensitive receptors.							--	--	--
Ellis (3C)	TX 34 to TX 22	NB	No noise sensitive receptors.							--	--	--
Ellis (3C)	TX 34 to TX 22	SB	No noise sensitive receptors.							--	--	--

Source: Cross-Spectrum Acoustics 2019

[a] The maximum speed was assumed throughout the corridor (205 mph).

[b] 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 Residential Land Uses[a]

County/ Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Existing Noise Level (Ldn)	Project Noise Level – Ldn (dBA)			Number and Type of Impacts				Mapbook Page
					HSR	FRA Criteria						
						Mod.	Sev.	Mod.	Sev.	Impact Type	Reason	
Navarro (3A)	TX 34 to TX 22	NB	665-982	36	47-49	50	55	0	0	--	--	--
Navarro (3A)	TX 34 to TX 22	SB	908-958	36	47-48	50	55	0	0	--	--	--
Navarro (3A)	TX 22 to TX 31	NB	294-637	39	48-54	50	55	2	0	Single-Family Residences	Operations and Low Existing Noise Levels	51
				36		50	55	0	0			--
Navarro (3A)	TX 22 to TX 31	SB	237-873	39	48-55	50	55	2	0	Single-Family Residences	Operations and Low Existing Noise Levels	51
				36		50	55	0	0			--
Navarro (3A)	TX 31 to FM 3194	NB	No noise sensitive receptors.							--	--	--
Navarro (3A)	TX 31 to FM 3194	SB	430	46	53	52	59	1	0	Single-Family Residences	Operations and Low Existing Noise Levels	52
Navarro (3A)	FM 3194 to Navarro County Line	NB	240	46	58	52	59	1	0	Single-Family Residences	Operations and Low Existing Noise Levels	58
Navarro (3A)	FM 3194 to Navarro County Line	SB	889	46	47	52	59	0	0	--	--	--
Navarro (3B)	TX 34 to TX 22	NB	794-848	36	48-49	50	55	0	0	--	--	--
Navarro (3B)	TX 34 to TX 22	SB	175-976	36	46-59	50	55	4	1	Single-Family Residences	Operations and Low Existing Noise Levels	64-66
Navarro (3B)	TX 22 to TX 31	NB	261-996	46	48-56	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	49-55	52	59	2	0	Single-Family Residences	Operations and Low Existing Noise Levels	70
Navarro (3B)	TX 31 to Bonner Avenue	NB	340-1001	46	43-54	52	59	1	0	Single-Family Residences	Operations and Low Existing Noise Levels	73
Navarro (3B)	TX 31 to Bonner Avenue	SB	280-1017	46	42-54	52	59	1	0	Single-Family Residences	Operations and Low Existing Noise Levels	70
				39		50	55	4	0			70
Navarro (3B)	Bonner Avenue to Navarro County Line	NB	142-751	46	49-60	52	59	2	1	Single-Family Residence	Operations and Low Existing Noise Levels	73-77
Navarro (3B)	Bonner Avenue to Navarro County Line	SB	398	46	52	52	59	1	0	Single-Family Residences	Operations and Low Existing Noise Levels	77
Navarro (3C)	TX 34 to TX 22	NB	665-982	36	46-49	50	55	0	0	--	--	--
Navarro (3C)	TX 34 to TX 22	SB	908-958	36	47-48	50	55	0	0	--	--	--
Navarro (3C)	TX 22 to TX 31	NB	294-637	36	48-54	50	55	0	0	Single-Family Residences	Operations and Low Existing Noise Levels	--
				39		50	55	2	0			89
Navarro (3C)	TX 22 to TX 31	SB	237-873	39	48-55	50	55	2	0	Single-Family Residences	Operations and Low Existing Noise Levels	89
Navarro (3C)	TX 31 to TX 14	NB	352-1017	46	47-55	52	59	1	0	Single-Family Residences	Operations and Low Existing Noise Levels	94
Navarro (3C)	TX 31 to TX 14	SB	430	46	53	52	59	1	0	Single-Family Residences	Operations and Low Existing Noise Levels	94
Navarro (3C)	TX 14 to Navarro County Line	NB	176-1000	46	46-59	52	59	1	0	Single-Family Residence	Operations and Low Existing Noise Levels	95
Navarro (3C)	TX 14 to Navarro County Line	SB	194-940	46	46-56	52	59	1	0	Single-Family Residence	Operations and Low Existing Noise Levels	96
Freestone (3C)	Navarro County Line to FM 1090	NB	177-885	29	46-59	50	55	3	1	Single-Family Residence	Operations and Low Existing Noise Levels	99-100
Freestone (3C)	Navarro County Line to FM 1090	SB	568-989	29	46-49	50	55	0	0	--	--	--
Freestone (3C)	FM 1090 to US 84	NB	No noise sensitive receivers.							--	--	--
Freestone (3C)	FM 1090 to US 84	SB	257-511	52	50-56	54	60	2	0	Single-Family Residences	Operations and Low Existing Noise Levels	103-104
				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	366-452	50	51-52	53	60	0	0	--	--	--
				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	306-905	42	46-54	52	57	1	0	Single-Family Residences	Operations and Low Existing Noise Levels	160
				43		52	58	1	0			156
Freestone (4)	Navarro County Line to FM 930	SB	739	43	50	52	58	0	0	--	--	--
Freestone (4)	FM 930 to Freestone County Line	NB	812-989	42	47-49	52	57	0	0	--	--	--
Freestone (4)	FM 930 to Freestone County Line	SB	166-993	42	48-59	52	57	4	1	Single-Family Residences	Operations and Low Existing Noise Levels	160-163
Limestone (4)	Limestone County	NB	345-862	48	49-53	53	59	1	0	Single-Family Residences	Operations and Low Existing Noise Levels	173
Limestone (4)	Limestone County	SB	452-832	48	49-53	53	59	0	0	--	--	--
Leon (3C)	Freestone County Line to CR 3051	NB	No noise sensitive receivers.							--	--	--

Source: Cross-Spectrum Acoustics 2019

[a] The maximum speed was assumed throughout the corridor (205 mph).

[b] 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 Residential Land Uses[a]

County/ Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Existing Noise Level (Ldn)	Project Noise Level – Ldn (dBA)			Number and Type of Impacts				Mapbook Page
					HSR	FRA Criteria						
						Mod.	Sev.	Mod.	Sev.	Impact Type	Reason	
Leon (3C)	Freestone County Line to CR 3051	SB	322-503	55	50-55	55	61	0	0	--	--	--
Leon (3C)	CR 3051 to TX 7	NB	221-333	55	53-55	55	61	1	0	Single-Family Residence	Operations and Low Existing Noise Levels	126
Leon (3C)	CR 3051 to TX 7	SB	271-428	55	51-55	55	61	0	0	--	--	--
Leon (3C)	TX 7 to FM 977	NB	500	55	52	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	48	51	57	0	0	--	--	--
Leon (4)	Limestone County Line to US 79	SB	883	42	46	51	57	0	0	--	--	--
Leon (4)	US 79 to TX 7	NB	296-885	42	46-53	51	57	1	0	Single-Family Residence	Operations and Low Existing Noise Levels	177
Leon (4)	US 79 to TX 7	SB	124-519	42	50-61	51	57	0	0	Single-Family Residence	Operations and Low Existing Noise Levels	--
				62		59	64	1	0			180
Leon (4)	TX 7 to FM 977	NB	439-797	42	47-51	51	57	0	0	--	--	--
				62		59	64	0	0			--
Leon (4)	TX 7 to FM 977	SB	211-843	62	48-58	59	64	0	0	--	--	--
				52		54	60	0	0			--
Leon (4)	FM 977 to FM 2289	NB	243-745	52	49-55	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	46-52	54	60	0	0	--	--	--
Madison (3C)	FM 977 to Waldrip Road	NB	No noise sensitive receivers.							--	--	--
Madison (3C)	FM 977 to Waldrip Road	SB	190-379	65	54-58	61	66	0	0	--	--	--
Madison (3C)	Waldrip Road to FM 1452	NB	338	50	55	53	60	1	0	Single-Family Residence	Operations and Low Existing Noise Levels	144
Madison (3C)	Waldrip Road to FM 1452	SB	532-640	50	50	53	60	0	0	--	--	--
Madison (3C)	FM 1452 to FM 1696	NB	787-970	54	46-49	55	61	0	0	--	--	--
Madison (3C)	FM 1452 to FM 1696	SB	No noise sensitive receptors.							--	--	--
Madison (4)	FM 977 to FM 2289	NB	279-480	52	51-56	54	60	2	0	Single-Family Residence	Operations and Low Existing Noise Levels	190
Madison (4)	FM 977 to FM 2289	SB	338-982	52	46-53	54	60	0	0	--	--	--
Madison (4)	FM 2289 to US 190	NB	353-714	50	48-54	53	60	0	0	--	--	--
				54		55	61	0	0			--
Madison (4)	FM 2289 to US 190	SB	456-693	50	48-53	53	60	0	0	--	--	--
Madison (4)	US 190 to FM 1696	NB	182-909	54	48-59	55	61	2	0	Single-Family Residences	Operations and Low Existing Noise Levels	196-197
Madison (4)	US 190 to FM 1696	SB	436-990	54	46-53	55	61	0	0	--	--	--
Grimes (5)	FM 1696 to FM 39	NB	235-404	47	51-55	52	59	0	0	Single-Family Residences	Operations and Low Existing Noise Levels	--
				49		53	59	1	0			207
Grimes (5)	FM 1696 to FM 39	SB	No noise sensitive receivers.							--	--	--
Grimes (5)	FM 39 to TX 90	NB	313-942	49	46-55	53	59	2	0	Single-Family Residence	Operations and Low Existing Noise Levels	211-212
Grimes (5)	FM 39 to TX 90	SB	225-852	49	49-57	53	59	2	0	Single-Family Residences	Operations and Low Existing Noise Levels	209-211
Grimes (5)	TX 90 to CR 215	NB	207-952	49	43-56	53	59	0	0	--	--	--
Grimes (5)	TX 90 to CR 215	SB	392-798	49	44-52	53	59	0	0	--	--	--
Grimes (5)	CR 215 to TX 105	NB	395-850	48	48-52	53	59	0	0	--	--	--
Grimes (5)	CR 215 to TX 105	SB	414-873	48	46-53	53	59	0	0	--	--	--
Grimes (5)	TX 105 to Grimes County Line	NB	157-972	49	44-60	53	59	7	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	563-992	49	43-49	53	59	0	0	--	--	--
Waller (5)	Waller County	NB	196-994	45	46-58	52	59	3	0	Single-Family Residence	Operations and Low Existing Noise Levels	231-232
				49		53	59	10	0			228
Waller (5)	Waller County	SB	113-1000	45	46-60	52	59	11	1	Single-Family Residence	Operations and Low Existing Noise Levels	231-232
				49		53	59	5	1			228-229
Harris (5)	Harris County Line to Old Highway 290	NB	664-971	51	46-50	54	60	0	0	--	--	--
Harris (5)	Harris County Line to Old Highway 290	SB	238-992	51	46-57	54	60	1	0	Single-Family Residence	Operations and Low Existing Noise Levels	234

Source: Cross-Spectrum Acoustics 2019

[a] The maximum speed was assumed throughout the corridor (205 mph).

[b] 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 Residential Land Uses[a]

County/ Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Existing Noise Level (Ldn)	Project Noise Level – 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 Parkway	NB	147-918	51	48-60	54	60	2	1	Single-Family Residence	Operations and Low Existing Noise Levels	238-240
Harris (5)	Old Hwy 290 to Grand Parkway	SB	210-994	51	48-58	54	60	11	0	Single-Family Residence	Operations and Low Existing Noise Levels	239
Harris (5)	Grand Parkway to TX 6	NB	502	59	52	57	63	0	0	--	--	--
				69		64	69	0	0			--
Harris (5)	Grand Parkway to TX 6	SB	132-520	59	52-61	57	63	3	0	Single- and Multi-Family Residences	Operations	246-247
Harris (5)	Grand Parkway to TX 6	SB		69		64	69	0	0			--
Harris (5)	TX 6 to Blalock Road	NB	340-493	46	52-55	52	59	2	0	Single- and Multi-Family Residences	Operations and Low Existing Noise Levels	247-250
Harris (5)	TX 6 to Blalock Road	SB	No noise sensitive receivers.							--	--	--
Harris (5)	Blalock Road to Houston Station	NB	156-510	55	52-60	55	64	22[b]	0	Single- and Multi-Family Residences	Operations and Low Existing Noise Levels	251-252
Harris (5)	Blalock Road to Houston Station	NB		46		52	59	2[b]	0			251
Harris (5)	Blalock Road to Houston Station	NB		49		53	59	61[b]	2			252-253
Harris (5)	Blalock Road to Houston Station	SB	227-524	55	52-57	55	64	81[b]	0	Single- and Multi-Family Residences	Operations and Low Existing Noise Levels	251-252
Harris (5)	Blalock Road to Houston Station	SB		49		49	56	5[b]	0			252-253

Source: Cross-Spectrum Acoustics 2019

[a] The maximum speed was assumed throughout the corridor (205 mph).

[b] 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 3.4-14: Summary of Operational Noise Impacts for Institutional Land Uses[a]

County/ Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Existing Noise Level Leq (dBA)	Project Noise Level – Leq (dBA) HSR	FRA Criteria Mod.	FRA Criteria Sev.	Number and Type of Impacts Mod.	Sev.	Type	Reason	Mapbook Page
Dallas (1)	Friendship Missionary Baptist Church	SB	311	75	54	70	78	0	0	--	--	4
Dallas (1)	The Church of Revelation	SB	357	75	53	70	78	0	0	--	--	4
Dallas (1)	College Park Baptist Church	SB	670	50	49	58	65	0	0	--	--	6
Dallas (1)	Full Faith Deliverance Church	SB	463	50	52	58	65	0	0	--	--	6
Ellis (2B)	Palmyra Studios	NB	963	62	47	64	70	0	0	--	--	31
Freestone (4)	Furney-Richardson School	NB	837	49	48	58	64	0	0	--	--	162
Grimes (5)	Shiloh Church Cemetery	SB	988	45	47	57	64	0	0	--	--	202
Harris (5)	St. Aidan's Episcopal Church	SB	487	67	51	67	72	0	0	--	--	244
Harris (5)	Fairbanks United Methodist Church	NB	451	44	52	57	64	0	0	--	--	250
Harris (5)	Christian Family Church	NB	177	44	58	57	64	1	0	Church	Operations and Low Existing Noise Levels	250

Source: Cross-Spectrum Acoustics 2019

[a] The maximum speed was assumed throughout the corridor (205 mph).

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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 trainsets 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 trainsets, 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 assessing the effects of noise from passing HSR trainsets on animals, the FRA noise exposure criterion limit is a SEL of 100 dBA. For the HSR trainsets operating at the maximum speed of 205 mph, this limit would only be exceeded within 15 feet from the HSR tracks.[16] 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 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, there would be no noise impact on wildlife.

3.4.5.2.5 Operational Vibration Impacts

As indicated in the tables in the following sections, HSR trainset vibration levels would be well below the thresholds for damage to structures, including underground utilities, which are 90 VdB or greater. Therefore, the vibration impact assessment focused on potential annoyance effects.

Based on a detailed vibration analysis, the assessment of vibration impacts from operations is summarized by county and segment in **Table 3.4-15** for FRA Category 2 (residential) land use and in **Table 3.4-16** for FRA 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 3.4-15** and **Table 3.4-16**, operations would result in no vibration impacts at any residential or institutional locations. Mapbook pages reference where locations are displayed.

[16] The SEL for a passing trainset at a speed of 205 mph is projected to be 90 dBA at a reference distance of 50 feet from the track. Because the SEL is projected to vary in proportion to 15 times the logarithm of distance, corresponding to an increase of 4.5 dB for each halving of distance from the track, the SEL is projected to be 100 dBA at a distance of 10 to 15 feet from the track.

Table 3.4-15: 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 Level (VdB)		Number of Impacts	Mapbook Page
						HSR	FRA Impact Criterion		
Dallas	1	Dallas Station to IH-20	NB	225-415	205	42	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 Road	NB	300-793	205	48	72	0	6-12
Dallas	1	IH-20 to Bluff Springs Road	SB	223-970	205	52	72	0	6-12
Ellis	1	IH-20 to Bluff Springs Road	NB	183-910	205	44	72	0	6-12
Ellis	1	IH-20 to Bluff Springs Road	SB	122-914	205	49	72	0	6-12
Ellis	2A	Bluff Springs Road to FM 813	NB	176-982	205	66	72	0	12-16
Ellis	2A	Bluff Springs Road to FM 813	SB	199-777	205	66	72	0	12-16
Ellis	2A	FM 813 to TX 287	NB	824-896	205	54	72	0	16-22
Ellis	2A	FM 813 to TX 287	SB	163-989	205	67	72	0	16-22
Ellis	2A	TX 287 to TX 34	NB	712-908	205	64	72	0	22-25
Ellis	2A	TX 287 to TX 34	SB	289-957	205	67	72	0	22-25
Ellis	2A	TX 34 to TX 22	NB	947	205	68	72	0	25-27
Ellis	2A	TX 34 to TX 22	SB	No sensitive receivers.					25-27
Ellis	2B	Bluff Springs Road to FM 813	NB	338-988	205	67	72	0	28-32
Ellis	2B	Bluff Springs Road to FM 813	SB	325-901	205	58	72	0	28-32
Ellis	2B	FM 813 to TX 287	NB	154-947	205	66	72	0	32-38
Ellis	2B	FM 813 to TX 287	SB	660	205	65	72	0	32-38
Ellis	2B	TX 287 to TX 34	NB	183-757	205	61	72	0	38-41
Ellis	2B	TX 287 to TX 34	SB	191-945	205	68	72	0	38-41
Ellis	2B	TX 34 to TX 22	NB	947	205	68	72	0	41-43
Ellis	2B	TX 34 to TX 22	SB	No sensitive receivers.					41-43
Ellis	3A	TX 34 to TX 22	NB	No sensitive receivers.					43-44
Ellis	3A	TX 34 to TX 22	SB	No sensitive receivers.					43-44
Ellis	3B	TX 34 to TX 22	NB	No sensitive receivers.					62-63
Ellis	3B	TX 34 to TX 22	SB	857	205	54	72	0	62-63
Ellis	3C	TX 34 to TX 22	NB	No sensitive receivers.					81-82
Ellis	3C	TX 34 to TX 22	SB	No sensitive receivers.					81-82
Navarro	3A	TX 34 to TX 22	NB	665-982	205	64	72	0	43-48
Navarro	3A	TX 34 to TX 22	SB	908-958	205	64	72	0	43-48
Navarro	3A	TX 22 to TX 31	NB	294-637	205	67	72	0	48-52
Navarro	3A	TX 22 to TX 31	SB	237-873	205	68	72	0	48-52
Navarro	3A	TX 31 to FM 3194	NB	No sensitive receivers.					52-57
Navarro	3A	TX 31 to FM 3194	SB	430	205	55	72	0	52-57
Navarro	3A	FM 3194 to Navarro County Line	NB	240	205	58	72	0	57-61
Navarro	3A	FM 3194 to Navarro County Line	SB	889	205	64	72	0	57-61
Navarro	3B	TX 34 to TX 22	NB	794-848	205	64	72	0	63-67

Table 3.4-15: 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 Level (VdB)		Number of Impacts	Mapbook Page
						HSR	FRA Impact Criterion		
Navarro	3B	TX 34 to TX 22	SB	175-976	205	67	72	0	63-67
Navarro	3B	TX 22 to TX 31	NB	261-996	205	58	72	0	67-70
Navarro	3B	TX 22 to TX 31	SB	324-759	205	57	72	0	67-70
Navarro	3B	TX 31 to Bonner Avenue	NB	340-1001	205	66	72	0	70-73
Navarro	3B	TX 31 to Bonner Avenue	SB	280-1017	205	67	72	0	70-73
Navarro	3B	Bonner Avenue to Navarro County Line	NB	142-751	205	61	72	0	73-80
Navarro	3B	Bonner Avenue to Navarro County Line	SB	398	205	66	72	0	73-80
Navarro	3C	TX 34 to TX 22	NB	665-982	205	64	72	0	82-86
Navarro	3C	TX 34 to TX 22	SB	908-958	205	64	72	0	82-86
Navarro	3C	TX 22 to TX 31	NB	294-637	205	67	72	0	86-90
Navarro	3C	TX 22 to TX 31	SB	237-873	205	68	72	0	86-90
Navarro	3C	TX 31 to TX 14	NB	352-1017	205	64	72	0	90-95
Navarro	3C	TX 31 to TX 14	SB	430	205	55	72	0	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	194-940	205	69	72	0	95-97
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.					102-105
Freestone	3C	FM 1090 to US 84	SB	257-511	205	58	72	0	102-105
Freestone	3C	US 84 to TX 179	NB	No sensitive receivers.					105-111
Freestone	3C	US 84 to TX 179	SB	366-452	205	60	72	0	105-111
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	306-905	205	61	72	0	153-160
Freestone	4	Navarro County Line to FM 930	SB	739	205	46	72	0	153-160
Freestone	4	FM 930 to Freestone County Line	NB	812-989	205	55	72	0	160-166
Freestone	4	FM 930 to Freestone County Line	SB	166-993	205	62	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	49	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

Table 3.4-15: 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 Level (VdB)		Number of Impacts	Mapbook Page
						HSR	FRA Impact Criterion		
Leon	3C	CR 3051 to TX 7	NB	221-333	205	72	72	0	121-126
Leon	3C	CR 3051 to TX 7	SB	271-428	205	70	72	0	121-126
Leon	3C	TX 7 to FM 977	NB	500	205	58	72	0	126-136
Leon	3C	TX 7 to FM 977	SB	No sensitive receptors.					126-136
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	205	55	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	124-519	205	68	72	0	177-180
Leon	4	TX 7 to FM 977	NB	439-797	205	69	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	243-745	205	71	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 Road	NB	No sensitive receivers.					136-140
Madison	3C	FM 977 to Waldrip Road	SB	190-379	205	47	72	0	136-140
Madison	3C	Waldrip Road to FM 1452	NB	338	205	34	72	0	140-145
Madison	3C	Waldrip Road to FM 1452	SB	532-640	205	37	72	0	140-145
Madison	3C	FM 1452 to FM 1696	NB	787-970	205	28	72	0	145-152
Madison	3C	FM 1452 to FM 1696	SB	No sensitive receptors.					145-152
Madison	4	FM 977 to FM 2289	NB	279-480	205	61	72	0	189-191
Madison	4	FM 977 to FM 2289	SB	338-982	205	57	72	0	189-191
Madison	4	FM 2289 to US 190	NB	353-714	205	35	72	0	191-196
Madison	4	FM 2289 to US 190	SB	456-693	205	37	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	33	72	0	196-201
Grimes	5	FM 1696 to FM 39	NB	235-404	205	65	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	313-942	205	62	72	0	208-212
Grimes	5	FM 39 to TX 90	SB	225-852	205	60	72	0	208-212
Grimes	5	TX 90 to CR 215	NB	207-952	205	65	72	0	212-218
Grimes	5	TX 90 to CR 215	SB	392-798	205	61	72	0	212-218
Grimes	5	CR 215 to TX 105	NB	395-850	205	61	72	0	218-223
Grimes	5	CR 215 to TX 105	SB	414-873	205	60	72	0	218-223
Grimes	5	TX 105 to Grimes County Line	NB	157-972	205	54	72	0	223-228
Grimes	5	TX 105 to Grimes County Line	SB	563-992	205	55	72	0	223-228
Waller	5	Waller County	NB	196-994	205	50	72	0	228-233
Waller	5	Waller County	SB	113-1000	205	66	72	0	228-233
Harris	5	Harris County Line to Old Highway 290	NB	664-971	205	38	72	0	233-237

Table 3.4-15: 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 Level (VdB)		Number of Impacts	Mapbook Page
						HSR	FRA Impact Criterion		
Harris	5	Harris County Line to Old Highway 290	SB	238-992	205	46	72	0	233-237
Harris	5	Old Highway 290 to Grand Pkwy	NB	147-918	205	55	72	0	237-242
Harris	5	Old Highway 290 to Grand Parkway	SB	210-994	205	52	72	0	237-242
Harris	5	Grand Parkwayto TX 6	NB	502	205	47	72	0	242-247
Harris	5	Grand Parkwayto TX 6	SB	132-520	205	55	72	0	242-247
Harris	5	TX 6 to Blalock Road	NB	340-493	205	50	72	0	247-251
Harris	5	TX 6 to Blalock Road	SB	No sensitive receivers.					247-251
Harris	5	Blalock Road to Houston Station	NB	156-510	205	57	72	0	251-257
Harris	5	Blalock Road to Houston Station	SB	227-524	205	61	72	0	251-257

Source: Cross-Spectrum Acoustics 2019

Table 3.4-16: Summary of Operational Vibration Impacts for Institutional Land Uses

County	Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Speed (mph)	Project Vibration Level (VdB)		Number of Impacts	Mapbook Page
						HSR	FRA Impact Criterion		
Dallas	1	Friendship Missionary Baptist Church	SB	311	205	38	78	0	4
Dallas	1	The Church of Revelation	SB	357	205	37	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	54	65	0	31
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	St. Aidan’s Episcopal Church	SB	487	205	47	78	0	244
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

Source: Cross-Spectrum Acoustics 2019

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 six Build Alternatives, 48 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 (see **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports**).

Other design features include maximizing the use of viaduct to minimize the startle effect on wildlife and livestock. Approximately 55 percent of the Project would be on viaduct. In most places, the height of the viaduct would exceed the minimum distance for startle effect impacts.

Additional design features include the use of 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 4 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 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 is another potential design feature. 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.

During final design, TCRR shall conduct additional noise and vibration assessments of the sensitive receivers. This evaluation shall determine whether 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

TCRR would be required to comply with the following Compliance Measure (CM):

NV-CM#1: Compliance with Local Regulations. TCRR shall complete all construction activities in compliance with the applicable provisions of the local noise and vibration regulations described in **Section 3.4.2, Regulatory Context**. Construction noise and vibration mitigation measures that may be required include, but are not limited to, the following:

- 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 backup alarms, which automatically adjust the alarm level based on the background noise level, or switch off backup 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
- Use moveable sound barriers at the source of the construction activity
- Coordinate with utilities to identify where relocation and/or encasement of pipelines would be needed to avoid vibration damage from nearby construction and compensate the utilities for such work

3.4.6.2 Mitigation Measures

TCRR would be required to implement the following Mitigation Measures (MM):

NV-MM#1: Additional Noise and Vibration Assessments for Operation. During final design, TCRR shall conduct additional noise and vibration assessments for sensitive receivers in accordance with the methodology outlined in **Section 3.4.3, Methodology**. TCRR shall mitigate noise and vibration impacts as defined in **NV-MM#3: Operational Noise Mitigation and Monitoring**. TCRR shall provide FRA a copy of the assessment prior to construction.

NV-MM#2: Construction Noise Control Plan. TCRR shall prepare a detailed Noise Control Plan as part of the overall Construction Management Plan (see **SC-CM#1**: **Emergency Preparedness Plan**). A noise control engineer or acoustician shall prepare the Noise Control Plan to comply with local noise ordinances and to identify TCRR's specific equipment and methods of construction. The plan shall address:

- 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 pile driving and certain other types of equipment and processes during the nighttime hours
- 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 and Monitoring. TCRR shall mitigate noise and vibration impacts to a level below severe, as determined by the updated assessments in **NV-MM#1: Additional Noise and Vibration Assessments for Operation**. Severe noise impacts are defined by FRA guidance criteria as detailed in **Section 3.4.3.2.3, Operational Noise Impact Criteria**. Where TCRR proposes to use sound barriers to mitigate noise impacts, TCRR shall seek input from the impacted landowners and local jurisdictions on barrier types and designs. If TCRR does not implement sound barriers, TCRR shall compensate impacted landowners for the cost of sound insulation treatments for buildings that would reduce the noise impact to a level below severe. The compensation cost shall be site-specific and shall include the cost of labor and materials. As described previously in **Section 3.4.6**, building sound insulation treatments include, but are not limited to, adding an extra layer of glazing to windows, sealing holes in exterior surfaces that act as sound leaks and providing forced ventilation and air conditioning so that windows do not need to be opened.

As described in **Section 3.4.5.2.4, HSR Operational Noise Impacts**, the severe 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.**

In accordance with mitigation monitoring, TCRR shall continue monitoring noise and vibration levels during the operations testing phase of the Project. Should additional operational noise and/or vibration impacts be identified, TCRR shall hold a community noise and vibration mitigation workshop to identify appropriate mitigation.

3.4.7 Build Alternatives Comparison

Table 3.4-17 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 discussed in **Section 3.4.5.2.1, Construction Noise and Vibration Impacts**.

Table 3.4-17: 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	10	12	10	9	11	9
	Institutional	0	0	0	0	0	0
Moderate Noise Impact	Residential	280	290	275	285	295	280
	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 2019

The noise impacts did not vary substantially by Build Alternative. There are slightly fewer severe noise impacts under Build Alternatives D and F. There would be no vibration impacts for Build Alternatives A through F.

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 use, handling and storage are regulated by USDOT and by the Occupational Safety and Health Act of 1970.[1] Solid waste and hazardous waste are regulated by EPA. 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, ensure construction worker safety and minimize 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 (RCRA)[2] was enacted in 1976 and includes several amendments. It is the principal federal law regulating the management of solid waste and hazardous waste. RCRA 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 RCRA and authorized 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 RCRA, referred to as the Corrective Action Program, regulates active facilities that are permitted to treat, store or dispose

[1] 29 U.S.C. 651 et seq.
[2] 42 U.S.C. 6901 et seq.

of hazardous waste. To obtain a RCRA 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)[3] was enacted in 1980 and authorizes EPA to respond to releases or threatened releases of hazardous substances, pollutants or contaminants that may endanger human health or the environment. CERCLA 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 of 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. 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 on 1975 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 USDOT, hazardous materials are defined as materials of a particular quantity

[3] U.S.C. 9601 et seq.

and form that may pose risk to health, safety or property. Hazardous materials may include, but are 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 of 1970[4] 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 – Solid Waste Disposal Act, Chapter 361

The Texas Health and Safety Code, Solid Waste Disposal Act, Chapter 361 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.

The Texas Health and Safety Code, Solid Waste Disposal Act, Chapter 361.751-361.754 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.

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 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 USTs and ASTs, 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

[4] 29 U.S.C. 651 et seq.

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 1 mile beyond the Project 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 Project. An Initial Site Assessment of the Study Area was conducted following TxDOT guidelines[5] to identify potential hazardous material areas. The Initial Site Assessment consisted of a database search, a review of historical 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[6] and state databases.[7]

Table 3.5-1: Standard Environmental Database Sources

Regulatory Database	Search Distance (miles)
NPL list 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.	1.0
Federal Delisted NPL list 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.	0.5
Federal Comprehensive Environmental Response, Compensation, and Liability Information System list 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.	0.5
Federal Comprehensive Environmental Response, Compensation, and Liability Information System No Further Remedial Action Planned site list This database includes sites, determined by the EPA following preliminary assessment, that 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.	0.5
Federal Resource Conservation and Recovery Act generators This database includes hazardous waste handlers, generators (large, small and conditionally exempt), transporters, corrective actions and treatment, storage and disposal facilities regulated under RCRA.	Property and adjoining properties
TCEQ Industrial Hazardous Waste Corrective Action sites 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.	1.0

[5] TxDOT, *Hazardous Materials Initial Site Assessment (ISA) Report*, Effective Date: 12/2014, Version 3, **Appendix E, Technical Memorandum**.
[6] EPA, Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.
[7] TCEQ, Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/.

Table 3.5-1: Standard Environmental Database Sources	
Regulatory Database	**Search Distance (miles)**
TCEQ Superfund sites 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 that do not qualify for action under the federal Superfund program.	1.0
Closed and abandoned Municipal Solid Waste landfill sites Sites listed within a solid waste landfill database may include active landfills and inactive landfills, where solid waste is treated or stored. Includes unauthorized landfills that have no permit and are considered abandoned.	0.5
TCEQ leaking petroleum storage tank remediation lists (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.	0.5
TCEQ registered petroleum storage tank lists (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.	Property and adjoining properties
TCEQ voluntary cleanup program sites 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.	0.5
TCEQ Innocent Owner/Operator sites 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.	0.5
TCEQ Dry Cleaners Remediation Database 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.	0.5
TCEQ Brownfields Database This database includes information on former contaminated industrial facilities or Brownfields that are being assessed for cleanup.	0.5
Texas Railroad Commission voluntary cleanup program sites 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.	0.5

Source: TxDOT, *Hazardous Materials Initial Site Assessment (ISA) Report*, Effective Date: 12/2014, Version 3, **Appendix E, Technical Memorandum**.

The database search was followed by a review of historical USGS topographic maps, historical 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 have the potential to pose a high or moderate risk to the Project. However, the selective field reconnaissance did not meet the Phase I Environmental Site Assessment (ESA) standard or the EPA All Appropriate Inquiries (AAI) rule. The parcels that make up the entire corridor were not assessed for the presence of recognized environmental conditions, which is a deviation from the Phase I ESA standard and TXDOT standard for hazardous material identification process. Prior to construction, TCRR will complete Phase I ESAs, as discussed in **Section 3.5.6.2, Mitigation Measures, HM-MM#1: Environmental Site Assessments.** There is a potential to discover previously unidentified hazardous materials sites, as discussed in **Section 3.5.6.2, Mitigation Measures, HM-MM#3: Previously Unidentified Hazardous Materials.**

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 the 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 RCRA 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 cleanup program.
  - *Example of moderate-risk site:* an LPST with final closure issued within 0.25 mile of the proposed centerline because some contaminants may 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 visible concerns such as significant staining, distressed vegetation or dumping of hazardous waste 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, further investigations such as Phase I and/or Phase II ESAs would be required at 70 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. Moderate-risk sites that are not adjacent to the LOD would not require further investigation because it was determined that contamination migration to the LOD is unlikely to occur. 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 greater than 0.25 mile from the Project centerline and are not adjacent to LOD; therefore, contamination migration is unlikely to occur.

3.5.3.2 Solid Waste

Solid waste facilities that may serve the Project 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 Project was estimated and compared to the annual amounts disposed of 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 Final Conceptual Engineering Design and Constructability Reports**) 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 of 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.[8]

Solid waste would also be generated during operations of the Project from passenger and employee usage. The estimated HSR ridership[9] in 2040 is 7.2 million annual passengers and the estimated number of full-time employees in 2040 at the stations, TMFs and MOW facilities is 1,584 (per **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports**). A solid waste generation rate of 4.38 pounds per person per day[10] 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 495 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 **Appendix D, Potential Hazardous Materials Sources Mapbook .** A Hazardous Materials Initial Site Assessment Report was completed[11] and a photographic log documenting the field reconnaissance is presented in **Appendix E, Hazardous Materials Initial Site Assessment Report**.

[8] Franklin Associates, *Characterization of Building-Related Construction and Demolition Debris in the United States,* Prepared for USEPA, June 1998, pages ES-3 and 2-7.

[9] As discussed in further detail in **Section 3.1.1., General Methodology**, even though TCRR provided ridership estimates of 6.4 million in 2029 and 9.9 million in 2040; the original ridership estimates used in the Draft EIS of 4.4 million in 2026 and 7.2 million in 2040 have been carried forward by FRA in the Final EIS to conduct conservative analyses in the Final EIS.

[10] EPA, Municipal Solid Waste Generation, Recycling, and Disposal in the U.S.: Facts and Figures for 2012, February 2014.

[11] The Hazardous Materials Initial Site Assessment Report was completed in June 2017 following the TxDOT methodology and reporting guidelines. While the Initial Site Assessment Report has not been updated since 2017, all databases searched based on criteria detailed in **Table 3.5-1** were updated in 2019 as detailed in **Table 3.5-2**.

Table 3.5-2: Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (miles)	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.
496	0.86 N	Higher	Pay to Park Parking Lot Northwest corner of Record St. & Pacific Avenue, Dallas, TX 75202	Dallas	1	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2015.
497	0.67 NE	Higher	Dallas Transportation Service Facility 1711 Canton St. Dallas, TX 75201	Dallas	1	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2018. **LPST**: 3 occurrences, final concurrences issued, cases closed in 1993, 1996 and 2018.
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

Notes:

- Sites are not sorted by numerical order. Sites are 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.
- Further investigation will include Phase I ESA, and Phase II ESA (if needed).
- Acronyms- **L**: Low, **M**: Moderate, **H**: High, **Y**: Yes, **N**: No, **N***: Site is adjacent to LOD, **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.
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Table 3.5-2: Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	Distance From Alternative Centerline (miles)	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.
498	0.13 NE	Higher	CCH Alamo/ G Dallas Realty 1005 S. Lamar St., Dallas, TX 75215	Dallas	1	N*	M	Y	**VCP:** Active 2015 VCP agreement for soils/groundwater affected by metals, TPH, and VOCs. Currently in investigation phase. **PST**: One UST temporarily out of service.
499	0.45 NE	Higher	DAFW Holdings, LLC 1225 Belleview Street, Dallas TX 75215	Dallas	1	N	L	N	**VCP:** Completed VCP, with final certificate issued in 2017 for soils/groundwater affected by metals.
500	0.24 E	Higher	Standard Fixture Co. Inc., 913 Powhattan St., Dallas, TX 75215	Dallas	1	N	M	N	**VCP:** Active 2017 VCP agreement for soils/groundwater affected by metals, TPH, and VOCs. Currently in investigation phase.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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; case closed in 2011. **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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Table 3.5-2: Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.
501	0.26 NE	Higher	Cedars Vacant Property 2300 2320 Lamesa St./229 2236 2400 Cockrell Ave., Dallas TX 75219	Dallas	5	N	M	N	**VCP:** Active 2018 VCP agreement for soils/groundwater affected by metals and TPH. Currently in investigation phase.
27	0.24 NE	Higher	Princeton Packaging 2236 Cockrell Ave, Dallas, 75215	Dallas	1	N	M	N	**LPST:** Final concurrence issued; case closed in 1989. **PST:** Five USTs filled in place and ten removed in 1988.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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	Y	M	Y	**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.
502	0.45 NE	Higher	St. Philips Expansion 1632 Martin Luther King Jr. Blvd, Dallas, TX 75215	Dallas	1	N	L	N	**TX Brownfields:** Brownfield site assessment application accepted in 2017. Currently in investigation phase.
503	0.4 NE	Higher	St. Philips Expansion Retail Complex 1624 and 1628 Martin Luther King Jr. Blvd, Dallas, TX 75215	Dallas	1	N	L	N	**TX Brownfields:** Brownfield site assessment application accepted in 2018. Currently in investigation phase.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
504	0.38 NE	Higher	Kwik Stop Beer & Wine 1602 Martin Luther King Jr. Blvd, Dallas 75215	Dallas	1	N	L	N	**TX Brownfields**: Brownfield site assessment application accepted in 2019. Currently in investigation phase.
505	0.34 NE	Higher	3007 Holmes and 1516 Martin Luther King Jr. Blvd, Dallas 75215	Dallas	1	N	L	N	**TX Brownfields**: Brownfield site assessment application accepted in 2019. Currently in investigation phase.
33	0.09 SW	Lower	Whitlock 401 Corinth St, Dallas, 75207	Dallas	1	N	M	N	**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	N	**LPST:** Final concurrence issued; case closed in 2009. **PST:** Three gasoline USTs in use.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
37	0.12 SW	Equal	Metro Cost Plus 201 Corinth St, Dallas, 75207	Dallas	1	N	M	N	**LPST:** Final concurrence issued; case closed in 2018. **PST:** Two gasoline USTs in use. Four USTs removed in 1992. Site had two closed enforcements in 2004 and 2012 and a closed complaint in 2018.
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.
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.
506	0.27 NE	Higher	3203 Holmes St, Dallas 75215	Dallas	1	N	L	N	**TX Brownfields:** Brownfield site assessment application accepted in 2018. Currently in investigation phase.
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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:** Two USTs removed in 1995. **RCRA:** Inactive generator. **VCP:** Completed VCP for soil/groundwater contamination. Final certificate issued in 2006.
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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51	0.07 SW	Lower	Unnamed Historic Landfill 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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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507	0.52	Lower	Dallas Floodway Extension Upper Chain of Wetlands Located in the Trinity River Floodplain	Dallas	1	N	L	N	**IHW:** Active corrective action since 2010 for groundwater affected by metals. Ongoing workload. This site has an MSD (#258).
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.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.
508	0.33	Higher	South Lamar Street Property 4801, 5003, 5019, 5029 Lamar St, Dallas 75215	Dallas	1	N	L	N	**VCP:** VCP application received in 2010 for soil/groundwater contamination. Withdrawn from VCP in 2013.
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 and 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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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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.
509	0.8 NE	Higher	West Dallas -Cadillac Heights between Pontiac Cadillac and Sargent Streets, Dallas, TX 75201	Dallas	1	N	L	N	**IHW:** Active corrective action since 2002 for groundwater contamination. Ongoing workload.
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.

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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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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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.

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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.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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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.
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.

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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	Y	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	Dallas	1	N	L	N	**VCP:** Completed VCP, with final certificate issued in 2013 for groundwater affected by VOCs and chlorinated solvents.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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510	0.17 E	Lower	Amazon.Com.Kydc LLC 33333 LBJ FWY, Dallas, TX, 75241	Dallas	1	N*	L	N	**RCRA:** Active LQG of ignitable and corrosive waste, and various waste streams.
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.

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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	M	N	**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 Department of HEW Survey, 1 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.

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99	0.18 NE	Higher	Pencco Bardwell Site 6555 W Highway 34, Ennis	Ellis	2A	N*	H	Y	**IHW:** Active corrective action site since 2019. Ongoing workload. **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	0.23 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.
102	0.42 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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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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.
511	0.06 E	Lower	Personville Texaco HWY 164 & 39, Personville, TX, 76642	Limestone	4	N	M	N	**LPST**: Final concurrence issued, case closed in 1992. **PST:** Three USTs removed in 1984.
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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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.
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.

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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.

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- Acronyms- **L**: Low, **M**: Moderate, **H**: High, **Y**: Yes, **N**: No, **N***: Site is adjacent to LOD, **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.
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Table 3.5-2: Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Table 3.5-2: Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (miles)	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

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Table 3.5-2: Hazardous Materials Database Search									
Map ID	**Distance From Alternative Centerline (miles)**	**Site's Relative Elevation to Rail**	**Facility Name and Address**	**County**	**Segment**	**In LOD**	**Risk**	**Further Investigation Required**	**Summary of Findings from Database Search**
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.
512	0.1 W	Lower	Tiger Mart Exxon 2430 W US Highway 79, Buffalo, TX, 75831	Leon	3C	N*	M	Y	**LPST:** Active LPST reported in 2016, in assessment phase. **PST:** Three active USTs. Three USTs removed in 1999.
513	0.01 E	Lower	Central Freight Lines Truck Fire IH 45 Mile Marker 172	Leon	3C	Y	M	Y	**IHW:** Active corrective action site since 2005. Ongoing workload.
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.

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Table 3.5-2: Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.
514	0.5 E	Lower	Texaco Service Station IH 45 HWY 7, Centerville, TX 75833	Leon	3C	N	L	N	**LPST**: Final concurrence issued, case closed in 1999. **PST:** Five USTs removed in 2002.
515	0.5 E	Lower	TETCO 1110 IH 45 HWY 7, Centerville, TX, 75833	Leon	3C	N	L	N	**LPST**: Final concurrence issued, case closed in 2001. **PST:** Three active UST. Three USTs removed in 1999.
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.
516	0.01 W	Higher	Sunmart 118 IH 45 & FM 977 Leona, TX 75850	Leon	3C	Y	L	N	**PST:** Four USTs temporarily out of service
517	0.13 W	Higher	Leona Country Store 1167 FM 977 W, Leona, TX 75850	Leon	3C	Y	L	N	**PST:** Two active USTs in use and three USTs removed in 1996
136	0.11 SW	Lower	Yellow Rose Travel Plaza 23456 OSR, Normangee, 77871	Madison	3C	N*	L	N	**PST:** Four active USTs in use.
518	0.12 W	Lower	Yellow Rose Country Store 23475 OSR, Madisonville, TX 77864	Madison	3C	N*	L	N	**PST**: Two active USTs in use.

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Table 3.5-2: Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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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.

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146	0.24 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.
519	0.82 NE	Lower	Preferred Industries 14710 Cypress North Houston Rd, Cypress, TX 77429	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2017.
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.

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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	M	Y	**IHW:** Inactive corrective action. Completed workload in 2014. **LPST:** Final concurrence issued, case closed in 1996. **RCRA:** Active SQG. Site had 7 emergency responses and 10 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.

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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.
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Table 3.5-2: Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	Distance From Alternative Centerline (miles)	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:** Inactive corrective action. Completed workload in 2018. **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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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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.
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.

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Table 3.5-2: Hazardous Materials Database Search									
Map ID	**Distance From Alternative Centerline (miles)**	**Site's Relative Elevation to Rail**	**Facility Name and Address**	**County**	**Segment**	**In LOD**	**Risk**	**Further Investigation Required**	**Summary of Findings from Database Search**
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.
520	0.09 SW	Higher	Dresser Rand Power Turbo Products Division, 11500 Charles Rd, Jersey Village, TX 77041	Harris	5	N	L	N	**RCRA:** Inactive RCRA Generator
184	0.17 SW	Higher	Guardsman/ Cytex Industries 11502 Charles Rd, Jersey Village, 77041	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 2016. **VCP:** Completed VCP, with final certificate issued in 2017 for soils/groundwater affected by BTEX. **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.

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186	0.37 SW	Higher	Fairview Gardens Developments WWTP 11800 Charles Rd, Jersey Village, 77041	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2011. **RCRA:** Active SQG of numerous waste streams.
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
521	0.99 SW	Higher	Impreglaon Surface Engineering 7134 Satsuma Rd., Houston, TX 77041	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2016.
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	**PST:** One UST permanently filled in place. Four ASTs out of use.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.

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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.
522	0.3 SW	Higher	General Storage Systems 11333 FM 529 Rd., Houston, TX 77041	Harris	5	N	L	N	**IOP:** Completed IOP, with final certificate issued in 2004.
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.
523	0.96 NE	Higher	Houston Campus 9700 W Gulf Bank Rd. Houston, TX 77041	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2018. **LPST:** Final concurrence issued, case closed in 1992. **PST**: Four UST removed between 1989 and 1992.

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Table 3.5-2: Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Table 3.5-2: Hazardous Materials Database Search									
Map ID	**Distance From Alternative Centerline (miles)**	**Site's Relative Elevation to Rail**	**Facility Name and Address**	**County**	**Segment**	**In LOD**	**Risk**	**Further Investigation Required**	**Summary of Findings from Database Search**
524	0.45 NE	Lower	Harris County Multi Use Facility 6900 Gessner Rd, Houston, TX, 77040	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 2016. **PST:** Two temporarily out of service UST in 2007. Three USTs removed in 1997**. VCP:** Completed VCP, with final certificate issued in 2016 for soil affected TPH, VOCs, and petroleum and metals.
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Table 3.5-2: Hazardous Materials Database Search									
Map ID	**Distance From Alternative Centerline (miles)**	**Site's Relative Elevation to Rail**	**Facility Name and Address**	**County**	**Segment**	**In LOD**	**Risk**	**Further Investigation Required**	**Summary of Findings from Database Search**
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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 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	Y	M	Y	**MSW:** Closed Type 5TS (transfer station) with 1977 start date and 2014 end date.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	**Distance From Alternative Centerline (miles)**	**Site's Relative Elevation to Rail**	**Facility Name and Address**	**County**	**Segment**	**In LOD**	**Risk**	**Further Investigation Required**	**Summary of Findings from Database Search**
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, 77040	Harris	5	N*	M	Y	**LPST:** Final concurrence issued, case closed in 1991. **PST:** Three USTs removed in 1991.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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*	M	Y	**LPST:** Active LPST reported in 2017, in assessment phase **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:** Six USTs in use and four removed in 1993.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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247	0.12 SW	Lower	Vallourec Tube Alloy 14333 Sommermeyer St, Houston, 77041	Harris	5	N	M	N	**IHW:** Inactive corrective action. Completed workload in 2018. **RCRA:** Inactive generator of phosphate sludge and other waste.
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, 77041	Harris	5	N	L	N	**PST:** Two USTs removed in 1999.

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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, case closed. **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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Table 3.5-2: Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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- BSI Construction 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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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 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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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
525	0.15 SW	Lower	Performance Plastics Products 5055 Cranswick Rd. Houston, TX77041	Harris	5	N	M	N	**IHW:** Inactive corrective action. Completed workload in 2009. **IOP:** Inactive IOP, as of 2008.
270	0.07 NE	Higher	Dril Quip 13550 Hempstead Highway & 8221 Leghorn Street, Houston, 77040	Harris	5	N*	M	Y	**LPST:** Active LPST reported in 2018**.** **PST:** One UST removed in 1998. One AST in use. **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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
273	0.03 NE	Higher	Fairbanks Gulf 13438 Hempstead Rd, Houston, 77040	Harris	5	N*	M	Y	**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.
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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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	Y	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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Table 3.5-2: Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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 dichloroethylene.
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.
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.

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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:** 2017 IOP agreement for groundwater impacted by chlorinated solvents. Withdrawn/transferred to corrective action program in 2018. **IHW:** Active corrective action since 2018. Ongoing workload
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	**Distance From Alternative Centerline (miles)**	**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 solvent, and PCE. Currently in active remediation 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.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Table 3.5-2: Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.
526	0.23 SW	Lower	Templo Pentecostal de Jesuscristo Getsamani 8502 Rayson Rd. Houston, TX 77080	Harris	5	N	M	N	**IOP:** Completed IOP, with final certificate issued in 2019.
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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:** Completed VCP, with final certificate issued in 2015 for soil/groundwater affected by TPH, chlorinated solvents and other contaminants.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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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.
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.

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Table 3.5-2: Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.

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332	0.18 SW	Lower	American Door Products 7967 Blankenship Drive, Houston	Harris	5	N	M	N	**VCP:** Completed VCP for soils/groundwater affected by pesticides, metals and arsenic. Pending proof of filing.
333	0.04 SW	Lower	Hogan Hardwoods & Molding 7770 Blankenship Dr, Houston, 77055	Harris	5	N	L	N	**PST:** Two USTs removed in 1997.
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	Y	M	Y	**LPST:** Final concurrence issued in 2011, case closed. **PST:** Two USTs removed in 1991 and four USTs currently in use. **RCRA:** Inactive generator of ignitable waste, benzene and tetrachloroethylene.

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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.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.
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.

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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.
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Table 3.5-2: Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	Distance From Alternative Centerline (miles)	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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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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:** Four 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	Y	M	Y	**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	Y	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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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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.
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.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.
527	0.1 SW	Lower	Long Point Industrial Park Bldg. C, 6500 Long Point Rd., Houston, TX 77024	Harris	5	N	M	N	**IHW:** Inactive corrective action. Completed workload in 2009.
528	0.1 SW	Lower	Long Point Industrial Park Bldg. A, 6600 Long Point Rd., Houston, TX 77024	Harris	5	N	M	N	**IHW:** Inactive corrective action. Completed workload in 2009.
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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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	Y	M	Y	**LPST:** Final concurrence issued, case closed in 1999. **PST:** Five USTs removed in 2000 and 2006.
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Table 3.5-2: Hazardous Materials Database Search									
Map ID	**Distance From Alternative Centerline (miles)**	**Site's Relative Elevation to Rail**	**Facility Name and Address**	**County**	**Segment**	**In LOD**	**Risk**	**Further Investigation Required**	**Summary of Findings from Database Search**
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. **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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Table 3.5-2: Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.
407	0.07 S	Lower	South Texas Equipment 1495 N Post Oak Rd, Houston, 77055	Harris	5	Y	M	Y	**IOP:** Completed IOP, with final certificate issued in 2015 for groundwater affected by benzene, toluene and tetrachloroethylene.
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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	Y	**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	Y	**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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.
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:** Completed VCP for groundwater affected by vinyl chloride, trichloroethylene, and dichloroethylene. Final certificate issued in 2017.
529	0.2 E	Lower	West Loop Business Plaza 1500 West Loop N., Houston, TX 77008	Harris	5	N	M	N	**VCP:** Active 1999 VCP agreement for soils/groundwater affected by various contaminants. Currently in investigation phase.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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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.
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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Map ID	**Distance From Alternative Centerline (miles)**	**Site's Relative Elevation to Rail**	**Facility Name and Address**	**County**	**Segment**	**In LOD**	**Risk**	**Further Investigation Required**	**Summary of Findings from Database Search**
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

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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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

Notes:

- Sites are not sorted by numerical order. Sites are 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.
- Further investigation will include Phase I ESA, and Phase II ESA (if needed).
- Acronyms- **L**: Low, **M**: Moderate, **H**: High, **Y**: Yes, **N**: No, **N***: Site is adjacent to LOD, **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. High-risk sites require Phase I and/or Phase II ESA by TCRR prior to construction.
- Rows highlighted in orange are moderate-risk sites that require Phase I ESA by TCRR prior to construction.

Table 3.5-2: Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (miles)	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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

Notes:

- Sites are not sorted by numerical order. Sites are 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.
- Further investigation will include Phase I ESA, and Phase II ESA (if needed).
- Acronyms- **L**: Low, **M**: Moderate, **H**: High, **Y**: Yes, **N**: No, **N***: Site is adjacent to LOD, **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. High-risk sites require Phase I and/or Phase II ESA by TCRR prior to construction.
- Rows highlighted in orange are moderate-risk sites that require Phase I ESA by TCRR prior to construction.

Table 3.5-2: Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
530	0.45 E	Lower	Enduro Systems Composite Product 7100 Old Katy Rd, Houston, TX 77024	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2012. **VCP:** Inactive 2013 VCP agreement for soils affected by metals.
531	0.35 E	Higher	Home Depot Supply MAI 5418 7108 Old Kate Rd. Ste 100, Houston, TX 77024	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2011.
532	0.5 SE	Lower	Maryland Club Foods Inc 7105 Old Katy Rd, Houston 77024	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 1992.
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.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

Notes:

- Sites are not sorted by numerical order. Sites are 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.
- Further investigation will include Phase I ESA, and Phase II ESA (if needed).
- Acronyms- **L**: Low, **M**: Moderate, **H**: High, **Y**: Yes, **N**: No, **N***: Site is adjacent to LOD, **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. High-risk sites require Phase I and/or Phase II ESA by TCRR prior to construction.
- Rows highlighted in orange are moderate-risk sites that require Phase I ESA by TCRR prior to construction.

Table 3.5-2: Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
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.
533	0.83 SW	Lower	Legends of Memorial Apartments 915 Silber Rd, Houston, TX 77024	Harris	5	N	L	N	**IOP:** Completed IOP, with final certificate issued in 2018.
534	0.83 SW	Higher	Former Shell 7703 Katy Frwy, Houston, 77024	Harris	5	N	M	N	**LPST:** Active LPST reported in 2006, in assessment phase. **PST**: Five USTs removed in 2005
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

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

Notes:

- Sites are not sorted by numerical order. Sites are 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.
- Further investigation will include Phase I ESA, and Phase II ESA (if needed).
- Acronyms- **L**: Low, **M**: Moderate, **H**: High, **Y**: Yes, **N**: No, **N***: Site is adjacent to LOD, **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. High-risk sites require Phase I and/or Phase II ESA by TCRR prior to construction.
- Rows highlighted in orange are moderate-risk sites that require Phase I ESA by TCRR prior to construction.

Table 3.5-2: Hazardous Materials Database Search									
Map ID	**Distance From Alternative Centerline (miles)**	**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/ Stinnes Houston 6922 Old Katy Rd, Houston, TX 77024	Harris	5	N	L	N	**IHW:** Site has three IHW corrective action registrations. 1) Inactive corrective action, completed workload in 1996. 2) Inactive corrective action, completed workload in 2004. 3) Active corrective action since 2002 for groundwater contamination. Ongoing workload.

Source: AECOM 2019; TCEQ2019. Central Registry Query, accessed January 2019, https://www15.tceq.texas.gov/crpub/; EPA Envirofacts Multisystem Search Form, accessed January 2019, http://www3.epa.gov/enviro/facts/multisystem.html.

Notes:

- Sites are not sorted by numerical order. Sites are 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.
- Further investigation will include Phase I ESA, and Phase II ESA (if needed).
- Acronyms- **L**: Low, **M**: Moderate, **H**: High, **Y**: Yes, **N**: No, **N***: Site is adjacent to LOD, **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. High-risk sites require Phase I and/or Phase II ESA by TCRR prior to construction.
- Rows highlighted in orange are moderate-risk sites that require Phase I ESA by TCRR prior to construction.

A summary of past land uses based on review of historical USGS topographic maps, historical aerial maps and Sanborn Fire Insurance Rate maps is provided in the Initial Site Assessment Report. Six sites of concern (MAP ID 466 to 469, 494, and 495) were identified based on the historical maps review and have been plotted for reference purposes in **Appendix D, Potential Hazardous Materials Sources Mapbook**. These six sites of concern are summarized in **Table 3.5-3**.

Based on the database search, 4 sites were classified as high-risk sites (highlighted in red), 161 sites were classified as moderate-risk sites and the remaining 330 sites were classified as low-risk sites. Sites classified as presenting a high-risk of potential hazardous materials contamination are described in more detail in this section. 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 this section. All referenced photos are included in **Appendix E, Hazardous Materials Initial Site Assessment Report, Attachment 1**.

Based on historical maps review, five sites were classified as moderate-risk sites and one site was classified as a low-risk site. The identified sites (MAP IDs 466 to 469, 494, and 495) are summarized in **Table 3.5-3** and are discussed in more detail in this section.

Table 3.5-3: Hazardous Materials Sites from Historical Maps Review

Map ID	Distance From Alternative Centerline (miles)	Site's Relative Elevation to Rail	County	Segment	In LOD?	Risk	Further Investigation Required	Summary of Findings from Database Search
466	0.05	Equal	Dallas	1	Y	M	Y	Several industrial and warehouse type facilities were dominant in the Dallas Terminal Station Option area south of Cadiz Street from the 1960s until 2006.
467	0.05	Higher	Harris	5	N[a]	M	Y	A tank farm existed in this area from the 1940s to 2004 along Segment 5.
468	0.04	Lower	Harris	5	N[a]	L	N	A sewage disposal pond was located at this area along Segment 5.
469	0.003	Equal	Harris	5	Y	M	Y	Industrial facilities were located at this area from the 1950s to 2013.
494	0.04	Lower	Harris	5	N[a]	M	Y	A waterbody existed from the 1970s to 2016 on this property. This property was owned by Wyman Gordon Forgings.
495	0.06	Lower	Harris	5	Y	M	Y	A waterbody existed from the 1980s to 2006 on this property. This property was owned by Wyman Gordon Forgings.

Source: AECOM, 2019

[a] Adjacent to LOD

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 Station Option 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, semivolatile organic compounds (SVOC) and metals. The site is a 6.6 acre 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 and the case was closed in 2011. 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 historical aerial maps review, several industrial and warehouse type facilities were dominant in the Dallas Terminal Station Option 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 Option 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. 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. 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 moderate-risk site. This facility is a gas station in operation located 600 feet southwest of Segment 1. It currently has two gasoline USTs in use. LPST was reported, final concurrence was issued and the case was closed in 2018. Listed responsible party is Chevron Environmental Management Company. Four USTs were removed in 1992. 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 in 2004 and 2012 for failure to complete the required monitoring for the USTs. The facility had a complaint in 2018 for failure to maintain the spill and overfill prevention devices.

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 (IHW) 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 VOCs. 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 RCRA 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, VOCs, 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, VOCs 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 partially within 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 moderate-risk site. The site is located 1,600 feet west of Segment 1. It is an active IHW 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 970 feet northeast of Segment 2A and is adjacent to the LOD. It is an active IHW corrective action site since 2019, with ongoing workload. It is an active conditionally exempt small quantity generator of chromium. A temporary construction area would be located northwest of the site. 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 were 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 1,200 feet east of Segment 3C and is adjacent to the LOD. LPST was reported in 1992 for minor soil contamination. No remedial action was required. Final concurrence was issued, and case was closed in 1992. Four USTs were removed in 1992. Currently, this site is in operation (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #42**) and four active USTs are in use. No visible concerns were observed during field reconnaissance.

Map ID 512: Tiger Mart Exxon is a moderate risk site. The site is located 580 feet west of Segment 3C and is adjacent to the LOD. LPST was reported in 2016 due to a chemical release and is currently in cleanup phase. Three USTs were removed in 1999, and three active USTs are in use.

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. Four active USTs are 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 494: Based on historical aerial maps review, a waterbody existed from the 1970s to 2016 on this property (tax parcel ID# 1385350010001, 22400 Northwest Lake Dr., Houston). Photos taken in 2016 when the waterbody was drained show the water having a metallic iridescent sheen. According to the property's vesting deeds, this property was owned by Wyman Gordon Forgings until 2012. This property is adjacent to the LOD. It is considered a moderate-risk site and would require a Phase I ESA by TCRR prior to construction. Currently, Visual Comfort is operating at this property. The pond was drained and new construction (Visual Comfort) was built in its place in 2017.

MAP ID 495: Based on historical aerial maps review, a waterbody existed from the 1980s to 2006 on this property (tax parcel ID# 1272810010010, 0 Northwest Lake Dr., Houston). According to the property's vesting deeds, this property was owned by Wyman Gordon Forgings until 2012. This property is within the LOD. A drainage feature and MOW facility is proposed by the Project at this property. It is considered a moderate-risk site and would require a Phase I ESA by TCRR prior to construction. Currently, Gulf Coast Modification LP is operating at this property. The pond was drained in 2008 and new construction (Gulf Coast Modifications) was built in its place in 2019.

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 IHW corrective action site, with completed workload in 2015. The 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 historical 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/waterbody. Currently the area is developed into industrial facilities, but that waterbody 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. An 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 VOCs. The 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. An LPST was reported at this site, with final concurrence issued and the case closed in 1997. Four USTs were 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. An 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 270: Dril Quip is a moderate-risk site. The site is located 300 feet northeast of Segment 5 and is adjacent to the LOD. It has one active AST in use. An LPST was reported in 2018 and is currently in cleanup phase. This site is currently in operation.

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. An 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 historical 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. An 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 was in the voluntary cleanup program for soil/groundwater affected by total petroleum hydrocarbons, chlorinated solvents and other contaminants. Remediation has been completed. A final certificate of completion was issued in 2015. An 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 proof of filing. 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 partially within the LOD. Site has four USTs in use and two USTs were removed in 1991. An 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 within the LOD. An 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. An LPST was reported in 1996, groundwater was 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 within the LOD. An 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. Eight USTs were removed in 1990.

MAP ID 397: Handi Stop 107 is a moderate-risk site. The site is within the Houston Northwest Mall Terminal Station Option LOD. An 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 three USTs are 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. Four active USTs are in use. An 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. An 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, VOCs, 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 IHW corrective action since 2002, with ongoing workload. This site is in operation (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #86**). Monitoring wells were observed during field reconnaissance.

MAP ID 469: Based on historical 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 IHW corrective action site, with completed workload in 2012. An LPST was reported, final concurrence was issued, and the case was closed in 2003. Also, this is an inactive voluntary cleanup program site for groundwater affected by vinyl chloride, trichloroethylene and dichloroethylene. Final certificate of completion was issued in 2017. 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 Houston Northwest Transit Center Terminal Station Option LOD. This is an inactive IHW corrective action site, with completed workload in 2011. It is a RCRA 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 Houston 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 Houston 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. An 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 Houston 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 Houston 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 historical landfills were identified within the Study Area and are presented in **Table 3.5-2**. Solid waste facilities that would be near the Project and may receive solid waste generated during the construction and operation are provided in **Table 3.5-4**. The table also lists the type of the facility, the total tons of waste landfilled in 2017 and the remaining capacity in years and tons. The solid waste facilities have daily receiving weight limits that cannot be exceeded. The daily limits were not readily available at time of preparation of the Final EIS. TCRR will take into consideration the daily limits when preparing the Waste Management Plan discussed in **Section 3.5.6.2, Mitigation Measures**. Any hazardous waste generated during the construction and operation would potentially be disposed of at the US Ecology facility in Robstown, Texas, and/or Waste Management Chemical Waste facility in Lake Charles, Louisiana.

Table 3.5-4: Solid Waste Capacity

County	Name	Type[a]	2017 Tons	Remaining Capacity (years)	Remaining Capacity (tons)
Dallas	City of Dallas McCommas Bluff Landfill	1	1,887,251	32	64,557,250
Ellis	Waste Management Skyline Landfill	1	1,234,826	28	32,242,954
Navarro	City of Corsicana Landfill	1	102,860	133	13,059,343
Limestone	BFI Mexia Landfill	1	31,581	107	3,961,748
Grimes	Twin Oaks Landfill	1	392,956	64	25,148,481
Harris	McCarty Road Landfill	1	1,364,814	16	23,748,385
	Atascocita Recycling and Disposal Facility	1	1,209,440	24	29,228,482
	Greenhouse Road Landfill	4	124,622	21	4,113,628
	Hawthorn Park Landfill[b]	4	16	4	33,788
	Fairbanks Landfill[c]	4	176,600	37	13,029,083
	Tall Pines [b]	4	344,369	3	1,318,835
	Lone Star Recycling & Disposal	4	303,486	16	5,479,259
Total			**7,172,821**		

Source: TCEQ, *Municipal Solid Waste in Texas: A Year in Review, FY 2017 Data Summary and Analysis*, October 2017, https://www.tceq.texas.gov/assets/public/comm_exec/pubs/as/187-18.pdf.

[a] 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.

[b] Landfills identified that will reach capacity during construction

[c] Identified alternative landfill during construction

3.5.5 Environmental Consequences

3.5.5.1 No Build Alternative

Under the No Build Alternative, the HSR system would not be constructed. Existing hazardous materials sites would not be disturbed because no Project-related construction activities would occur. Additional solid waste would not be generated because no construction or operation of the HSR 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. The impacts of other planned projects, such as the Dallas County SH 121 widening project, in addition to this Project, are discussed in **Section 4.4, Indirect and Cumulative Impacts, Cumulative Impacts**. Additionally, existing hazardous materials sites may be remediated in accordance with federal, state and local requirements under the No Build Alternative. It is assumed that any new developments or projects would be required to comply with federal and state regulations to protect the environment and workers.

3.5.5.2 Build Alternatives

3.5.5.2.1 Construction Impacts

Hazardous Materials

All the Build Alternatives and the Houston Terminal Station options 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 **Table 3.5-3,** summarized by Build Alternative in **Table 3.5-5,** and summarized by county in **Table 3.5-6**.

Table 3.5-5: Hazardous Material Sites by Build Alternative

Site	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F
Low-Risk Sites	297	298	326	297	298	326
Moderate-Risk Sites	155	155	165	155	155	165
High-Risk Sites	4	4	4	3	3	3
Total Impacts	**456**	**457**	**495**	**455**	**456**	**494**

Source: AECOM 2019

Table 3.5-6: Hazardous Material Sites by County

Site	Dallas	Ellis	Navarro	Limestone	Freestone	Leon	Madison	Grimes	Waller	Harris
Low-Risk Sites	74	2	4	0	17	12	3	2	2	215
Moderate-Risk Sites	40	0	0	1	7	4	0	2	0	112
High-Risk Sites	1	1	0	0	0	0	0	0	0	2
Total Hazmat Sites	115	3	4	1	24	16	3	4	2	329
Sites in LOD	8	0	0	0	3	5	0	1	0	38
Sites adjacent to LOD	13	1	0	0	4	4	2	0	0	46
Sites Requiring Phase I ESA	13	1	0	0	1	3	0	0	0	52

MAP IDs 403 and 405, which would be located within Segment 5 (Harris County), are high-risk sites and would pose the greatest concern because they are undergoing remediation/monitoring activities and would be within 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. Three of the four 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 29 low-risk sites and 10 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 in **Table 3.5-3** 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, Mitigation Measures**. The hazardous materials sites within the LOD of the Houston Terminal Station Options are summarized in **Table 3.5-7**. Out of the three station options, the Houston Northwest Mall Terminal Option has the least hazardous materials site impacts.

Table 3.5-7: Hazardous Material Sites by Houston Terminal Station Option

Site	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, 2019

Construction of the Project 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, Mitigation Measures**.

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, Utility Crossings**. Relocation of existing wells and pipelines may be necessary during construction of the Project. 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 Project due to accidental damage, remediation would be conducted prior to continuation of construction activities as detailed in **Section 3.5.6.2, Mitigation Measures**.

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 Project.

Solid Waste

Construction of the Project 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 Project would generate 7.8 million cubic yards of cut material from excavation activities and would require 24.5 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 Project would generate 60 thousand cubic yards of concrete waste and 32.2 million pounds of rebar waste that would be eventually disposed of in a landfill. This would be an estimated 61 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, Mitigation Measures**.

The amount of waste that would be generated from buildings demolition is presented by segment in **Table 3.5-8** and summarized by Build Alternative in **Table 3.5-9**. The amount of waste that would be generated from the Houston Terminal Station options is also presented in **Table 3.5-8**. Out of the three station options, the Houston Northwest Transit Center Terminal Station Option would have the least solid waste impacts. Alternative F, along with the Houston Northwest Mall Terminal Station Option, would generate the highest amount of demolition waste. This would be an estimated 251,900 tons of waste. Based on a waste generation rate of 155 pounds per square foot and a 25 percent recycling rate as discussed in **Section 3.5.3.2, Methodology, Solid Waste**, the amount of demolition waste that would be disposed of at landfills would be 188,925 tons.

Table 3.5-8: Building Demolition Analysis

Segment	Number of Buildings	Area in Square Feet	Demolition Waste (tons)
1	88	621,416	48,160
2A	27	59,519	4,613
2B	64	139,493	10,811
3A	30	62,922	4,876
3B	68	135,428	10,496
3C	145	600,286	46,522
4	103	152,454	11,815
5	275	950,478	73,662
Segment 5: Houston Industrial Site Terminal Station Option	19	726,757	56,324
Segment 5: Houston Northwest Mall Terminal Station Option	36	938,154	72,707
Segment 5: Houston Northwest Transit Center Terminal Station Option	28	641,505	49,717

Source: AECOM 2019.

Table 3.5-9: Demolition Waste by Build Alternative (in tons)

ALT A	143,126
ALT B	148,745
ALT C	172,957
ALT D	149,324
ALT E	154,943
ALT F	179,155

Source: AECOM 2019

The estimate of solid waste that would be generated from construction and demolition activities would be approximately 250,000 tons. Based on the proposed 4-year construction schedule, this would represent 1 percent of the total annual amount disposed of in 2017 at the solid waste facilities listed in **Table 3.5-4**. Based on these estimates, there would be sufficient existing landfill capacity to accommodate the projected solid waste generated by the Project. Therefore, the impact of the construction of any of the Build Alternatives on landfill capacity would be minimal.

3.5.5.2.2 Operational Impacts

Hazardous Materials

The System would only provide passenger rail service, and the transportation of hazardous materials in revenue service and joint operations with heavy freight equipment would not be permitted on the trainsets or within the HSR ROW. However, the operation and maintenance of the Project would involve transporting, using and storing hazardous materials not in revenue service, and would generate hazardous waste. Hazardous materials could include diesel fuel, lubricants, hydraulic fluids and cleaning products used during the routine maintenance of the ROW, 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 Project 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 Project would generate approximately 4,400 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 Project would be approximately 0.06 percent of the total annual amount disposed of at the landfills listed in **Table 3.5-4**. Therefore, the operational impacts of the Project on existing remaining landfill capacity would be minimal.

3.5.6 Avoidance, Minimization and Mitigation

3.5.6.1 Compliance Measures

TCRR would be required to comply with the following Compliance Measures (CM):

HM-CM#1: Demolition of Structures. During construction, TCRR shall test for and properly manage lead-based paint, asbestos-containing building materials or PCB-containing equipment prior to demolition and transport the materials 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. TCRR shall implement the BMPs specified in the SWPPP and other site-specific plans during construction and operation activities to reduce or prevent potential impacts to nearby receptors through actions 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

TCRR would be required to implement the following Mitigation Measures (MM):

HM-MM#1: Environmental Site Assessments. Prior to construction, TCRR shall investigate the 70 high- and moderate-risk sites identified in **Table 3.5-2** and **Table 3.5-3** using industry standard site assessment process (Phase I ESA- ASTM 1527). The Phase I ESA shall include review of available TCEQ files (existing sampling data and/or investigation reports).

If the results of a Phase I ESA reveal recognized environmental conditions (release of hazardous substances or petroleum products to the environment), TCRR shall perform a Phase II ESA (ASTM 1903) that could include soil and groundwater sampling to quantify contamination. Where conditions warrant a Phase II ESA, TCRR 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 Phase II ESAs indicate the presence of contaminated soil and/or groundwater at concentrations exceeding TCEQ screening values in locations where ground-disturbing activities will occur, TCRR shall conduct appropriate remediation prior to construction. Remediation activities may include removal of contaminated soil, in situ treatment or soil capping. Contaminated soil shall be disposed of properly (**HM-MM#4: Waste Management**). If contamination is intrinsic to construction activities and remediation prior to construction is impractical, TCRR shall complete mitigation measures during construction.

HM-MM#2: Hazardous Materials Management. Prior to construction, TCRR shall prepare a Hazardous Materials Management Plan to ensure that the handling, use, storage and disposal of hazardous materials would be in accordance with applicable federal, state and local regulations 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. TCRR shall obtain all required local and state permits for installation and operation of fuel/oil storage tanks 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. TCRR shall develop a Spill Prevention, Control, and Countermeasure (SPCC) Plan for fuel and oil storage tanks/drums if there is an aggregate aboveground capacity greater than 1,320 gallons or a completely buried storage capacity of greater than 42,000 gallons and there is a reasonable expectation of oil discharge into waters of the U.S., should a spill occur. The PST requirements are enforced by TCEQ. TCRR shall provide a copy of the Hazardous Materials Management Plan to FRA.

HM-MM#3: Previously Unidentified Hazardous Materials. Prior to construction, TCRR 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 in the affected area. 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. Prior to construction, TCRR 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 be consistent with applicable federal, state and local regulations and 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 waste during construction and operation activities to adhere to the Waste Management Plan and to 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. Solid and hazardous waste regulations are enforced by TCEQ. Asbestos regulations are enforced by the Texas Department of State Health Services. Depending on the amount of hazardous waste generated, TCRR shall prepare a RCRA Contingency Plan, if applicable. The Contingency Plan and the SPCC Plan may be combined into a single plan.

HM-MM#5: Removal of PSTs. During construction, TCRR shall handle the decommissioning of PSTs that will be impacted, in accordance with federal and local regulations including RCRA 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 and Houston Terminal Station options 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 Build Alternatives A through F and the Houston Terminal Station options is presented in **Table 3.5-10**. The high-risk sites would be located in Segments 1 and 5, which are common to all Build Alternatives. Build Alternatives C and F would have slightly higher impacts than the other Build Alternatives because of the presence of additional low- and moderate-risk sites in proximity to Segment 3C.

Table 3.5-10: Hazardous Material Sites by Build Alternative and Houston Terminal Station Options

Site	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F	Industrial Site	Northwest Mall	Northwest Transit Center
Low-Risk Sites	297	298	326	297	298	326	4	0	6
Moderate-Risk Sites	155	155	165	155	155	165	3	3	8
High-Risk Sites	4	4	4	3	3	3	2	0	0
Total Impacts	**456**	**457**	**495**	**455**	**456**	**494**	**9**	**3**	**14**

Source: AECOM 2019

The hazardous materials sites within the LOD of the Houston Terminal Station Options are summarized in **Table 3.5-10**. Two high-risk sites and three moderate-risk sites would be located within the Houston Industrial Site Terminal Station Option. Eight moderate-risk sites would be located within the Houston

Northwest Transit Center Terminal Station Option. Out of the three station options, the Houston Northwest Mall Terminal Station Option would have the least hazardous materials site impacts.

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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 plant communities are referred to as vegetation, and animal species are referred to as wildlife. Habitat is defined as the resources and conditions present in an area that support 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 evaluates 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.[2] In the State of Texas, 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, Regulatory Context.**

3.6.2 Regulatory Context

Regulatory compliance requirements vary based on the authorities under which a 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 of 1973

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,[3] 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.[4] The 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, the USFWS has the authority to designate critical habitat.[5] 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] L. S. Hall, 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. 1531 et seq.
[3] Ibid.
[4] 16 U.S.C. 1532.
[5] 16 U.S.C. 1533(b)(2).

The USFWS also maintains a list of candidate species. Candidate species are plant or animal species for which the 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.[6] 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."[7] Harm is defined in regulations implementing the Act as "any act that kills or injures the species, including significant habitat modification."[8] 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.[9] 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 whether 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 BA that identifies the threatened or endangered species that are likely to be affected by the action and consult with the USFWS.

Formal consultation is concluded when the USFWS formulates a 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.[10] 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

[6] L. S. Hall, P. R. Krausman, and M. L. Morrison, "The habitat concept and a plea for standard," *Wildlife Society Bulletin 25*, 1997:173-182.
[7] 16 U.S.C. 1532(19).
[8] 50 C.F.R. 17.3.
[9] 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.
[10] 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 they are currently occupied by the listed species. Not all federally listed threatened or endangered species have designated critical habitat.

Migratory Bird Treaty Act of 1918

The Migratory Bird Treaty Act (MBTA),[11] 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."[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 C.F.R. 2I.27 are required if an action would take, possess or involve the sale or transport of birds protected by the MBTA. On December 22, 2017, a memorandum (M-37050) was provided by the U.S. Department of the Interior (DOI) outlining that the MBTA does not prohibit incidental or accidental take.[13] This memorandum found that, consistent with the text, history and purpose of the MBTA, the statute's prohibitions on pursuing, hunting, taking, capturing, killing or attempting to do the same apply only to affirmative actions that have as their purpose the taking or killing of migratory birds, their nests or their eggs.

Bald and Golden Eagle Protection Act of 1940

The Bald and Golden Eagle Protection Act of 1940, and as amended,[14] prohibits anyone without a permit issued by the 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."[15] 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."[16] The USFWS has a permitting process for activities that 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. The 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

[11] 16 U.S.C. 703-712.
[12] 50 C.F.R. 10.12.
[13] DOI, Memorandum M-37050, MTBA, December 22, 2017, https://www.doi.gov/sites/doi.gov/files/uploads/m-37050.pdf.
[14] 16 U.S.C. 668–668d.
[15] 16 U.S.C. 668c.
[16] 50 C.F.R. 22.3.

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 an active or inactive nest.

Executive Order 13112

Executive Order (EO 13112) on invasive species 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 restoration of native species; conduct research on invasive species and promote public education.[17]

Fish and Wildlife Coordination Act of 1934

The Fish and Wildlife Coordination Act of 1934 and subsequent amendments protect wildlife when federal actions result in the control or modification of a natural stream or body of water.[18] 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.[19]

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 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 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, the USFWS has the final authority. The Texas Natural Diversity Database (TXNDD) catalogs, monitors and provides information on rare species and communities of concern.

TPWD Code – Chapter 64

TPWD Code Title 5, Subtitle B Chapter 64 Birds, Subchapter A, Section 64.002 states that no person may: (1) catch, kill, injure, pursue, or possess, dead or alive, or purchase, sell, expose for sale, transport, ship, or receive or deliver for transportation, a bird that is not a game bird; (2) possess any part of the plumage, skin, or body of a bird that is not a game bird; or (3) disturb or destroy the eggs, nest, or young

[17] 64 Federal Register 6183, February 3, 1999.
[18] 16 U.S.C. 661-666(c).
[19] William J. Clinton, Memorandum for the Heads of Executive Departments and Agencies, Subject: Environmentally and Economically Beneficial Practices on Federal Landscaped Grounds, April 26, 1994, accessed April 2020, https://www.govinfo.gov/content/pkg/WCPD-1994-05-02/pdf/WCPD-1994-05-02-Pg916.pdf.

of a bird that is not a game bird. No exemptions to this regulation exist for incidental take. Additionally, there is no permitting process for incidental take of non-game birds.

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, no protection of habitat is 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.

TPWD Code Sections 66.007 and 66.0072 and TAC Title 31, Part 2, Chapter 57, Subchapter A, give TPWD the authority to develop a list of exotic, harmful or potentially harmful fish, shellfish and aquatic plants that may not be possessed, transported or introduced into public waters except as authorized by permit issued by TPWD. Possession or transfer of controlled aquatic invasive species (AIS) including the eggs, seeds, or fragments of living or dead individuals, is punishable as a Class C Misdemeanor (with a fine up to $500), with elevated fines for repeated violations.

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 (*Anaxyrus 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.[20] Similarly, the Study Area for the Houston toad included the LOD for each Build Alternative. However, surveying for this species was extended an additional 3.1 miles (5 km) on each side of the LOD based on mobility of the species and recommendations from the USFWS.

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 **Appendix D, Natural Resources Mapbook**).

A desktop analysis was conducted using publicly 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), National Wetland Inventory (NWI)
- **TPWD**: TXNDD, Rare, Threatened and Endangered Species of Texas by County (RTEST), Ecological Mapping Systems of Texas (EMST)
- **USGS**: National Hydrography Dataset (NHD), National Land Cover Dataset (NLCD)
- **United States Department of Agriculture (USDA)**: Natural Resources Conservation Service (NRCS)

[20] USFWS, *National Bald Eagle Management Guidelines*, May 2007, accessed January 29, 2018, https://www.fws.gov/southdakotafieldoffice/NationalBaldEagleManagementGuidelines.pdf.

To evaluate vegetation, wildlife and potential protected species occurrence within the Study Area, GIS data were used to evaluate the Project from a landscape perspective by overlaying the LOD with the collected natural resource data.[21, 22]

The TPWD EMST was used to determine vegetation types within the Study Area.[23] The EMST was created to provide an expansive set of land cover classes to allow for better ecological interpretation of the landscape. Note the classification by EMST is a framework and multiple factors influence habitat diversity. This system is meant for generalized guidance; therefore, 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.

Habitat fragmentation may occur outside the Study Area where existing vegetation remains between parallel developed corridors that becomes isolated from larger blocks. The amount of habitat fragmentation as a result of the Project was assessed through a combination of EMST data and aerial imagery in locations where the Project 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, were calculated. Perimeter/area ratios consider the shape and complexity of habitat patches and are an expression of the spatial heterogeneity of a landscape. As field surveys continue (as discussed below), these corridors of fragmented habitat will be further identified and refined for mapping. These efforts will be completed in conjunction with the 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 habitat suitability models to delineate habitat for the four species based on their unique habitat parameters. Habitat suitability models were utilized to focus field presence/absence survey efforts, which were conducted by qualified biologists where access to private property was granted.

For the Houston toad, using NRCS data, sandy soils to a depth of 24 inches or greater were included in the habitat suitability model. Furthermore, canopy cover was analyzed for the Houston toad using a custom python script in ArcGIS 10.1 to delineate areas of 60 percent or greater canopy cover. Distance to water source was ranked so that areas closer to water sources received higher ranking than areas further from water sources using field collected data, NHD and NWI. Parameters representing soils, canopy cover and distance to water source were combined in GIS to produce a Houston toad habitat suitability model. The resulting habitat suitability model provided suitability on a scale of low suitability (0 percent) to high suitability (100 percent). For the purposes of this study, areas of 60 percent suitability or greater were delineated to allow for one habitat parameter (soil, canopy cover or water source) to be absent, resulting in the presence of both optimal and marginal habitat within the final delineation. This allowed for dispersal habitats and some native prairies to be included within the modeled habitat. The data generated by the modeling was then reviewed with aerial imagery, and areas

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[21] USFWS, *USFWS Threatened & Endangered Species Active Critical Habitat Report,* accessed June 19, 2019, http://criticalhabitat.fws.gov/crithab.

[22] TPWD, "TPWD County Lists of Protected Species and Species of Greatest Conservation Need," *Wildlife Division, Diversity and Habitat Assessment,* accessed June 17, 2019, http://tpwd.texas.gov/gis/rtest/.

[23] Lee F. Elliott, David D. Diamond, C. Diane True, Clayton F. Blodgett, Dyan Pursell, Duane German, and Amie Treuer-Kuehn, *Ecological Mapping Systems of Texas: Summary Report,* Austin: Texas Parks and Wildlife Department, April 2014.

of unlikely presence (i.e., large areas with no canopy cover for the Houston toad) were removed from the dataset.

From February to May 2017, nocturnal surveys were conducted at 120 points located near ponds and wetlands (85 in Leon County and 35 in Grimes County) within or directly adjacent to modeled Houston toad habitat up to 3.1 miles from the LOD, as recommended by the USFWS. From February to May 2018 and 2019, nocturnal surveys were conducted at 90 points located near ponds and wetlands (54 in Leon County and 36 in Grimes County) within or directly adjacent to modeled Houston toad habitat up to 3.1 miles from the LOD. Surveys were conducted 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[24] and likely hold 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, an average of 20 surveys per observation point were conducted during the toad's active season (February to May).

For large-fruited sand verbena, sandy soils over sandy clay loam soils from the Carrizo Sand, Sparta Sand and Queen City Sand geologic formations were included in the habitat suitability model. The results of the habitat suitability model were then reviewed and compared to recent aerial imagery to eliminate developed areas. Three years of visual surveys for the large-fruited sand verbena were conducted in accordance with the large-fruited sand verbena protocol provided by the USFWS February 15, 2017, using pedestrian methods within areas delineated by the habitat suitability model. Surveys were conducted within the Study Area, where access was provided and during peak flowering season (March and April). Surveys were conducted March 30 to April 4, 2017, March 18 and 19, 2018, March 30, 2018, and March 11 to 14, 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 layers, a habitat suitability model was completed using the weighted sum tool in ArcMap 10.1. The results of the habitat suitability model were then reviewed and compared to aerial imagery to eliminate developed areas. Three years of 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 Study Area, where access was provided, and during peak flowering season (October and November). Surveys were conducted October 31 to November 15, 2016, October 23 to November 3, 2017, and October 15 to 26, 2018.

Creating a habitat suitability model is difficult for the Texas prairie dawn due to the lack of research regarding the species' habitat requirements.[25] To determine areas of potential occurrence 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.[26] Using ArcMap 10.1, the two layers were intersected to delineate areas with a high probability for occurrence. In addition, Texas prairie dawn have been known to occur on low sloping

[24] Personal communication with Mike Forstner, Distinguished professor at Texas State University.
[25] USFWS, Texas prairie dawn (*Hymenoxys texana*) 5-year review, 2015.
[26] Ibid.

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.[27,28,29] Due to the association between Texas prairie dawn and mima mounds, the Study Area was further investigated for the occurrence of these mounds using historical and current aerial imagery and field investigations.[30]

FRA initiated formal Section 7 consultation with the USFWS for federally listed species that may be adversely impacted. FRA requested the official species list on September 24, 2019, which is included in the BA submitted by FRA to the USFWS on November 14, 2019. FRA has conducted 3 years of protected species presence/absence surveys in accordance with the USFWS approved methods for the endangered Houston toad, large-fruited sand verbena and Navasota ladies'-tresses. Surveys have been limited to modeled habitat for federally listed target species on properties for which right-of-entry has been obtained. FRA will continue to informally coordinate with the USFWS on appropriate mitigation measures to avoid or minimize impacts to protected species habitat.

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.

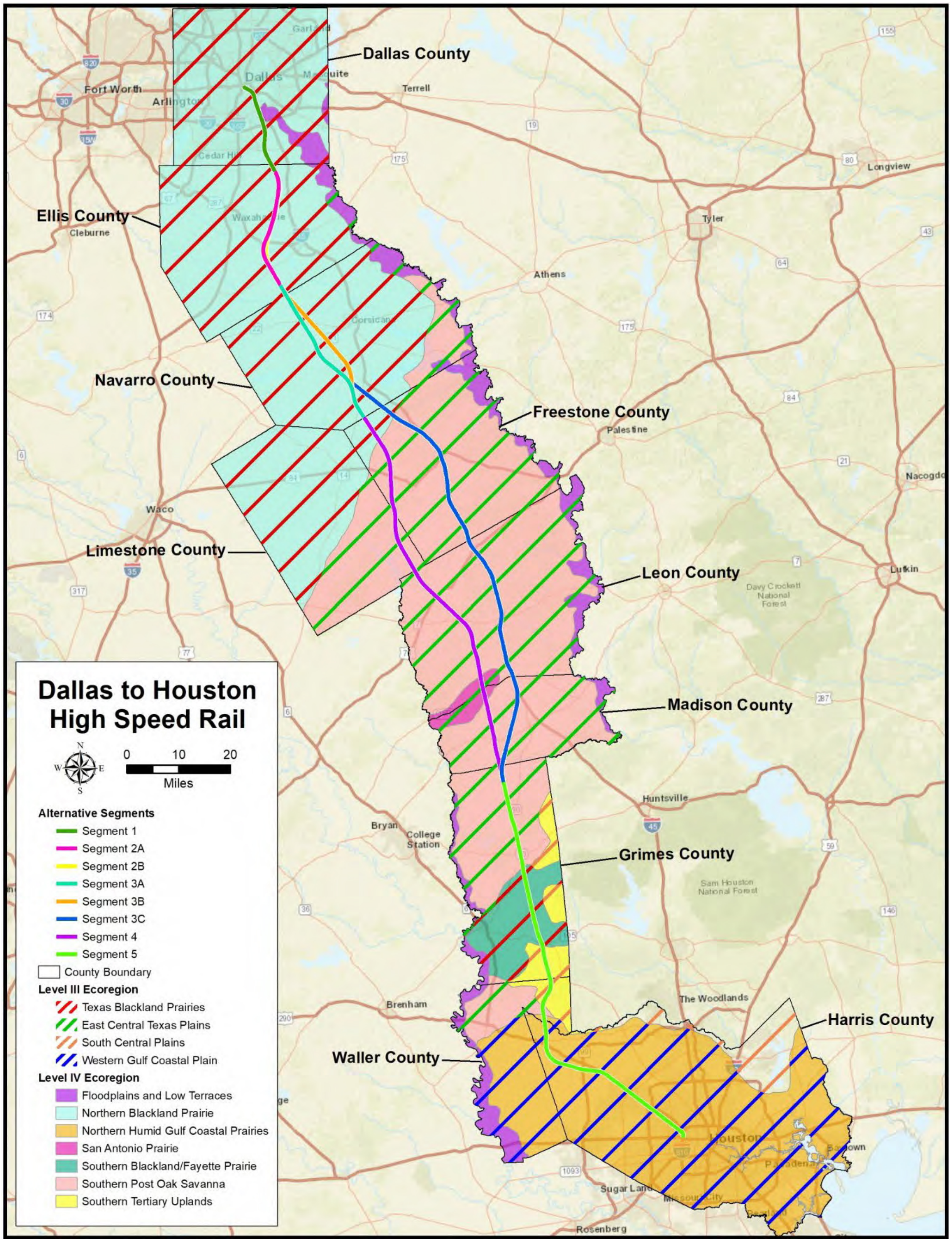
3.6.4.1 Ecoregions

The geographic location of Texas puts it at the convergence of eastern and western habitats, southern subtropical habitats and northern temperate ones.[31] 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 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;[32] 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**).

The Level III and Level IV ecoregions are described in the sections that follow.

[27] Jackie M. Poole, William R Carr, Dana M. Price, and Jason R. Singhurst, *Rare Plants of Texas*, College Station, Texas: Texas A&M University Press, 2007.
[28] USFWS, *Hymonoxys texana* Recovery Plan," Albuquerque, New Mexico: U.S. Fish and Wildlife Service, 1990.
[29] USFWS, Texas prairie dawn (*Hymenoxys texana*) 5-year review, 2015.
[30] AECOM, *Hunting Bayou Federal Flood Control Project Biological Assessment*, Harris County Flood Control District, 2010.
[31] TPWD, "Texas Ecoregions," accessed January 25, 2019, https://tpwd.texas.gov/education/hunter-education/online-course/wildlife-conservation/texas-ecoregions.
[32] Glenn E. Griffith, 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 2019

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

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.[33]

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.

- **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 –

[33] Glenn E. Griffith, Sandra A. Bryce, James M. Omerik, and Anne C. Rogers, *Ecoregions of Texas,* Austin: Texas Commission on Environmental Quality, 2007.

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.).[34]

- **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.[35]

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.).[36]

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

[34] Glenn E. Griffith, Sandra A. Bryce, James M. Omerik, and Anne C. Rogers, *Ecoregions of Texas,* Austin: Texas Commission on Environmental Quality, 2007.
[35] Ibid.
[36] Ibid.

adjacent regions; pasture and forage production for livestock is common. Large areas of the region have been converted to urban and industrial uses.[37]

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 the native Blackland Prairie communities are gone.[38]
- **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.[39]
- **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.[40]

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 production is common.[41] 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

[37] Glenn E. Griffith, Sandra A. Bryce, James M. Omerik, and Anne C. Rogers, *Ecoregions of Texas,* Austin: Texas Commission on Environmental Quality, 2007.
[38] Ibid.
[39] Ibid.
[40] Ibid.
[41] Ibid.

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.[42]

3.6.4.2 Vegetation

As defined by the EMST, 47 vegetation types are present within the Study Area, of which 4 comprise 70 percent of the total Study Area acreage. These four dominant vegetation types are described 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.
- **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 presents the EMST vegetation types found within the Study Area by county and segment.

[42] Ibid.

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Table 3.6-2: Vegetation Types within the Study Area (acres)

Vegetation Types (EMST Code[a])	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 Station Option**	**NW Mall Terminal Station Option**	**NW Transit Center Terminal Station Option**
Blackland Prairie: Disturbance or Tame Grassland (207)	109	12	287	294	6	4	6	594	675	681	1	1	45	291	--	17	7	--	--	--	--	191	1	--	--	--	--
Post Oak Savanna: Live Oak Motte and Woodland (602)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4	--	--	--
Post Oak Savanna: Post Oak - Redcedar Motte and Woodland (603)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	--	--	--
Post Oak Savanna: Post Oak Motte and Woodland (604)	3	--	--	--	--	--	--	58	70	50	--	--	348	178	88	403	554	56	119	40	13	231	62	10	--	--	--
Post Oak Savanna: Savanna Grassland (607)	--	--	--	--	--	--	--	14	46	14	--	--	519	288	216	694	541	459	415	51	33	449	9	--	--	--	--
Post Oak Savanna: Post Oak - Yaupon Motte and Woodland (613)	--	--	--	--	--	--	--	--	--	--	--	--	11	11	--	3	1	--	1	--	--	5	--	--	--	--	--
Post Oak Savanna: Sandyland Woodland and Shrubland (706)	--	--	--	--	--	--	--	--	--	--	--	--	1	15	--	8	23	--	--	--	--	--	--	--	--	--	--
Post Oak Savanna: Sandyland Grassland (707)	--	--	--	--	--	--	--	--	--	--	--	--	1	1	--	14	13	--	--	--	--	--	--	--	--	--	--
Edwards Plateau: Oak/Hardwood Slope Forest (904)	--	--	1	--	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Edwards Plateau: Live Oak Motte and Woodland (1102)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Edwards Plateau: Deciduous Oak Evergreen Motte and Woodland (1103)	35	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Edwards Plateau: Oak/Hardwood Motte and Woodland -(1104)	60	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Edwards Plateau: Savanna Grassland (1107)	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Central Texas: Floodplain Live Oak Forest (1802)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Central Texas: Floodplain Hardwood/Evergreen Forest (1803)	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Central Texas: Floodplain Hardwood Forest (1804)	78	1	29	33	--	--	--	28	34	30	--	--	74	38	11	28	24	--	--	--	--	19	--	--	--	--	--
Central Texas: Floodplain Deciduous Shrubland (1806)	--	--	--	3	--	--	--	4	6	1	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Central Texas: Floodplain Herbaceous Vegetation (1807)	14	--	7	14	--	--	--	92	31	87	--	--	32	29	10	44	22	--	--	--	--	11	--	--	--	--	--
Central Texas: Floodplain Seasonally Flooded Hardwood Forest (1814)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Central Texas: Riparian Hardwood/Evergreen Forest (1903)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--	--	--
Central Texas: Riparian Hardwood Forest (1904)	4	--	11	17	2	--	2	3	6	3	--	--	1	5	2	--	6	--	--	--	--	3	--	--	--	--	--
Central Texas: Riparian Deciduous Shrubland (1906)	--	--	1	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Central Texas: Riparian Herbaceous Vegetation (1907)	--	--	10	7	--	--	--	6	15	6	--	--	4	5	2	2	8	--	--	--	--	10	--	--	--	--	--
Pineywoods: Pine Forest or Plantation (3001)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7	--	--	--	--	--	76	54	--	--	--	--

Table 3.6-2: Vegetation Types within the Study Area (acres)

Vegetation Types (EMST Code[a])	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 Station Option**	**NW Mall Terminal Station Option**	**NW Transit Center Terminal Station Option**
Pineywoods: Pine - Hardwood Forest or Plantation (3003)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	31	11	--	--	--	--
Pineywoods: Upland Hardwood Forest (3004)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	134	70	--	--	--	--
Pineywoods: Small Stream and Riparian Temporarily Flooded Mixed Forest (4803)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--
Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest (4804)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	45	46	5	16	23	6	1	--	--	--
Pineywoods: Small Stream and Riparian Seasonally Flooded Hardwood Forest (4814)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--
Pineywoods: Small Stream and Riparian Wet Prairie (4817)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	27	11	7	7	24	2	--	--	--	--
Gulf Coast: Coastal Prairie (5207)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	96	826	--	--	--
Gulf Coast: Coastal Prairie Pondshore (5307)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--
Barren (9000)	--	--	--	--	--	--	--	7	--	7	--	--	6	--	3	2	6	--	--	--	--	--	--	2	--	3	6
Swamp (9004)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Marsh (9007)	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--
Native Invasive: Juniper Woodland (9101)	--	--	--	--	--	--	--	2	--	2	--	--	25	16	--	2	--	--	5	--	--	--	--	--	--	--	--
Native Invasive: Deciduous Woodland (9104)	74	5	57	98	8	3	8	28	30	56	--	--	4	8	--	--	3	--	--	--	--	17	--	12	--	--	--
Native Invasive: Juniper Shrubland (9105)	4	--	--	1	--	--	--	--	--	--	--	--	--	--	--	10	--	--	--	--	--	--	--	--	--	--	--
Native Invasive: Mesquite Shrubland (9106)	7	--	12	14	--	--	--	19	14	22	--	--	13	7	--	--	--	--	--	--	--	2	--	2	--	--	--
Native Invasive: Huisache Woodland or Shrubland (9124)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	22	--	--	--
Native Invasive: Deciduous Shrubland (9126)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	3	--	--	--	--
Pineywoods: Disturbance or Tame (9197)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	293	17	1	--	--	--
Pine Plantation > 9 feet (3 meters) tall (9301)[b]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	12	--	--	--
Row Crops (9307)[b]	125	49	535	488	42	52	42	193	283	183	--	--	--	--	--	--	1	--	--	--	--	--	--	86	--	--	--
Grass Farm (9317)[b]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Urban High Intensity (9410)	112	--	--	--	--	--	--	--	5	--	--	--	196	--	1	81	1	36	--	--	--	1	--	171	84	100	92
Urban Low Intensity (9411)	169	1	6	13	--	--	--	10	16	13	--	--	131	4	2	85	5	3	2	--	--	7	--	153	8	1	1
Open Water (9600)	5	--	1	1	--	--	--	--	2	--	--	--	--	--	--	--	2	--	--	--	--	7	--	--	--	--	--

Source: TPWD 2014

[a] The EMST Code, presented with each specific vegetation type in the table, is the unique number assigned by TPWD.

[b] Are considered agricultural types.

"—" Vegetation type not present

3.6.4.2.1 Commercially or Recreationally Important Plant Species

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 NRCS soil surveys reviewed in **Section 3.20.3.1, Soils and Geology, Soils** 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.

Approximately 15 percent of the Study Area is comprised of commercially or recreationally important plant species according to EMST. Within the Study Area, three of the identified vegetation types are considered agricultural within the EMST: grass farm (9317), pine plantation greater than nine 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.[43] **Table 3.6-2** details the acreages of these vegetation types within the Study Area.

3.6.4.3 Wildlife

Wildlife includes all vertebrate species, except for those identified as protected species (see **Section 3.6.4.4, 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 is divided into the following wildlife categories: amphibians and reptiles, fish, mammals and birds. **Tables 3.6-3** through **3.6-6** present the most common species within each category and their potential occurrence within the Study Area counties. These tables are not all-inclusive for wildlife species that may occur in the Study Area.

3.6.4.3.1 Amphibians and Reptiles

The Study Area primarily lies within the Texan Biotic Province, straddling the border with the Austroriparian Biotic Province in the southern portion.[44] 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)[45] recognized 16 lizard species, 39 snake species, 18 anuran species (frogs and toads), 2 land turtles, 5 species of salamanders and newts and 49 species of mammals within the Texan Biotic Province. 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.

[43] Lee F. Elliott, David D. Diamond, C. Diane True, Clayton F. Blodgett, Dyan Pursell, Duane German, and Amie Treuer-Kuehn, *Ecological Mapping Systems of Texas: Summary Report,* Austin: Texas Parks and Wildlife Department, April 2014.
[44] W. Frank Blair, "The Biotic Provinces of Texas," *Texas Journal of Science*, 1957:93-117.
[45] Ibid.

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 vegetation types within the Study Area.[46] However, water snakes (*Nerodia* spp.) and the cottonmouth (*Agkistrodon piscivorus*) tend to occur in habitats near water,[47] 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**).[48]

3.6.4.3.2 Fish

As previously stated, the Study Area lies within the Texan Biotic Province.[49] Although the biotic provinces were originally separated based on terrestrial animal distributions, research has shown that the distribution of freshwater fishes within the state generally corresponds with the terrestrial-vertebrate province boundaries.[50] 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 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 **Appendix D, Natural Resources Mapbook.**

[46] James R. Dixon, *Amphibians and Reptiles of Texas,* College Station: Texas A&M University Press, 2013.
[47] J. R. Dixon and J. E. Werler, *Texas Snakes*: *A Field Guide*, Austin: University of Texas Press, 2000.
[48] James R. Dixon, *Amphibians and Reptiles of Texas,* College Station: Texas A&M University Press, 2013.
[49] W. Frank Blair, "The Biotic Provinces of Texas," *Texas Journal of Science*, 1957:93-117
[50] Carl Hubbs, "Distributional Patterns of Texas Freshwater Fishes," *Southwestern Naturalist 2*, 1957:89-104.

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*	●	○	○	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Houston toad	*Anaxyrus houstonensis*	○	○	○	○	○	○	○	○	○	●	●	○	○	○	○	○	○	○
Blanchard's cricket frog	*Acris blanchardi*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Gray treefrog	*Hyla versicolor*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Green treefrog	*Hyla cinerea*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Spring peeper	*Pseudacris crucifer*	○	○	○	○	○	○	●	●	○	●	●	●	●	○	○	○	○	●
Gulf Coast toad	*Incilius 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	*Aspidoscelis sexlineata*	●	●	●	●	●	●	○	○	●	●	●	●	●	●	●	●	●	●

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
Snakes																			
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	*Haldea striatula*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Copperhead	*Agkistrodon contortix*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Cottonmouth	*Agkistrodon piscivorus*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Source: Conant 1998; Dixon 2013; TPWD 2019

○ – No County Record; ● – County Record

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**.[51]

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[a]	*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*

Source: Thomas et al. 2007

[a] The river chubshucker is not anticipated to be found in Segments 2A and 2B in Ellis County.

[51] Ibid.

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,[52] including all five of the most common EMST vegetation types within the Study Area. Bats within the Study Area are mostly forest dwellers[53] and 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 man-made structures that can occur in any of the vegetation types.[54] The carnivores and even-toed ungulates mostly consist of habitat generalists that can also be found in all of the EMST vegetation types.[55] Rodents also occur in varying habitat types. According to Schmidly (2004), 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 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.[56] 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 within the Study Area. 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.[57]

[52] David J. Schmidly, *The Mammals of Texas,* Austin: University of Austin Press, 2004.
[53] Loren K. Ammerman, Christina L. Hice, and David J. Schmidly, *Bats of Texas,* College Station: Texas A&M Press, 2004.
[54] Ibid.
[55] David J. Schmidly, *The Mammals of Texas,* Austin: University of Austin Press, 2004.
[56] Ibid.
[57] 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*	●	○	○	●	●	●	○	○	○	○	○	○	○	○	○	○	●	●
Tri-colored bat	*Perimyotis subflavus*	●	○	○	○	○	○	○	○	○	○	○	○	○	●	●	●	●	●
Evening bat	*Nycticeius humeralis*	●	○	○	○	○	●	●	●	●	●	●	●	●	●	●	●	●	●
Carnivores																			
Coyote	*Canis latrans*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Common gray fox	*Urocyon cinereoargenteus*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Striped skunk	*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*	●	○	○	○	○	●	●	●	●	●	●	●	●	●	●	●	●	●
Eastern cottontail	*Sylvilagus floridanus*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

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
Black-tailed jackrabbit	*Lepus californicus*	○	○	○	○	○	●	●	●	●	●	●	●	●	●	●	●	●	●

Source: Schmidly 2004

[a] Invasive and/or exotic species.

○ – No County Record; ● – County Record

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 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. Additionally, **Table 3.6-6** identifies them as year-round residents or migrants, and provides what season migrants may be present. 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 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 element of occurrence (EOR) for colonial wading bird colonies within 1 mile of the Study Area, three within 5 miles of the Study Area in Dallas County and one within 5 miles in Ellis, Freestone, Grimes and Navarro Counties (see **Appendix D, Natural Resources Mapbook)**.[58] 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 eagles, owls, woodpeckers and wood warblers.[59] All other avian families listed below typically occur in a variety of vegetation communities and habitats[60] and can potentially be found in all five of the dominant EMST vegetation types within the Study Area.

3.6.4.3.5 Commercially or Recreationally Important Wildlife

As stated in **Section 3.6.4.2, Vegetation**, 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, as well as TPWD's Fort Boggy State Park, offer non-consumptive, wildlife viewing opportunities.

[58] TPWD, "Texas Natural Diversity Database," Austin: Texas Parks and Wildlife Department, Wildlife Diversity Branch, 2019.
[59] David Allen Sibley, *The Sibley Field Guide to Birds of Eastern North America*, New York: Alfred A. Knopf, Inc., 2003.
[60] 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*	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW
American wigeon	*Anas americana*	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW
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*	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW
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

Source: Lockwood and Freeman 2014

[a] Invasive and/or exotic species

M – Present during migration; W – Present during winter; S – Present during summer; YR – Present year-round

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
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
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

Source: Lockwood and Freeman 2014

[a] Invasive and/or exotic species

M – Present during migration; W – Present during winter; S – Present during summer; YR – Present year-round

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
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
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

Source: Lockwood and Freeman 2014

[a] Invasive and/or exotic species

M – Present during migration; W – Present during winter; S – Present during summer; YR – Present year-round

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
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*	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

Source: Lockwood and Freeman 2014

[a] Invasive and/or exotic species

M – Present during migration; W – Present during winter; S – Present during summer; YR – Present year-round

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
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
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 [a]	*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

Source: Lockwood and Freeman 2014

[a] Invasive and/or exotic species

M – Present during migration; W – Present during winter; S – Present during summer; YR – Present year-round

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
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*	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[a]	*Molothrus ater*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR

Source: Lockwood and Freeman 2014

[a] Invasive and/or exotic species

M – Present during migration; W – Present during winter; S – Present during summer; YR – Present year-round

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
Finches and Allies																			
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[a]	*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

[a] Invasive and/or exotic species

M – Present during migration; W – Present during winter; S – Present during summer; YR – Present year-round

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.[61] 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,[62] squirrel, rabbit and wild turkey.[63] Recreational fishing opportunities within the Study Area may be afforded by the Navasota River, Trinity River and West Fork San Jacinto River, as well as reservoirs and minor waterbodies or stock ponds for species including but not limited to sunfish, catfish, trout and bass.[64] There are no commercial fisheries 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, two protected plant species have potential to occur in the Study Area. The query also yielded 48 plant species designated as rare or Species of Greatest Conservation Need (SGCN) by TPWD. Species designated as rare or 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. Based on the current distribution information and the presence of suitable habitat, it was determined that two federally protected plant species, large-fruited sand verbena and Navasota ladies'-tresses, have potential to occur in the Study Area (**Table 3.6-7;** also see **Appendix D, Natural Resources Mapbook**). Texas prairie dawn was determined to have no potential to occur within the Study Area due to lack of appropriate habitat (i.e., mima mounds). Note 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 the USFWS are afforded federal protection under the Endangered Species Act.

[61] David J. Schmidly, *The Mammals of Texas,* Austin: University of Austin Press, 2004.
[62] Mark Lockwood and Brush Freeman, *The Texas Ornithological Society Handbook of Texas Birds*, College Station: Texas A&M University Press, 2014.
[63] David J. Schmidly, *The Mammals of Texas,* Austin: University of Austin Press, 2004.
[64] Chad Thomas, Tim H. Bonner, and Bobby G. Whiteside, *Freshwater Fishes of Texas,* College Station: Texas A&M University Press, 2007.

Table 3.6-7: Federally 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 within the Study Area
	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	No

Source: Poole et al. 2007; USFWS 2019; TPWD 2019

○ – Not Reported in County; ● – Reported 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 7 inches tall with one to seven 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.[65] According to the TXNDD, 26 EORs for this species exist within 5 miles of the Study Area in Harris County (see **Appendix D, Natural Resources Mapbook**).[66] Of the 26 EORs, 12 did not occur within areas identified as suitable habitat based on the habitat suitability 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 Study Area 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 all field investigations, no mima mounds were observed within the Study Area. 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 investigations prior to or during construction, surveys for the species would be conducted at these locations.

The large-fruited sand verbena is known to occur within the Post Oak Belt of east-central Texas in Freestone, Leon and Robertson Counties.[67] It is a herbaceous perennial that grows to approximately 20 inches tall with magenta flowers that bloom from late February through May or June.[68] 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 5 miles of the Study Area in Leon County (see **Appendix D, Natural Resources Mapbook**).[69] Per the results of the large-fruited sand verbena habitat suitability model, presence/absence surveys for the large-fruited sand verbena were conducted within the Study Area in Freestone and Leon Counties on March 30 and April 4, 2017; March 18 and 19, 2018; March 30, 2018; and March 11 to 14, 2019. During these surveys, no large-fruited sand verbena was observed; thus, absence of the species can be presumed for properties that were surveyed all 3 years.[70] Additionally, no sandy blowouts were identified during survey efforts. The TXNDD search reported three EORs for large-fruited sand verbena within Leon and Freestone Counties. While no EORs for large-fruited sand verbena were reported within the Study Area, the nearest EOR record was recorded approximately 3 miles west of Segment 4 of the Study Area within Leon County. However, TXNDD reported that this population was last observed in 1994. An EOR was also reported approximately 5.5 miles east of Segment 3C of the Study Area within Freestone County, and another was reported for the reference population observed at Hilltop Lakes approximately 7.8 miles west of Segment 4 of the Study Area within Leon County.[71] In addition to the EORs, Dr. Paula Williamson identified an additional three wild populations of large-fruited sand verbena in Leon and Freestone Counties. [72] Due to the previously confirmed occurrence of the species within 5 miles of the Study Area, 92 percent of the potential large-

[65] Jackie M. Poole, William R Carr, Dana M. Price, and Jason R. Singhurst, *Rare Plants of Texas*, College Station, Texas: Texas A&M University Press, 2007.
[66] TPWD, "Texas Natural Diversity Database," Austin: Texas Parks and Wildlife Department, Wildlife Diversity Branch, 2019.
[67] Jackie M. Poole, William R Carr, Dana M. Price, and Jason R. Singhurst, *Rare Plants of Texas*, College Station, Texas: Texas A&M University Press, 2007.
[68] Ibid.
[69] TPWD, "Texas Natural Diversity Database," Austin: Texas Parks and Wildlife Department, Wildlife Diversity Branch, 2019.
[70] USFWS, *Large-Fruited Sand-Verbena (Abronia macrocarpa) Galloway 5-Year Review: Summary and Evaluation,* Austin, Texas: U.S. Fish and Wildlife Service, 2010.
[71] TPWD, "Texas Natural Diversity Database," Austin: Texas Parks and Wildlife Department, Wildlife Diversity Branch, 2019.
[72] USFWS, *Large-Fruited Sand-Verbena (Abronia macrocarpa) Galloway 5-Year Review: Summary and Evaluation*, Austin, Texas: U.S. Fish and Wildlife Service, 2010.

fruited sand verbena habitat not yet 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.

The amount of large-fruited sand verbena suitable habitat present within the Study Area changed each year as a result of LOD refinements (refer to **Section 2.5.4, Engineering Refinements,** for more detail) and field verification. After field investigation of delineated habitat in 2017, AECOM recommended the removal of approximately 439 acres of the 873 acres, within the Study Area, previously classified as suitable large-fruited sand verbena habitat due to dense canopy cover and lack of sunlight. This was accomplished using the NLCS 2011 USFS Tree Canopy raster file to delineate areas with 40 percent or less canopy and intersecting those areas with the initial habitat model. During surveys, the removed areas were characterized as "dense canopy cover" or "dense canopy cover with thick understory." This alteration was appropriate according to Dr. Paula Williamson (University Distinguished Professor at Texas State University-San Marcos).[73,74] For 2018 survey efforts, survey access was granted for 52 parcels that contained approximately 256 acres of suitable habitat with 33 acres of suitable habitat occurring within the Study Area. For 2019 survey efforts, survey access was granted for approximately 200 acres of suitable large-fruited sand verbena habitat within 39 parcels. However, only 21 acres of the 200 acres were within the current Study Area. These 21 acres surveyed in 2019 within the Study Area were surveyed for three consecutive years. **Table 3.6-8** provides habitat acreage and surveyed acreage by segment.

Table 3.6-8: Large-fruited Sand Verbena Habitat by Segment

Year	Segment	Total Habitat Acreage[a]	Surveyed Acreage within Study Area	Surveyed Acreage outside Study Area[b]
2017	3C	428	45	162
	4	445	64	263
	Total	**873**	**109**	**425**
2018	3C	290	10	105
	4	144	23	118
	Total	**434**	**33**	**223**
2019	3C	160	8	101
	4	129	13	78
	Total	**289**	**21**	**179**

[a] Calculated based on Study Area at time of survey.

[b] If suitable habitat was present on an accessible parcel, all suitable habitat within that parcel was surveyed for large-fruited sand verbena.

Navasota ladies'-tresses are known to occur in association with post oak savanna vegetation[75] and endemic to Bastrop, Brazos, Burleson, Fayette, Freestone, Grimes, Jasper, Leon, Limestone, Madison, Milam, Robertson and Washington Counties.[76] It has a creamy white flower that grows to approximately 6 to 13 inches tall and flowers from late October through November or early December.[77] 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.

The amount of Navasota ladies'-tresses suitable habitat present within the Study Area changed each year as a result of Study Area refinements (refer to **Section 2.5.4, Engineering Refinements,** for more

[73] P.S. Williamson, personal communication, Email received September 13, 2017.
[74] P.S. Williamson, *Final Report: Protection on Private Lands and Research for Recovery of Large-fruited Sand verbena*, USFWS Contract Number 146696, 2008.
[75] USFWS, *Navasota Ladies'-Tresses (Spiranthes parksii) Recovery Plan*, Albuquerque, New Mexico: U.S. Fish and Wildlife Service, 1984.
[76] Jackie M. Poole, William R Carr, Dana M. Price, and Jason R. Singhurst, *Rare Plants of Texas*, College Station, Texas: Texas A&M University Press, 2007.
[77] Ibid.

detail) and field verification. Presence/absence surveys were conducted for Navasota ladies'-tresses on approximately 652 acres (approximately 34 percent) of the 1,925 acres of modeled suitable habitat within the Study Area from October 31 to November 15, 2016. During these surveys, no Navasota ladies'-tresses were observed. Additionally, 928 acres (approximately 50 percent) of the 1,874 acres of modeled suitable habitat within the Study Area were surveyed October 23 to November 3, 2017 and 837 acres (approximately 46 percent) of the 1,802 acres of modeled suitable habitat within the Study Area were surveyed October 15 to 26, 2018 and November 2, 2018. During 2017, four individuals were observed on a single parcel in Madison County. In 2018, 21 individuals were observed on the same parcel in Madison County, 1 individual on a different parcel in Madison County, and 4 individuals on a parcel in Freestone County. Note that Navasota ladies'-tresses flowering is positively correlated with rainfall in August and September.[78] Given the adequate amounts of rainfall prior to the flowering season in 2016, 2017 and 2018, combined with the high occurrence of nodding ladies' tresses (a known sympatric species), there was an increased chance for detecting Navasota ladies'-tresses during field surveys. [79,80] 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 the viable plants will flower.[81] Therefore, nonflowering or dormant individuals may in fact be present but undetectable at any given location. Due to the presence of Navasota ladies'-tresses within the Study Area, FRA initiated formal Section 7 consultation with the USFWS on November 14, 2019, and prepared a BA outlining specific avoidance and minimization measures to reduce impacts to the species, as discussed in **Section 3.6.5.2.3, Protected Species,** and **Section 3.6.6, Avoidance, Minimization and Mitigation**.

3.6.4.4.2 <u>Protected Wildlife Species</u>

Based on the review of IPaC, RTEST and EORs, 38 protected wildlife species and/or subspecies have the potential to occur in the affected counties. 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. In addition, 60 wildlife species reported are designated as rare or SGCN by TPWD. This includes the Eastern Black Rail (*Laterallus jamaicensis* ssp. *jamaicensis*), which is not currently protected by the Endangered Species Act but is proposed for federal listing as threatened and is considered rare by TPWD. Since rare species or SGCN have no regulatory protection with the state, they are not included in this analysis. Only those species listed as threatened or endangered by the USFWS are afforded federal protection under the Endangered Species Act.

After further data review for this Project as described in **Section 3.6.3**, **Methodology**, FRA determined that 22 out of the 38 protected wildlife species have the potential to occur within the Study Area (**Table 3.6-9**). FRA determined that the remaining 16 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. Of the 22 species with potential to occur within the Study Area, 5 are considered to be transient or migrant bird species that do not have breeding or wintering habitat within the Study Area and include the white-faced ibis (*Plegardis chihi*), wood stork (*Mycteria americana*), whooping crane (*Grus americana*), piping plover (*Charadrius melodus*) and red knot (*Calidris canutus rufa*).

[78] C. L. Wonkka, 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," *Native Plants Journal* 13. No.3: 236-243, 2012.
[79] National Oceanic and Atmospheric Administration, "Climate Data Online: Dataset Discovery – Global Summary of the Month," accessed December 5, 2016, https://www.ncdc.noaa.gov/data-access.
[80] USDA NRCS, "Field Office Technical Guide – Madison County, Texas: WETS Tables," accessed December 5, 2016, https://www.wcc.nrcs.usda.gov/climate/navigate_wets.html.
[81] USFWS, *Navasota Ladies'-Tresses (Spiranthes parksii) 5-Year Review: Summary and Evaluation*, Austin, Texas: U.S. Fish and Wildlife Service, 2009.

Table 3.6-9: 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 within the Study Area
	1	2A	2B	3A	3B	3C	3C	4	4	3C	4	3C	4	3C	4	5	5	5	--	--	--
Amphibians																					
Black-spotted newt/ *Notophthalmus meridionalis*	○	○	○	○	○	○	●	●	●	○	○	○	○	○	○	○	○	○	-	T	No
Houston toad/ *Anaxyrus houstonensis*	○	○	○	○	○	○	○	○	●	●	●	○	○	○	○	●	●	●	E	E	Yes
South Texas siren (Large Form)/Siren sp. 1 (no scientific name specified)	○	○	○	○	○	○	○	○	○	○	○	●	●	○	○	○	○	○	-	T	No
Birds																					
Reddish egret/ *Plegardis chihi*	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	●	-	T	No
White-faced ibis/ *Plegardis chihi*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	-	T	Yes*
Wood stork/ *Mycteria americana*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	-	T	Yes*
Bald eagle/ *Haliaeetus leucocephalus*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	DL	T	Yes
Black Rail/ *Laterallus jamaicensis*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	PL	R	Yes*

○ – Not Reported for County; ● – Reported for County; E – Endangered, in danger of extinction; T – Threatened, severely depleted or impacted by man; DL – Federally delisted; C – Candidate for federal listing; PL – Proposed 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 the USFWS recovery plans or 5-year reviews, if available, or one of the following sources: James R. Dixon, *Amphibians and Reptiles of Texas.* College Station: Texas A&M University Press, 2013; Robert G. Howells, Raymond W. Neck, and Harold D. Murray, *Freshwater Mussels of Texas,* Austin: University of Texas Press, 1996; Mark Lockwood and Brush Freeman, *The Texas Ornithological Society Handbook of Texas Birds,* College Station: Texas A&M University Press, 2014; David J. Schmidly, *The Mammals of Texas,* Austin: University of Austin Press, 2004; Michael R.J. Forstner 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 Verbena (*Abronia macrocarpa*) Recovery Plan, Albuquerque: USFWS, 1992; USFWS, *Interior Least Tern (Sternula antillarum) 5-Year Review: Summary and Evaluation,* Albuquerque, 2013; USFWS, *International Recovery Plan Whooping Crane (Grus americana) Third Revision,* Albuquerque, 2007; USFWS, *Navasota Ladies'-Tresses (Spiranthes parksii) Recovery Plan,* Albuquerque, 1984; NatureServe, *NatureServe,* 2016, accessed April 13, 2019, http://explorer.natureserve.org/servlet/NatureServe?searchName=Rhododon+ciliatus; Bruce C. Thompson, 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 Linda Campbell, *Endangered and Threatened Animals of Texas: Their Life History and Management,* Austin: Texas Parks and Wildlife Press, 1995.

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	1	2A	2B	3A	3B	3C	3C	4	4	3C	4	3C	4	3C	4	5	5	5	--	--	--
White-tailed hawk/ *Buteo albicaudatus*	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	●	-	T	Yes
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
Swallow-tailed kite/ *Elanoides forficatus*	○	○	○	●	●	●	○	○	●	●	●	●	●	●	●	●	●	●	-	T	Yes
Red-cockaded woodpecker/ *Picoides borealis*	○	○	○	○	○	○	○	○	○	●	●	●	●	●	●	●	●	●	E	E	No+
Black-capped vireo/ *Vireo atricapilla*	●	●	●	○	○	○	●	●	○	○	○	○	○	○	○	○	○	○	DL	E	No
Golden-cheeked warbler/ *Setophaga chrysoparia*	●	●		○	○	○	●	●	○	○	○	○	○	○	○	○	○	○	E	E	No
Bachman's sparrow/ *Aimophila aestivalis*	○	○	○	○	○	○	○	○	○	●	●	●	●	○	○	○	○	○	-	T	No

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Common Name/ Scientific Name	Dallas	Ellis		Navarro			Freestone		Limestone	Leon		Madison		Grimes			Waller	Harris	USFWS	TPWD	Potential for Occurrence within the Study Area
	1	2A	2B	3A	3B	3C	3C	4	4	3C	4	3C	4	3C	4	5	5	5	--	--	--
Fish																					
Smalleye shiner/ *Notropis buccola*	○	○	○	○	○	○	○	○	●	●	●	●	●	●	●	●	●	●	E	R	No
Sharpnose shiner/ *Notropis oxyrhyncus*	●	○	○	○	○	○	●	●	●	●	●	●	●	●	●	●	●	○	E	R	No
Blue sucker/ *Clycleptus elongates*	●	●	●	●	●	●	●	●	○	●	●	●	●	●	●	●	●	●	-	T	Yes
Western creek chubsucker/ *Erimyzon claviformis*	●	●	●	●	●	●	●	●	○	●	●	●	●	●	●	●	●	●	-	T	Yes
Blackside darter/ *Percina maculata*	○	○	○	○	○	○	○	○	○	●	●	●	●	●	●	●	○	●	-	T	No
Paddlefish/*Polyodon spathula*	○	○	○	○	○	○	○	○	○	○	○	○	○	●	●	●	○	○	-	T	No
Mammals																					
Rafinesque's big-eared bat/ *Corynorhinus rafinesquii*	○	○	○	○	○	○	●	○	○	●	○	●	●	●	●	●	●	●	-	T	Yes
Black bear/ *Ursus amerincanus*	○	○	○	●	●	●	○	○	○	○	○	○	○	○	○	○	○	●	-	T	No
Louisiana black bear/ *Ursus amerincanus luteolus*	○	○	○	○	○	○	○	○	○	○	○	○	○	●	●	●	●	●	DL	T	No

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	1	**2A**	**2B**	**3A**	**3B**	**3C**	**3C**	**4**	**4**	**3C**	**4**	**3C**	**4**	**3C**	**4**	**5**	**5**	**5**	**--**	**--**	**--**
Humpback Whale/ *Megaptera novaeangliae*	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	LE	E	No
Mollusks																					
Sandbank pocketbook/ *Lampsilis satura*	●	●	●	●	●	●	●	●	○	●	●	●	●	○	○	○	○	●	-	T	Yes
Louisiana pigtoe/ *Pleurobema riddellii*	●	●	●	●	●	●	●	●	○	●	●	●	●	○	○	○	○	●	-	T	Yes
Texas heelsplitter/ *Potamilus amphichaenus*	●	●	●	●	●	●	●	●	○	●	●	●	●	○	○	○	○	○	-	T	Yes
Smooth pimpleback/ *Quadrula houstonensis*	○	○	○	○	○	○	○	○	●	●	●	●	●	●	●	●	●	○	-	T	Yes
Texas fawnsfoot/ *Truncilla macrodon*	○	○	○	○	○	○	○	○	●	●	●	●	●	●	●	●	●	○	C	T	Yes
Reptiles																					
Loggerhead sea turtle/ *Caretta*	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	T	T	No
Alligator snapping turtle/ *Macrochelys temminckii*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	○	●	-	T	Yes
Texas horned lizard/ *Phrynosoma cornutum*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	-	T	Yes

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	1	2A	2B	3A	3B	3C	3C	4	4	3C	4	3C	4	3C	4	5	5	5	--	--	--
Timber rattlesnake/ *Crotalus horridus*	●	●	●	●	●	●	●	●	○	●	●	●	●	●	●	●	●	●	-	T	Yes
Texas tortoise/ *Gopherus berlandieri*	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	-	T	No

Source: USFWS 2019; TPWD 2019, TXNDD 2019

○ – Not Reported for County; ● – Reported for County; E – Endangered, in danger of extinction; T – Threatened, severely depleted or impacted by man; DL – Federally delisted; C – Candidate for federal listing; PL – Proposed 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 the USFWS recovery plans or 5-year reviews, if available, or one of the following sources: James R. Dixon, *Amphibians and Reptiles of Texas.* College Station: Texas A&M University Press, 2013; Robert G. Howells, Raymond W. Neck, and Harold D. Murray, *Freshwater Mussels of Texas,* Austin: University of Texas Press, 1996; Mark Lockwood and Brush Freeman, *The Texas Ornithological Society Handbook of Texas Birds,* College Station: Texas A&M University Press, 2014; David J. Schmidly, *The Mammals of Texas,* Austin: University of Austin Press, 2004; Michael R.J. Forstner 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 Verbena (*Abronia macrocarpa*) Recovery Plan, Albuquerque: USFWS, 1992; USFWS, *Interior Least Tern (Sternula antillarum) 5-Year Review: Summary and Evaluation,* Albuquerque, 2013; USFWS, *International Recovery Plan Whooping Crane (Grus americana) Third Revision,* Albuquerque, 2007; USFWS, *Navasota Ladies'-Tresses (Spiranthes parksii) Recovery Plan,* Albuquerque, 1984; NatureServe, *NatureServe,* 2016, accessed April 13, 2019, http://explorer.natureserve.org/servlet/NatureServe?searchName=Rhododon+ciliatus; Bruce C. Thompson, 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 Linda Campbell, *Endangered and Threatened Animals of Texas: Their Life History and Management,* Austin: Texas Parks and Wildlife Press, 1995.

No TXNDD records were reported for the whooping crane within affected counties of the Study Area. The Study Area is not within range of this species' wintering or nesting habitat. However, suitable stopover habitat for this species may be present in emergent wetlands and adjacent, relatively open habitats found within the Study Area. In addition, the Study Area occurs within the eastern portion of the whooping crane's 95 percent migration corridor, which extends from the panhandle eastward to the east-central portion of the state.[82] NWI data indicate a total of 20.15 acres (0.08 km^2) of temporary impacts and 4.84 acres (0.02 km^2) of permanent impacts to whooping crane suitable stopover habitat (emergent wetlands only) for the Study Area. Therefore, there is potential for this species to occur as a migrant/transient within suitable stopover habitat throughout the Study Area

Two federally listed endangered wildlife species have the potential to occur within the Study Area; these are the Houston toad and interior least tern (see **Appendix D, Natural Resources Mapbook**).

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.[83] 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.[84] The breeding season for the Houston toad lasts from January to June, with a typical year's peak in March and April.[85] The TXNDD reported one historical EOR within the Study Area in Harris County and no others within 5 miles of the Study Area. Presence/absence surveys were completed in 2017, 2018 and 2019. No Houston toads were observed within the survey area; however, Houston toads were observed multiple times throughout the survey period at a location where this species had been found previously near Blackjack, in Robertson County, Texas, which is located approximately 28 miles from the Study Area. Deep sandy soils and areas with high canopy cover occur throughout the Study Area in Leon County (see **Appendix D, Natural Resources Mapbook)**; therefore, there is potential for this species to occur within the Study Area. Methodology for the habitat suitability model and surveys can be found in **Section 3.6.3, Methodology**.

The interior least tern is a federally listed endangered bird. USFWS published a proposed rule on October 24, 2019, to remove the interior least tern from the federal list of endangered and threatened wildlife.[86] 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. 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.[87, 88] 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

[82] Jon L. Dunn and Jonathan Alderfer, *National Geographic Field Guide to the Birds of North America,* 2006.
[83] USFWS, "Houston Toad (*Bufo houstonensis*) 5-year Review: Summary and Evaluation," Austin, TX: U.S. Fish and Wildlife Service, 2011.
[84] Michael R. J. Forstner and James R. Dixon, "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 2011.
[85] USFWS, "Houston Toad (*Bufo houstonensis*) 5-year Review: Summary and Evaluation," Austin, TX: U.S. Fish and Wildlife Service, 2011.
[86] USFWS, "Proposed Rule, Removal of the Interior Least Tern from the Federal List of Endangered and Threatened Wildlife," October 24, 2019, https://www.federalregister.gov/documents/2019/10/24/2019-23119/endangered-and-threatened-wildlife-and-plants-removal-of-the-interior-least-tern-from-the-federal.
[87] Linda Campbell, *Endangered and Threatened Animals of Texas: Their Life History and Management*, Austin, Texas: Texas Parks and Wildlife Press, 1995.
[88] Bruce C. Thompson, Jerome A. Jackson, Joanna Burger; Eileen M. Kirsch, Jonathan L. Atwood, *The Birds of North America,* Philadelphia: The Academy of Natural Sciences, 1997.

Reservoir, Zapata County[89]. 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.[90] According to the TXNDD, for this species there are two EORs within 5 miles of the Study Area in Dallas County, two EORs within 5 miles of the Study Area in Freestone County, and one EOR within 1 mile of the Study Area in Leon County[91] (see **Appendix D, Natural Resources Mapbook**). The interior least tern is assumed to be transient and/or migrant; however, the EORs in Freestone and Leon Counties, and one in the Study Area in Leon County, are for breeding/nesting populations.

Furthermore, based on information from observations recorded at the Jewett Mine between 1994 and 2018, interior least terns were recorded nesting throughout permitted portions of the mine property, except in 2008, 2016, 2017 and 2019.[92] In 2018, interior least terns were also observed fishing in various ponds located throughout the mine property. After review of information provided by the Jewett Mine operator, a portion of the EOR that intersects Segment 4 corresponds to recorded interior least tern nesting in 2001. The mine also recorded the species nesting adjacent to Segment 3C along IH-45 in 2007 and 2009. One nesting area was recorded at the Jewett Mine in 2018, including 10 individual nests observed near FM 39, approximately 3.5 miles east of Segment 4. Based on this information, the interior least tern has moderate potential to nest within and adjacent to the Study Area in Leon, Freestone and Dallas Counties. 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.

The Texas fawnsfoot, a species of freshwater mussel, is listed as a federal candidate species and a state-listed threatened species. It was historically found in the Colorado, Trinity, Navasota 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.[93] The TXNDD search did not report any EORs for this species within or immediately surrounding the Study Area.[94] The nearest EOR was recorded approximately 14 miles from the Study Area within the Navasota River in Grimes County. The species could occur in Freestone, Grimes, Navarro, Madison and Waller Counties within the Navasota, Brazos, and Trinity River basins. [95][96] The presumptive range of the Texas fawnsfoot within the Trinity River Basin is limited to Dallas, Ellis, and Navarro Counties in the Project Area. While sandy substrates are present within perennial streams within the Project area; there is no potential for this species to occur since the only major river crossed by the Project is in Dallas County where the species is not known to occur.[97] The Project would not cross any other large or major river stems such as the Navasota or Brazos Rivers. Therefore, there is no potential for this species to occur within the Study Area. Additionally, there is no protection afforded federal candidate species.

The following 13 non-transient state-listed species have the potential to inhabit the Study Area:

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[89] Mark Lockwood and Brush Freeman, *The Texas Ornithological Society Handbook of Texas Birds*, College Station: Texas A&M University Press, 2014.

[90] USFWS, "Interior Least Tern (*Sternula antillarum*) 5-Year Review: Summary and Evaluation," Albuquerque, New Mexico: U.S. Fish and Wildlife Service, 2013.

[91] TPWD, "Texas Natural Diversity Database," Austin: Texas Parks and Wildlife Department, Wildlife Diversity Branch, 2019.

[92] Personal communication, Texas Westmoreland Coal Company, Interior Least Tern Monitoring at Jewett Mine, Received April 4, 2019.

[93] Robert G. Howells, Raymond W. Neck, and Harold D. Murray, *Freshwater Mussels of Texas*, Austin, Texas: University of Texas Press, 1996.

[94] TPWD, "Texas Natural Diversity Database," Austin: Texas Parks and Wildlife Department, Wildlife Diversity Branch, 2019.

[95] Federal Register Vol. 76, No. 194 October 6, 2011: 62166-62212.

[96] Charles, R. Randklev, Kentaro Inouse, Michael Hart, and Anna Pieri, Assessing the Conservation Status of Native Freshwater Mussels (Family: Unionidae) in the Trinity River Basin, Final Report to Texas Parks and Wildlife Department, Texas A&M University, College Station, TX, 2017.

[97] USFWS, Texas mussel distribution maps, dated august 2, 2016, accessed September 13, 2019, https://www.fws.gov/southwest/es/Documents/R2ES/AUES_Mussels_DRAFT_maps_20160915.pdf l.

- The federally delisted bald eagle, a state-listed threatened species, 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.[98] They are found along lakes, rivers and coasts where prey is abundant and trees afford nest sites and an unobstructed view of surroundings.[99] According to the TXNDD, there are two EORs for this species within the Study Area, which includes 660 feet beyond the Study Area, one in Navarro County and one in Limestone County. Additionally, there is a single EOR within 5 miles of the Study Area in Limestone, Leon, Grimes and Harris Counties (see **Appendix D, Natural Resources Mapbook**).[100] 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.
- 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,[101] 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.[102] The TXNDD search did not report any EORs for this species within or immediately surrounding the Study Area;[103] 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 swallow-tailed kite, a state-listed threatened species, occurs in lowland forested regions including swamps in open woodlands and marshes along rivers, lakes and ponds. They nest in tall trees in clearings or the edge of forested woodlands, typically in pine, cypress or other deciduous trees.[104] The TXNDD search did not report any EORs for this species within or immediately surrounding the Study Area;[105] 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.[106] TPWD's TXNDD search did not report any EORs for this species within the Study Area;[107] however, main channels, deep chutes and riffles of the Navasota River and West Fork San Jacinto River occur within the Study Area. Therefore, there is potential for this species to occur within the Study Area.
- The western 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,

[98] Mark Lockwood and Brush Freeman, *The Texas Ornithological Society Handbook of Texas Birds*, College Station: Texas A&M University Press, 2014.
[99] David Allen Sibley, *The Sibley Field Guide to Birds of Eastern North America*, New York: Alfred A. Knopf, Inc., 2003.
[100] TPWD, "Texas Natural Diversity Database," Austin: Texas Parks and Wildlife Department, Wildlife Diversity Branch, 2019.
[101] Mark Lockwood and Brush Freeman, *The Texas Ornithological Society Handbook of Texas Birds*, College Station: Texas A&M University Press, 2014.
[102] David Allen Sibley, *The Sibley Field Guide to Birds of Eastern North America*, New York: Alfred A. Knopf, Inc., 2003.
[103] TPWD, "Texas Natural Diversity Database," Austin: Texas Parks and Wildlife Department, Wildlife Diversity Branch, 2019.
[104] TPWD Wildlife Division, Diversity and Habitat Assessment Programs, 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, January 11, 2016, February 26, 2019, April 15, 2019, and June 17, 2019].
[105] TPWD, "Texas Natural Diversity Database," Austin: Texas Parks and Wildlife Department, Wildlife Diversity Branch, 2019.
[106] Chad Thomas, Tim H. Bonner, and Bobby G. Whiteside, *Freshwater Fishes of Texas,* College Station: Texas A&M University Press, 2007.
[107] TPWD, "Texas Natural Diversity Database," Austin: Texas Parks and Wildlife Department, Wildlife Diversity Branch, 2019.

lake outlets and upstream in creeks.[108] The TXNDD has one EOR for this species within the Study Area along Hurricane Creek in Grimes County.[109] There is also potential for this species to occur in other waterways within the Study Area due to 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 search did not report any EORs for this species within the Study Area,[110] bottomland hardwoods do exist within the Study Area and this species has been recorded in Harris County.[111] Additionally, culverts under IH-45 could serve as suitable habitat for the Rafinesque's big-eared bat. Multiple culverts along IH-45 and within the Study Area of Build Alternatives C and F have EORs for bat roosts, including two EORs of the Southeastern myotis bat, a SGCN. Therefore, there is potential for this species to occur within the Study Area.
- The sandbank pocketbook is a state-listed threatened species and 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.[112] The TXNDD reported one EOR for this species within 1 mile of the Study Area in Dallas County[113] (see **Appendix D, Natural Resources Mapbook**). 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 a state-listed threatened species found in streams in the Trinity, Neches and Sabine river systems.[114] The TXNDD reported two EORs for this species within 5 miles of the Study Area in Dallas County and one EOR for this species within 1 mile of the Study Area in Dallas County[115] (see **Appendix D, Natural Resources Mapbook**). In addition, the Study Area is located within the Trinity River system and streams within this system occur within the Study Area; therefore, there is potential for this species to occur.
- The Texas heelsplitter is a state-listed threatened species found in quiet waters on sand and mud in the Sabine, Neches and Trinity River systems.[116] TPWD's TXNDD search did not report any EORs for this species within the Study Area.[117] However, the Study Area contains quiet waters on sand and mud within the Trinity River system; therefore, there is potential for this species to occur.
- The smooth pimpleback, a species of freshwater mussel, is 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. The Study Area is located within the smooth pimpleback's distribution range. The TXNDD search did not report any EORs for this species within or immediately surrounding the Study Area. The EOR record nearest in location was from the

[108] TPWD Wildlife Division, Diversity and Habitat Assessment Programs. 2019. 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, January 11, 2016, February 26, 2019, April 15, 2019, and June 17, 2019].
[109] TPWD, "Texas Natural Diversity Database," Austin: Texas Parks and Wildlife Department, Wildlife Diversity Branch, 2019.
[110] Ibid.
[111] Loren K. Ammerman, Christina L. Hice, and David J. Schmidly, *Bats of Texas,* College Station: Texas A&M Press, 2004.
[112] Robert G. Howells, Raymond W. Neck, and Harold D. Murray, *Freshwater Mussels of Texas*, Austin, Texas: University of Texas Press, 1996.
[113] TPWD, "Texas Natural Diversity Database," Austin: Texas Parks and Wildlife Department, Wildlife Diversity Branch, 2019.
[114] Robert G. Howells, Raymond W. Neck, and Harold D. Murray, *Freshwater Mussels of Texas*, Austin, Texas: University of Texas Press, 1996.
[115] TPWD, "Texas Natural Diversity Database," Austin: Texas Parks and Wildlife Department, Wildlife Diversity Branch, 2019.
[116] Robert G. Howells, Raymond W. Neck, and Harold D. Murray, *Freshwater Mussels of Texas*, Austin, Texas: University of Texas Press, 1996.
[117] TPWD, "Texas Natural Diversity Database," Austin: Texas Parks and Wildlife Department, Wildlife Diversity Branch, 2019.

Navasota River and is approximately 1,210 miles away from the Study Area but is within the Navasota River in Northern Grimes County. 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 alligator snapping turtle is a state-listed threatened species characterized by a large head and strongly hooked beak.[118] 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.[119] The TXNDD reported one EOR for this species within 1 mile of the Study Area in Harris County[120] and lakes, swamps and rivers exist within and near the Study Area (see **Appendix D, Natural Resources Mapbook**). Therefore, there is potential for this species to occur.
- 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.[121] There are records for this species in every county in the Study Area except Waller County.[122] The TXNDD search did not report any EORs for this species within the Study Area,[123] but since the Study Area is located within their 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.[124] While the TXNDD search did not report any EORs for this species in the Study Area,[125] it has been recorded in all Study Area counties except Limestone County.[126] As lowland forest and woodlands near water sources occur within the Study Area, there is potential for this species to occur.

3.6.4.5 Critical Habitat

No designated critical habitat for any federally protected wildlife species occurs within the Study Area.[127]

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 without the contribution of Build Alternatives. Other planned projects, such as the IH-35 East roadway improvement project in Dallas County, Waxahachie Line rail project in Dallas and Ellis Counties and Integrated Pipeline Project in Navarro and Ellis Counties and ongoing growth in the Study Area may require land clearing of vegetation

[118] Roger Conant and Joseph T. Collins, *Reptiles and Amphibians of Eastern and Central North America*, Third Edition Expanded, Boston: Houghton Mifflin Company, 1998.
[119] Ibid.
[120] TPWD, "Texas Natural Diversity Database," Austin: Texas Parks and Wildlife Department, Wildlife Diversity Branch, 2019.
[121] James R. Dixon, *Amphibians and Reptiles of Texas,* College Station: Texas A&M University Press, 2013.
[122] ibid.
[123] TPWD, "Texas Natural Diversity Database," Austin: Texas Parks and Wildlife Department, Wildlife Diversity Branch, 2019.
[124] J. R. Dixon and J. E. Werler, *Texas Snakes*: *A Field Guide*, Austin: University of Texas Press, 2000.
[125] TPWD, "Texas Natural Diversity Database," Austin: Texas Parks and Wildlife Department, Wildlife Diversity Branch, 2019.
[126] James R. Dixon, *Amphibians and Reptiles of Texas,* College Station: Texas A&M University Press, 2013.
[127] USFWS, *Critical Habitat Portal,* accessed June 19, 2019, http://criticalhabitat.fws.gov/crithab.

and wildlife habitat for construction. The impacts of these projects, in addition to this Project, are discussed in **Table 4-9** in **Chapter 4, Indirect and Cumulative Impacts**.

3.6.5.2 Build Alternatives

This section analyzes potential impacts to natural ecological systems and protected species as a result of constructing and operating the Project. **Section 2.4.3, Corridor Screening Methodology**, and specifically **Table 2-2: Level II, Stage I Environmental Criteria**, discuss how the alternatives were delineated to avoid impacts. Direct impacts and indirect effects (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 is adjacent to existing transportation and utility corridors, disturbed grasslands and agriculture. Nonetheless, all Build Alternatives would result in the direct loss of native vegetation. Impacts to vegetation would be limited to that necessary for the construction, operation and maintenance of the HSR.

Construction of the Project, including the rail infrastructure and ancillary facilities, would result in the permanent loss of vegetation. Construction of the Project would involve vegetation removal, ground clearing, placement of fill material and construction of roads, culverts, bridges, viaduct, embankment and stations facilities. These potentially could also result in disturbance to and destruction of rare plant populations and modification of existing plant species composition.

Staging areas, access roads and development of other facilities needed to support construction could also result in a permanent modification of vegetation. In some cases, vegetation could revert back to pre-construction conditions. However, until disturbed areas are stabilized, the potential would exist for increased sediment transport during storm events and an increased potential for the introduction or spread of non-native and invasive plant species. TCRR shall develop an SWPPP that will help address these issues, as outlined in **WQ-CM#3: Stormwater Management/Stormwater Pollution Prevention Plan,** and **NR-MM#3: Aquatic Species.**

Following construction, the necessary removal of trees and other vegetation that have the potential to interfere with the safe and reliable operation of the HSR would be performed during routine maintenance activities. This ground disturbance would also provide 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. See **Section 3.6.6, Avoidance, Minimization and Mitigation,** and **NR-CM#4: Section 7 Consultation and Biological Opinion,** for information regarding avoidance of these impacts. However, for some protected plant species such as Navasota ladies'-tresses (**Section 3.6.4.4.1, Protected Plant Species**), which has been observed in maintained ROWs and disturbed areas, a maintained ROW could help prevent the encroachment and competition of woody species.[128]

The following sections present potential temporary and permanent impacts to the EMST vegetation types by county and segment.

[128] C. L. Wonkka, 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," *Native Plants Journal* 13. No.3: 236-243, 2012.

Dallas County

The temporary and permanent impacts to the 16 vegetation types represented in Segment 1 can be found in **Table 3.6-10**. The three vegetation types with the largest acreage of impacts for Segment 1 would be:

- Blackland Prairie: Disturbance or Tame Grassland
- Central Texas: Floodplain Hardwood Forest
- Row Crops

Table 3.6-10: Potential Impacts to Vegetation (acres) – Dallas County		
Vegetation Type (EMST Code)	Segment 1	
	Temporary	Permanent
Blackland Prairie: Disturbance or Tame Grassland (207)	48	61
Post Oak Savanna: Post Oak Motte and Woodland (604)	2	1
Edwards Plateau: Deciduous Oak/Evergreen Motte and Woodland (1103)	0	35
Edwards Plateau: Oak/Hardwood Motte and Woodland (1104)	3	54
Edwards Plateau: Savanna Grassland (1107)	11	13
Central Texas: Floodplain Hardwood/Evergreen Forest (1803)	1	4
Central Texas: Floodplain Hardwood Forest (1804)	22	52
Central Texas: Floodplain Herbaceous Vegetation (1807)	6	8
Central Texas: Riparian Hardwood Forest (1904)	2	2
Native Invasive: Deciduous Woodland (9104)	19	54
Native Invasive: Juniper Shrubland (9105)	0	3
Native Invasive: Mesquite Shrubland (9106)	2	6
Row Crops (9307)	72	53
Urban High Intensity (9410)	42	72
Urban Low Intensity (9411)	74	94
Open Water (9600)	0	5

Source: TPWD 2014
'--' - Vegetation types not located in the segment.

Impacts to vegetation that occur within USACE-Project in Dallas County are detailed in **Appendix E, USACE 408 Impacts Technical Memorandum**.

Ellis County

The temporary and permanent impacts to the six vegetation types represented in Segment 1 can be found in **Table 3.6-11**. 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 3.6-11**. 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 14 vegetation types represented in Segment 2B can be found in **Table 3.6-11**. 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 3.6-11**. 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 six vegetation types represented in Segment 3B can be found in **Table 3.6-11**. 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 3.6-11**. 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

Navarro County

The temporary and permanent impacts to the 16 vegetation types represented in Segment 3A can be found in **Table 3.6-12**. 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 3.6-12**. 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 18 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:

- Blackland Prairie: Disturbance or Tame Grassland
- Row Crops

Table 3.6-11: 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	12	65	219	73	219	0	6	0	4	0	6
Edwards Plateau: Oak/Hardwood Slope Forest (904)	--	--	0	1	--	--	--	--	--	--	--	--
Central Texas: Floodplain Live Oak Forest (1802)	--	--	--	0	--	--	--	--	--	--	--	--
Central Texas: Floodplain Hardwood Forest (1804)	--	1	11	17	12	21	--	--	--	--	--	--
Central Texas: Floodplain Deciduous Shrubland (1806)	--	--	--	--	1	2	--	--	--	--	--	--
Central Texas: Floodplain Herbaceous Vegetation (1807)	--	--	0	7	6	8	--	--	--	--	--	--
Central Texas: Riparian Hardwood Forest (1904)	0	--	5	7	7	10	0	2	0	0	0	2
Central Texas: Riparian Deciduous Shrubland (1906)	--	--	--	1	--	2	--	--	--	--	--	--
Central Texas: Riparian Herbaceous Vegetation (1907)	--	--	1	8	1	6	--	--	--	0	--	--
Swamp (9004)	--	--	--	0	0	0	--	--	--	--	--	--
Native Invasive: Deciduous Woodland (9104)	4	2	24	33	38	60	0	8	0	3	0	8
Native Invasive: Juniper Shrubland (9105)	--	--	--	--	0	1	--	--	--	--	--	--
Native Invasive: Mesquite Shrubland (9106)	--	--	3	9	5	9	--	--	--	0	--	--
Row Crops (9307)	34	15	187	348	188	299	0	42	0	52	0	42
Urban Low Intensity (9411)	--	1	4	2	8	5	--	--	--	--	--	--
Open Water (9600)	--	--	--	1	0	1	--	--	--	--	--	--

Source: TPWD 2014

“--“ Vegetation type not present in segment

Table 3.6-12: 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)	179	405	157	513	210	464
Post Oak Savanna: Post Oak Motte and Woodland (604)	29	24	6	63	22	23
Post Oak Savanna: Savanna Grassland (607)	3	9	4	42	3	9
Post Oak Savanna: Post Oak - Yaupon Motte and Woodland (613)	--	0	--	--	--	0
Edwards Plateau: Oak/Hardwood Slope Forest (904)	--	0	0	2	--	0
Central Texas: Floodplain Hardwood Forest (1804)	2	26	8	22	1	29
Central Texas: Floodplain Deciduous Shrubland (1806)	2	2	4	2	0	1
Central Texas: Floodplain Herbaceous Vegetation (1807)	15	77	7	24	14	71
Central Texas: Riparian Hardwood - Evergreen Forest (1903)	--	--	--	--	--	--
Central Texas: Riparian Hardwood Forest (1904)	1	2	0	6	1	2
Central Texas: Riparian Deciduous Shrubland (1906)	--	--	--	--	--	--
Central Texas: Riparian Herbaceous Vegetation (1907)	1	5	0	15	1	4
Barren (9000)	--	7	--	--	--	7
Marsh (9007)	--	--	--	--	0	1
Native Invasive: Juniper Woodland (9101)	--	2	--	--	--	2
Native Invasive: Deciduous Woodland (9104)	6	22	3	27	7	51
Native Invasive: Mesquite Shrubland (9106)	5	14	3	11	2	20
Row Crops (9307)	31	166	64	216	31	159
Urban Low Intensity (9411)	3	7	1	15	6	6
Urban High Intensity	--	--	--	5	0	--
Open Water (9600)	--	--	--	2	--	--

Source: TPWD 2014

"--" Vegetation type not present in segment

Freestone County

The temporary and permanent impacts to the 17 vegetation types represented in Segment 3C can be found in **Table 3.6-13**. 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 14 vegetation types represented in Segment 4 can be found in **Table 3.6-13**. 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 3.6-13: Potential Impacts to Vegetation (acres) – Freestone County				
Vegetation Type (EMST Code)	Segment 3C		Segment 4	
	Temp.	Perm.	Temp.	Perm.
Blackland Prairie: Disturbance or Tame Grassland (207)	0	35	176	115
Post Oak Savanna: Post Oak Motte and Woodland (604)	129	218	9	168
Post Oak Savanna: Savanna Grassland (607)	142	377	39	247
Post Oak Savanna: Post Oak - Yaupon Motte and Woodland (613)	3	8	--	11
Post Oak Savanna: Sandyland Woodland and Shrubland (706)	--	1	--	15
Post Oak Savanna: Sandyland Grassland (707)	0	1	0	1
Central Texas: Floodplain Hardwood Forest (1804)	25	49	0	37
Central Texas: Floodplain Deciduous Shrubland (1806)	0	1	--	--
Central Texas: Floodplain Herbaceous Vegetation (1807)	9	23	8	21
Central Texas: Floodplain Seasonally Flooded Hardwood Forest (1814)	--	0	--	--
Central Texas: Riparian Hardwood - Evergreen Forest (1903)	--	0	--	--
Central Texas: Riparian Hardwood Forest (1904)	--	1	0	5
Central Texas: Riparian Deciduous Shrubland (1906)	--	0	--	0
Central Texas: Riparian Herbaceous Vegetation (1907)	0	4	0	5
Barren (9000)	0	6	--	--
Native Invasive: Juniper Woodland (9101)	4	21	0	16
Native Invasive: Deciduous Woodland (9104)	2	1	1	7
Native Invasive: Mesquite Shrubland (9106)	3	10	1	5
Urban High Intensity (9410)	7	189	--	--
Urban Low Intensity (9411)	2	128	0	4
Open Water (9600)	--	0	--	--

Source: TPWD 2014

"--" Vegetation type not present in segment

Limestone County

The potential temporary and permanent impacts to the seven 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: Savanna Grassland

Table 3.6-14: Potential Impacts to Vegetation (acres) – Limestone County		
Vegetation Type (EMST Code)	Segment 4	
	Temp.	Perm.
Post Oak Savanna: Post Oak Motte and Woodland (604)	0	88
Post Oak Savanna: Savanna Grassland (607)	23	193
Post Oak Savanna: Post Oak - Yaupon Motte and Woodland (613)	--	0
Central Texas: Floodplain Hardwood Forest (1804)	0	11
Central Texas: Floodplain Herbaceous Vegetation (1807)	0	10
Central Texas: Riparian Hardwood Forest (1904)	0	2
Central Texas: Riparian Herbaceous Vegetation (1907)	0	2
Barren (9000)	0	3
Urban High Intensity (9410)	--	1
Urban Low Intensity (9411)	--	2
Open Water (9600)	--	0

Source: TPWD 2014

Leon County

The temporary and permanent impacts to the 13 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 would be:

- Post Oak Savanna: Post Oak Motte and Woodland
- Post Oak Savanna: Savanna Grassland

The potential temporary and permanent impacts to the 15 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: Post Oak Motte and Woodland
- Post Oak Savanna: Savanna Grassland

Table 3.6-15: Potential Impacts to Vegetation (acres) – Leon County

Vegetation Type (EMST Code)	Segment 3C		Segment 4	
	Temp.	Perm.	Temp.	Perm.
Blackland Prairie: Disturbance or Tame Grassland (207)	--	17	--	7
Post Oak Savanna: Post Oak Motte and Woodland (604)	58	345	112	439
Post Oak Savanna: Savanna Grassland (607)	39	655	116	423
Post Oak Savanna: Post Oak - Yaupon Motte and Woodland (613)	--	3	--	1
Post Oak Savanna: Sandyland Woodland and Shrubland (706)	--	8	--	23
Post Oak Savanna: Sandyland Grassland (707)	--	14	--	13
Central Texas: Floodplain Hardwood Forest (1804)	0	28	1	23
Central Texas: Floodplain Herbaceous Vegetation (1807)	0	44	1	22
Central Texas: Riparian Hardwood Forest (1904)	--	--	1	5
Central Texas: Riparian Herbaceous Vegetation (1907)	--	2	6	4
Pineywoods: Pine Forest or Plantation (3001)	--	7	--	--
Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest (4804)	--	--	--	2
Pineywoods: Small Stream and Riparian Wet Prairie (4817)	--	--	--	1
Barren (9000)	1	0	2	4
Marsh (9007)	--	0	1	--
Native Invasive: Juniper Woodland (9101)	--	2	--	--
Native Invasive: Deciduous Woodland (9104)	--	--	--	3
Native Invasive: Juniper Shrubland (9105)	--	10	--	--
Row Crops (9307)	--	--	--	1
Urban High Intensity (9410)	14	69	0	1
Urban Low Intensity (9411)	5	80	0	4
Open Water (9600)	--	0	--	2

Source: TPWD 2014

"--" Vegetation type not present in segment

Madison County

The potential temporary and permanent impacts to the six 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 seven 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 4 would be:

- Post Oak Savanna: Savanna Grassland

Table 3.6-16: 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	25	94
Post Oak Savanna: Savanna Grassland (607)	12	438	133	280
Post Oak Savanna: Post Oak - Yaupon Motte and Woodland (613)	--	0	0	1
Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest (4804)	2	42	11	35
Pineywoods: Small Stream and Riparian Seasonally Flooded Hardwood Forest (4814)	--	--	1	0
Pineywoods: Small Stream and Riparian Wet Prairie (4817)	0	26	4	7
Marsh (9007)	--	0	--	--
Native Invasive: Juniper Woodland (9101)	--	--	--	5
Urban High Intensity (9410)	0	36	--	--
Urban Low Intensity (9411)	--	3	0	1
Open Water (9600)	--	0	--	--

Source: TPWD 2014

"--" 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 3.6-17**. 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 3.6-17**. 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 21 vegetation types represented in Segment 5 can be found in **Table 3.6-17**. 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 3.6-17: 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)	--	--	--	--	28	159
Post Oak Savanna: Post Oak - Redcedar Motte and Woodland (603)	--	--	--	--	0	--
Post Oak Savanna: Post Oak Motte and Woodland (604)	12	28	--	13	53	176
Post Oak Savanna: Savanna Grassland (607)	0	51	--	33	146	300
Post Oak Savanna: Post Oak - Yaupon Motte and Woodland (613)	--	--	--	--	--	5
Central Texas: Floodplain Hardwood Forest (1804)	--	--	--	--	4	14
Central Texas: Floodplain Herbaceous Vegetation (1807)	--	--	--	--	3	6
Central Texas: Riparian Hardwood - Evergreen Forest (1903)	--	--	--	--	1	0
Central Texas: Riparian Hardwood Forest (1904)	--	--	--	--	0	3
Central Texas: Riparian Herbaceous Vegetation (1907)	--	--	--	--	1	8
Pineywoods: Pine Forest or Plantation (3001)	--	--	--	--	2	74
Pineywoods: Pine - Hardwood Forest or Plantation (3003)	--	--	--	--	1	30
Pineywoods: Upland Hardwood Forest (3004)	--	--	--	--	13	121
Pineywoods: Small Stream and Riparian Temporarily Flooded Mixed Forest (4803)	--	--	--	--	--	1
Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest (4804)	0	4	--	16	--	22
Pineywoods: Small Stream and Riparian Wet Prairie (4817)	--	7	--	7	0	24
Barren (9000)	--	--	--	--	--	0
Marsh (9007)	--	--	--	--	--	0
Native Invasive: Deciduous Woodland (9104)	--	--	--	--	0	17
Native Invasive: Mesquite Shrubland (9106)	--	--	--	--	1	1
Native Invasive: Deciduous Shrubland (9126)	--	--	--	--	1	0
Pineywoods: Disturbance or Tame Grassland (9197)	--	--	--	--	144	149
Urban High Intensity (9410)	--	--	--	--	0	1
Urban Low Intensity (9411)	--	--	--	--	1	6
Open Water (9600)	--	--	--	-	--	7

Source: TPWD 2014

"--" Vegetation type not present in segment

Waller County

The potential temporary and permanent impacts to the 14 vegetation types represented in Segment 5 can be found in **Table 3.6-18**. The vegetation type with the largest acreage of impacts in Segment 5 would be:

- Gulf Coast: Coastal Prairie

Table 3.6-18: Potential Impacts to Vegetation (acres) – Waller County		
Vegetation Type (EMST Code)	Segment 5	
	Temp.	Perm.
Blackland Prairie: Disturbance or Tame Grassland (207)	--	1
Post Oak Savanna: Post Oak Motte and Woodland (604)	4	58
Post Oak Savanna: Savanna Grassland (607)	--	9
Pineywoods: Pine Forest or Plantation (3001)	0	54
Pineywoods: Pine - Hardwood Forest or Plantation (3003)	1	10
Pineywoods: Upland Hardwood Forest (3004)	11	58
Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest (4804)	--	6
Pineywoods: Small Stream and Riparian Wet Prairie (4817)	--	2
Gulf Coast: Coastal Prairie (5207)	6	90
Native Invasive: Deciduous Woodland (9104)	--	0
Native Invasive: Deciduous Shrubland (9126)	1	2
Pineywoods: Disturbance or Tame Grassland (9197)	5	11
Pine Plantation > 3 meters tall (9301)	0	1
Row Crops (9307)	--	0
Urban Low Intensity (9411)	0	0

Source: TPWD 2014
"--" Vegetation type not present in segment

Harris County

The potential temporary and permanent impacts to the 13 vegetation types represented in Segment 5 can be found in **Table 3.6-19**. The vegetation type with the largest acreage of impacts in this Segment 5 would be:

- Gulf Coast: Coastal Prairie

Table 3.6-19: Potential Impacts to Vegetation (acres) – Harris County								
Vegetation Type (EMST Code)	Segment 5		Industrial Site Terminal Station		Northwest Mall Terminal Station		Northwest Transit Center Terminal Station	
	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.
Post Oak Savanna: Live Oak Motte and Woodland (602)	--	4	--	--	--	--	--	--
Post Oak Savanna: Post Oak - Redcedar Motte and Woodland (603)	0	3	--	--	--	--	--	--
Post Oak Savanna: Post Oak Motte and Woodland (604)	8	2	--	--	--	--	--	--
Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest (4804)	--	1	--	--	--	--	--	--
Gulf Coast: Coastal Prairie (5207)	437	359	--	--	--	--	--	--
Gulf Coast: Coastal Prairie Pondshore (5307)	0	2	--	--	--	--	--	--
Barren (9000)	0	2	--	0	1	2	4	2
Marsh (9007)	0	0	--	--	--	--	--	--
Native Invasive: Deciduous Woodland (9104)	0	12	--	--	--	--	--	--

Table 3.6-19: Potential Impacts to Vegetation (acres) – Harris County

Vegetation Type (EMST Code)	Segment 5		Industrial Site Terminal Station		Northwest Mall Terminal Station		Northwest Transit Center Terminal Station	
	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.
Native Invasive: Mesquite Shrubland (9106)	0	2	--	--	--	--	--	--
Native Invasive: Huisache Woodland or Shrubland (9124)	5	16	--	--	--	--	--	--
Pineywoods: Disturbance or Tame Grassland (9197)	1	--	--	0	--	--	--	--
Pine Plantation > 3 meters tall (9301)	1	11	--	--	--	--	--	--
Row Crops (9307)	14	65	--	--	--	--	--	--
Urban High Intensity (9410)	28	141	0	84	26	73	8	84
Urban Low Intensity (9411)	42	109	--	8	0	1	--	1
Open Water (9600)	--	0	--	--	--	--	--	--

Source: TPWD 2014

"—" Vegetation type not present

3.6.5.2.2 *<u>Wildlife</u>*

All Build Alternatives would result in the direct loss of wildlife habitat, increase of habitat fragmentation and contribution 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 Project and existing infrastructure, creating areas of less value to wildlife and a loss of species diversity and abundance. Habitat fragmentation can restrict movement and dispersal of wildlife. As a result of restricting wildlife movement, habitat fragmentation can also decrease gene flow between separated populations of some wildlife species, which may in turn affect populations. **Table 3.6-20** and **Table 3.6-21** identify 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. For grasslands, all areas along the Project that would be constructed on embankment would be considered fragmented post construction. For shrub/woodlands, all areas along the Project that would be constructed on embankment or viaduct would be considered fragmented post construction.

Table 3.6-20: 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	15	127	7	238	5	204	3	562
Shrub/Woodland	15	277	4	110	5	168	9	154
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	3	615	5	2,065	5	1,596	5	1,569
Shrub/Woodland	12	165	4	1,258	13	1,190	15	816

Source: AECOM 2019

Table 3.6-21: 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	5	4,092	5	4,145	5	3,999
Shrub/Woodland	12	2,547	12	2,558	6	2,461
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	5	4,058	4	4,111	5	3,965
Shrub/Woodland	12	2,605	13	2,616	7	2,519

Source: AECOM, 2019

The summary of percent change in edge to area ratio and loss of habitat for the segments is provided below:

- Segment 3B would have the lowest percent of change in edge to area ratio for grasslands at 3 percent, and Segment 1 would have the highest percent of change in edge to area ratio for grasslands at 15 percent.
- Segment 3C would have the lowest change in edge to area ratio for shrub/woodlands at 4 percent, and Segment 1 would have the highest percent of change in edge to area ratio for shrub/woodlands at 15 percent.
- Segment 1 would have the lowest loss of habitat for grasslands at 127 acres, and Segment 3C would have the highest loss of habitat for grasslands at 2,065 acres.

- Segment 2A would have the lowest loss of habitat for shrub/woodlands at 110 acres, and Segment 3C would have the highest loss of habitat for shrub/woodlands at 1,258 acres.

The summary of percent change in edge to area ratio and loss of habitat for the Build Alternatives is provided below:

- Alternative E would have the lowest percent of change in edge to area ratio for grasslands at 4 percent, and Alternative C would have the highest percent of change in edge to area ratio for grasslands at 5 percent.
- Alternative C would have the lowest change in edge to area ratio for shrub/woodlands at 6 percent, and Alternative E would have the highest percent of change in edge to area ratio for shrub/woodlands at 13 percent.
- Alternative F would have the lowest loss of habitat for grasslands at 3,965 acres, and Alternative B would have the highest loss of habitat for grasslands at 4,145 acres.
- Alternative C would have the least amount of habitat loss for shrub/woodlands at 2,461 acres, and Alternative E would have the highest loss of habitat for shrub/woodlands at 2,616 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 as well as 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 55 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 **Section 3.7, Waters of the U.S.,** and **Section 3.8, Floodplains,** similar features installed for drainage and flood control may also be used by wildlife. Mitigation measures to minimize impacts to wildlife movement are described in **Section 3.6.6, Avoidance, Minimization and Mitigation, NR-MM#7: Wildlife Mortality Recording Forms**.

While habituation to transportation noise, such as at airports, highways and urban centers, is commonly seen in some species and wildlife, the effect of trainset noise and vibration on wildlife is unclear as it has not been thoroughly studied. While the passage of a trainset 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 trainsets. Migratory species and species that do not consistently inhabit the area may be more likely to be affected by noise from passing trainsets.[129] As detailed in **Section 3.4, Noise and Vibration,** and according to the *FRA Interim Criteria for Train Noise Effects on Animals*, the noise exposure limit for domestic (livestock and poultry) and wild animals (mammals and birds) is 100 decibels.[130] For HSR trainsets 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 embankment and there would be wildlife or livestock crossings enclosed in a culvert, noise levels would be reduced by shielding that is inherent in the design, either below the viaduct or within

[129] C. E. Hanson, "High Speed Train Noise Effects on Wildlife and Domestic Livestock," *Noise and Vibration Mitigation for Rail Transportation Systems*, edited by Burkhard Schulte-Werning, et al., 26-32. Springer, 2008.

[130] FRA, "Interim Criteria for Train Noise Effects on Animals," last updated October 24, 2012, https://railroads.dot.gov/elibrary/high-speed-ground-transportation-noise-and-vibration-impact-assessment.

the culvert. Except for blasting, which is not anticipated for the Project, the effects of construction noise (e.g., equipment involved in site preparation, grading and earthwork; and the installation of the rail tracks and infrastructure) on wildlife would be limited to the immediate area of the construction site. Currently, there are no criteria for assessment of impacts from vibration on wildlife. However, as detailed in **Section 3.4.5.2.1, Noise and Vibration, Construction Noise and Vibration Impacts,** during construction, some activities may cause perceptible ground-borne vibration, most notably pile driving for structures and vibratory compaction for ground improvements. Potential vibration impacts other than those from pile driving and vibratory compaction would be limited to annoyance effects. Potential mitigation measures include additional assessments under **NV-MM#1: Additional Noise and Vibration Assessments for Operation**.

The construction of the Project could result in the disturbance and potential mortality of wildlife, particularly during vegetation clearing and grading. The removal of vegetation during the breeding bird season, late winter through spring and summer, could result in the loss of active bird nests (i.e., a nest that contains viable eggs and/or chicks) and potentially adult birds. 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, currently there is not a permit process for the incidental take of migratory bird species. Take resulting from the construction or operation of the Project would be considered incidental. The primary potential impact to breeding birds would be related to active nests. Measures would be taken to identify active nests and avoid take when active. Applicable measures/deterrents for prevention of migratory bird nesting with the Study Area would be developed and implemented based on species potentially impacted and location along the Study Area. Avoiding take of migratory birds and/or their active nests would be addressed in a manner consistent with the MBTA. **NR-CM#1: MBTA Compliance** contains more information.

In addition, according to TPWD (**Appendix C, Public and Agency Involvement**), artificial nighttime lighting can attract and disorient night-migrating birds. Birds circling lights' glare can cause collision with structures or exhaustion mortality. As discussed in **Section 3.6.4.3.4, Birds**, the Project is located within the Central Flyway, a major 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, during operation, lighting for the Project would be located at stations and down-shielded. Mitigation measures to avoid impacts to migratory birds and comply with the MBTA are described in **Section 3.6.6, NR-CM#1: MBTA Compliance,** and **NR-MM#6: Wildlife Crossings.**

Construction of the Project is not anticipated to have impacts to forage vegetation, species reproduction or species survival of commercially or recreationally important wildlife species occurring within the Study Area. Game species, such as the 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 temporary loss of forage vegetation; however, the prevalence of similar habitats in adjacent areas would minimize the short-term effect of the loss. Mitigation measures that help avoid impacts to commercially or recreationally important wildlife species are described in **Section 3.6.6, Avoidance, Minimization and Mitigation,** and include **NR-CM#1: MBTA Compliance, NR-CM#2: Bald and Golden Eagle Protection Act Compliance, NR-CM#3: Bat Surveys, NR-CM#4: Section 7 Consultation and Biological Opinion, NR-CM#5: Aquatic Invasive Species Transport, NR-MM#1: Site Training, NR-MM#2: Field Delineation of Sensitive Habitat**

Areas, NR-MM#3: Aquatic Species, NR-MM#4: Minimize Limits of Disturbance in Sensitive Habitat Areas, NR-MM#5: Minimize Nighttime Lighting, and **NR-MM#6: Wildlife Crossings.**

There are currently no permitting mechanisms for incidental take of non-protected wildlife species in Texas; however, impacts on wildlife as a result of the Project would be minimized through the implementation of mitigation measures as described in **Section 3.6.6, Avoidance, Minimization and Mitigation**.

3.6.5.2.3 Protected Species

Five federally listed endangered species have the potential to occur in the Study Area: Houston toad, interior least tern, whooping crane, 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. The Study Area is not within range of the whooping crane wintering or nesting habitat; however, suitable stopover habitat may be present in emergent wetlands and adjacent, relatively open habitats found within the Study Area. For the Houston toad, Navasota ladies'-tresses, and the large-fruited sand verbena, **Table 3.6-22** provides acreage of potential impacts to habitat by Build Alternative Segment for each county. For mapped and modeled habitat of each of the federally listed species, refer to the **Appendix D, Natural Resources Mapbook**.

In addition, 14 state-listed threatened species, including one federal candidate species, may be impacted by the construction of each of the Build Alternatives as outlined in **Section 3.6.5.2.2, Wildlife**. Construction impacts to vegetation and habitat would be minimized and/or avoided by deploying qualified biologists to conduct surveys prior to and during construction activities within or near protected species and their habitat to identify sensitive habitats and ensure implementation of compliance and mitigation measures would help avoid endangered species and their habitats. Qualified biologists would also identify protected species and relocate individuals so that direct mortality would be avoided. Compliance and mitigation measures are described in **Section 3.6.6, Avoidance, Minimization and Mitigation,** and the Biological Assessment in **Appendix K, Agency Specific Reports, Biological Assessment**. While there is not a permitting mechanism for incidental take of state-listed species, TCRR shall incorporate appropriate compliance, mitigation and avoidance measures to avoid take of state-listed species during construction. These measures are described in **Section 3.6.6, Avoidance, Minimization and Mitigation,** and include **NR-CM#1: MBTA Compliance, NR-CM#2: Bald and Golden Eagle Protection Act Compliance, NR-CM#3: Bat Surveys, NR-MM#1: Site Training, NR-MM#2: Field Delineation of Sensitive Habitat Areas, NR-MM#3: Aquatic Species, NR-MM#4: Minimize Disturbance in Sensitive Habitat Areas, NR-MM#5: Minimize Nighttime Lighting, NR-MM#6: Wildlife Crossings, and NR-MM#7: Wildlife Mortality Recording Forms.** .

FRA anticipates that the Project may affect, but is not likely to adversely affect, the Houston toad, interior least tern and Whooping crane based on the results of presence/absence species surveys and the implementation of various avoidance and mitigation measures described in **Section 3.6.6, Avoidance, Minimization and Mitigation,** and **NR-CM#4: Section 7 Consultation and Biological Opinion**. Due to the presence of Navasota ladies'-tresses within the Study Area and the potential for large-fruited sand verbena in unsurveyed areas, FRA initiated formal Section 7 consultation with USFWS on November 14, 2019, and prepared a BA that outlines specific measures to avoid or minimize impacting the species, as discussed in **Section 3.6.5.2.3, Protected Species,** and **Section 3.6.6, Avoidance, Minimization and Mitigation**.

Table 3.6-22: Modeled 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/ *Anaxyrus houstonensis*	--	--	--	--	20	237	63[a]	245 [a]	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Plants																						
Large-fruited sand verbena/ *Abronia macrocarpa*	4	29	0	18	9	119	14	94	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Navasota ladies'-tresses/ *Spiranthes parksii*	49	73	--	--	49	255	--	6	12	334	83	309	11	60	--	41	168	346	--	--	--	--

Source: TPWD 2014; AECOM 2017

"—" No modeled habitat present

[a] Habitat within Build Alternative A is considered unoccupied due to the results of 3 consecutive years of presence/absence surveys.

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 the presence of bald eagles and their nests due to the crossing of lakes, rivers and streams by the Project. Impacts during construction could include potentially disturbing bald eagles and their nests indirectly due to noise and directly due to vegetation clearing. Impacts would be avoided following efforts outlined in the *National Bald Eagle Management Guidelines*[131] and in accordance with the Bald and Golden Eagle Protection Act, as described in **Section 3.6.6.1, Compliance Measures and Permitting,** and **Section 3.6.6.2, Mitigation Measures**. This includes surveying for eagle nests prior to construction activities and coordinating avoidance with USFWS.

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 included recommendations regarding the Project in a letter on October 28, 2014 (**Appendix C, Public and Agency Involvement),** including 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. Additionally, TCRR has incorporated avoidance and minimization measures into the Project design through the use of viaduct for approximately 55 percent of the alignment and by co-locating the Build Alternatives with existing transportation and utility corridors, where practicable, to maximize the use of disturbed lands and minimize habitat fragmentation.

3.6.6.1 Compliance Measures and Permitting

TCRR would be required to comply with the following Compliance Measures (CM):

NR-CM#1: MBTA Compliance. TCRR shall comply with the MBTA and memorandum M-37050. If ground clearing would occur during the nesting season (March 1 through August 31), TCRR shall hire a qualified surveyor to perform preconstruction surveys for nesting birds prior to the removal of vegetation. Additionally, if an inactive nest is found outside of nesting season, it will be removed to prevent use during nesting season.

NR-CM#2: Bald and Golden Eagle Protection Act Compliance. Prior to the start of construction, TCRR shall hire a qualified biologist to survey for bald eagle nests within the Study Area and 660 feet beyond the Study Area limits. If TCRR does not have right of entry areas within 660 feet of the Study Area limits, surveys shall be conducted with binoculars. In accordance with the *National Bald Eagle Management Guidelines*[132] 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, an appropriate buffer distance coordinated with USFWS 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. If an active or inactive nest is located within the vegetation clearing limits, TCRR shall consult with USFWS to determine whether a Bald and Golden Eagle permit from USFWS is required before any action that may result in take occurs, such as removing a nest.

NR-CM#3: Bat Surveys. For Build Alternatives C and F, prior to 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 (specifically culverts and bridges associated with

[131] USFWS, *National Bald Eagle Management Guidelines*, May 2007, accessed January 29, 2018, https://www.fws.gov/southdakotafieldoffice/NationalBaldEagleManagementGuidelines.pdf.
[132] Ibid.

IH-45) for maternity colonies and existing bat roosts. If roosts are found that would be disturbed by the Project, TCRR shall notify TPWD to determine appropriate mitigation. TCRR shall not disturb the colonies until pups are volant.

NR-CM#4: Section 7 Consultation and Biological Opinion. To ensure the appropriate measures to avoid and minimize harm from potential impacts to federally listed species under the ESA, FRA, in consultation with USFWS, determined it is appropriate to develop a BA and enter into formal Section 7 consultation. The BA includes avoidance and minimization efforts for the interior least tern, whooping crane, Houston toad, large-fruited sand verbena and Navasota ladies'-tresses. For specific language regarding these measures and in order to ensure measures to mitigation harm to protected species, TCRR will comply with the BO (**Appendix K, Agency Specific Reports, Biological Assessment)**.

NR-CM#5: Aquatic Invasive Species (AIS) Transport. Prior to construction, TCRR shall prepare and follow an AIS transfer prevention plan that outlines BMPs that will be used to prevent inadvertent transfer of AIS species to new areas via Project equipment and temporary fills that would enter and/or leave inland waters. This measure is for compliance with TPWD Code Sections 66.007 and 66.0072 and TAC Title 31, Part 2, Chapter 57, Subchapter A.

3.6.6.2 Mitigation Measures

TCRR would be required to implement the following Mitigation Measures (MM):

NR-MM#1: Site Training. Site awareness training will occur prior to and during construction. TCRR will hire a qualified biologist to develop appropriate environmental awareness training that TCRR will administer to all site personnel before beginning work on the Project. The training will include the definition of "take" relative to protected species, the potential presence of protected species, reporting requirements and measures to be taken to minimize impacts to the natural environment. TCRR will hire staff to train all site personnel on identification of protected species within suitable habitat before site personnel can begin work on the Project. TCRR will document training activities and retain documentation for the duration of construction, and provide copies to USFWS upon request. The documentation will include names of site personnel undergoing training, names of trainers, name of qualified biologist that developed the curriculum, dates and duration of training and curriculum materials.

NR-MM#2: Field Delineation of Sensitive Habitat Areas. Prior to vegetation clearing, TCRR will hire a qualified biologist to determine the boundary of sensitive habitat areas. Sensitive habitat areas are areas intended to be avoided by the Project or areas where impacts have not been accounted for in the Final EIS. TCRR shall install signs signaling the need to avoid construction activities in these areas. Specifically, sensitive habitats areas include the following:

- Protected species habitat detailed in the BA (**Appendix K, Agency Specific Reports, Biological Assessment)**
- Areas documented for protection in the BO developed by USFWS in **NR-CM#4: Section 7 Consultation and Biological Opinion**
- Lakes, wetlands, estuaries, lagoons, streams and rivers identified for protection in **WW-CM#5: Waters of the U.S. Mitigation Plan.** (Sensitive habitat areas exclude those features permitted for discharge or fill under CWA Section 404 in **WW-CM#4: CWA Section 404, Individual Permit.**)
- Areas where migratory birds or bald eagle nests are located
- Areas identified as bat roost sites

NR-MM#3: Aquatic Species. Prior to construction, TCRR shall develop an SWPPP to minimize impacts to resources, including aquatic protected species such as state- or federal-listed fish and mussel species. TCRR will coordinate with TPWD to determine whether protected mussel species presence/absence surveys are required prior to construction in streams that would be directly impacted to avoid take of individual species.

NR-MM#4: Minimize Disturbance in Sensitive Habitat Areas. During construction, TCRR shall minimize disturbance to vegetation by designating previously disturbed areas for staging and equipment storage and limit driving speeds near sensitive habitat areas when feasible. Sensitive habitat areas are defined in **NR-MM#2, Field Delineation of Sensitive Habitat Areas**. TCRR will consult with USFWS to determine appropriate speed limits for sensitive habitat areas as documented in the BO developed by USFWS in **NR-CM#4: Section 7 Consultation and Biological Opinion**, if necessary. The speed limits are dependent on the natural resources present within sensitive habitat areas and their sensitivity to dust generated by construction traffic. In addition, TCRR 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: Minimize Nighttime Lighting. During nighttime construction and operation, TCRR shall use the minimum amount of nighttime lighting needed for safety and security.

NR-MM#6: Wildlife Crossings. TCRR shall install wildlife crossings where the Project is on embankment to facilitate the movement of large and small species of wildlife and avoid habitat fragmentation. Through environmental analysis, TCRR, along with TxDOT, TPWD and USFWS, will identify existing wildlife corridors and large habitat blocks to facilitate in the placement of crossings. TCRR shall determine the location, frequency, size and monitoring of wildlife crossings in coordination with wildlife agencies and landowners; through field investigations by trained biologists; and largely based on species' biology, such as home range size, and habitat. TCRR will incorporate the wildlife crossings into the final design for the Project also considering the following specifications (see **Appendix E, Wildlife Crossings Technical Memorandum** for detailed information):

- Wildlife crossings shall be designed to facilitate movement of large and small species of wildlife across the landscape.
- Wildlife crossings shall include culvert crossings constructed within the Project embankments in areas with surrounding wildlife habitat.
- The recommended dimension of a wildlife crossing underpass for small to large mammals is 32 feet wide and greater than 13 feet high, with a minimum recommendation of 10 feet wide and 12 feet high.
- The minimum recommended dimension of a wildlife crossing underpass incorporated into large creek culvert crossings is greater than 10 feet wide and greater than 13 feet high, with a minimum of 6.5 feet wide and 10 feet high. This size could be used for small to large mammals as well as amphibians and reptiles. For smaller modified culverts, the recommended dimension for small- to medium-sized mammals and amphibians and reptiles is greater than 3 feet wide and greater than 4 feet high with a minimum of 1.5 feet wide and greater than 3 feet high .
- For wildlife crossings designed for small to medium-sized mammals, the recommended size is 1 to 4 feet wide and 1 to 4 feet high or a diameter of 1 to 4 feet.
- For areas constrained by engineering design requirements, wildlife crossings would be reduced in height to 6 feet (medium animal) or 2 to 4 feet (small animal).
- Water crossing designs shall incorporate aquatic and wildlife movement requirements to facilitate wildlife crossings.

- Culverts for wildlife crossings should be placed near those used to convey stormwater, but at an elevation above the design flood elevation. Travel routes to these wildlife crossing culverts would also need to be above the 100-year flood elevations and should have appropriate cover.
- Wildlife crossings shall be placed regardless of frequency to accommodate special situations (e.g., fenced stations or maintenance facilities and large road crossings).
- Wildlife crossings in highly urbanized areas shall be limited, namely in the City of Dallas and Houston, due to anticipated low wildlife populations.
- 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.
- Crossings shall be located 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.
- In areas where the Project parallels existing roadway corridors, TCRR shall place wildlife crossings in locations with high road mortality, as these areas are considered population sinks and known wildlife corridors.

NR-MM#7: Wildlife Mortality Recording Forms. During the operation of the HSR, once a trainset arrives at a terminal station, TCRR will remove any debris from the front of the trainset. TCRR staff shall record and document any obvious wildlife/bird mortality for a period of 5 years. TCRR will also record obvious wildlife mortality for overhead catenary system (OCS) electrocutions for a period of 5 years after initial operation. TCRR shall make the data available to FRA or other government agencies upon request.

3.6.7 Build Alternatives Comparison

Impacts to the vegetation types by Build Alternative are summarized in **Table 3.6-23** and impacts to vegetation by Houston Terminal Station options are summarized in **Table 3.6.24**. Total acreage of temporary and permanent vegetation impacts varies by alternative. Build Alternative C would have the least acreage of temporary impacts at 2,380 acres, while Build Alternative D would have the highest at 2,599 acres. In addition, Build Alternatives D would have the least acreage of permanent impacts at 6,609 acres, while Build Alternative C would have the highest (7,311 acres). Post Oak Savanna: Savanna Grassland would have the highest acreage of permanent impacts for all Build Alternatives, ranging from 1,493 acres under Build Alternatives A and D to 1,839 acres under Build 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 less than 1 acre permanently impacted by Build Alternatives C and F only. The Houston Industrial Site Terminal Station Option would have the highest acreage of permanent impacts at 92 acres, while the Houston Northwest Mall and Houston Northwest Transit Center Terminal Station Options would have the least acreage of permanent impacts at 76 and 87 acres, respectively. The primarily impacted vegetation type would be Urban High Intensity.

Build Alternative F would have the least loss of habitat for grasslands at 3,960.8 acres, and Build Alternative C would have the lowest loss of habitat for shrub/woodlands at 2,455.4 acres. Build Alternative B would have the highest loss of habitat for grasslands at 4,149.8 acres, and Build Alternative E would have the highest loss of habitat for shrub/woodlands at 2,618.0 acres.

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Table 3.6-23: 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)	496	987	474	1,091	351	973	504	984	482	1,091	359	973
Post Oak Savanna: Live Oak Motte and Woodland (602)	0	4	0	4	0	4	0	4	0	4	0	4
Post Oak Savanna: Post Oak - Redcedar Motte and Woodland (603)	0	3	0	3	0	3	0	3	0	3	0	3
Post Oak Savanna: Post Oak Motte and Woodland (604)	239	1,067	220	1,101	289	907	243	1,062	220	1,101	289	907
Post Oak Savanna: Savanna Grassland (607)	461	1,489	460	1,526	342	1,839	459	1,493	460	1,526	342	1,839
Post Oak Savanna: Post Oak - Yaupon Motte and Woodland (613)	0	18	0	18	3	17	0	18	0	18	3	17
Post Oak Savanna: Sandyland Woodland and Shrubland (706)	--	38	--	38	--	8	--	38	--	38	--	8
Post Oak Savanna: Sandyland Grassland (707)	--	14	--	14	--	15	--	14	--	14	--	15
Edwards Plateau: Oak/Hardwood Slope Forest (904)	1	1	1	2	1	1	--	0	--	2	--	0
Edwards Plateau: Live Oak Motte and Woodland (1102)	--	0	--	0	--	0	--	0	--	0	--	0
Edwards Plateau: Deciduous Oak/Evergreen Motte and Woodland (1103)	0	35	0	35	0	35	0	35	0	35	0	35
Edwards Plateau: Oak/Hardwood Motte and Woodland (1104)	3	55	3	54	3	54	3	54	3	54	3	54
Edwards Plateau: Savanna Grassland (1107)	11	13	11	13	11	13	11	13	11	13	11	13
Central Texas: Floodplain Live Oak Forest (1802)	--	0	--	0	--	0	--	--	--	--	--	--
Central Texas: Floodplain Hardwood/Evergreen Forest (1803)	1	4	1	4	1	4	1	4	1	4	1	4
Central Texas: Floodplain Hardwood Forest (1804)	40	182	46	178	63	190	40	186	46	182	64	195
Central Texas: Floodplain Deciduous Shrubland (1806)	2	2	4	2	0	2	3	4	6	4	2	3
Central Texas: Floodplain Herbaceous Vegetation (1807)	33	151	25	99	32	160	39	153	31	100	38	161
Central Texas: Floodplain Seasonally Flooded Hardwood Forest (1814)	--	--	--	--	--	0	--	--	--	--	--	0
Central Texas: Riparian Hardwood/Evergreen Forest (1903)	1	0	1	0	1	0	1	0	1	0	1	0
Central Texas: Riparian Hardwood Forest (1904)	10	27	9	29	8	16	12	30	11	32	10	20
Central Texas: Riparian Deciduous Shrubland (1906)	0	1	0	1	--	1	0	3	0	3	--	3
Central Texas: Riparian Herbaceous Vegetation (1907)	9	33	8	43	3	27	9	31	8	41	4	25
Pineywoods: Pine Forest or Plantation (3001)	2	128	2	128	2	135	2	128	2	128	2	135
Pineywoods: Pine - Hardwood Forest or Plantation (3003)	3	39	3	39	3	39	3	39	3	39	3	39
Pineywoods: Upland Hardwood Forest (3004)	25	179	25	179	25	179	25	179	25	179	25	179
Pineywoods: Small Stream and Riparian Temporarily Flooded Mixed Forest (4803)	--	1	--	1	--	1	--	1	--	1	--	1
Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest (4804)	11	83	11	83	3	75	11	83	11	83	3	75
Pineywoods: Small Stream and Riparian Seasonally Flooded Hardwood Forest (4814)	1	0	1	0	--	--	1	0	1	0	--	--
Pineywoods: Small Stream and Riparian Wet Prairie (4817)	5	39	5	39	0	58	5	39	5	39	0	58
Gulf Coast: Coastal Prairie (5207)	443	449	443	449	443	449	443	449	443	449	443	449
Gulf Coast: Coastal Prairie Pondshore (5307)	0	2	0	2	0	2	0	2	0	2	0	2
Barren (9000)	2	16	2	9	1	15	2	16	2	9	2	15
Swamp (9004)	--	1	--	0	--	1	0	1	0	0	0	1
Marsh (9007)	1	0	1	0	0	2	1	0	1	0	0	2
Native Invasive: Juniper Woodland (9101)	1	23	1	21	5	25	1	23	1	21	5	25
Native Invasive: Deciduous Woodland (9104)	53	158	50	157	56	179	68	184	65	183	70	205
Native Invasive: Juniper Shrubland (9105)	--	3	--	3	--	13	--	3	--	3	--	13
Native Invasive: Mesquite Shrubland (9106)	12	37	10	34	10	47	13	37	11	34	12	48
Native Invasive: Huisache Woodland or Shrubland (9124)	5	16	5	16	5	16	5	16	5	16	5	16
Native Invasive: Deciduous Shrubland (9126)	3	2	3	2	3	2	3	2	3	2	3	2
Pineywoods: Disturbance or Tame (9197)	150	160	150	160	150	160	150	160	150	160	150	160
Pine Plantation > 3 meters tall (9301)*	1	12	1	12	1	12	1	12	1	12	1	12

Table 3.6-23: 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
Row Crops (9307)*	338	691	371	751	338	682	340	642	372	702	339	633
Urban High Intensity (9410)	70	216	70	221	91	507	70	216	70	221	91	507
Urban Low Intensity (9411)	125	230	122	239	135	430	129	233	127	241	139	433
Open Water (9600)	--	15	--	17	--	13	--	15	--	17	--	13
Total Acreage of Impacts	**2,560**	**6,623**	**2,539**	**6,817**	**2,380**	**7,311**	**2,599**	**6,609**	**2,578**	**6,806**	**2,420**	**7,302**

Source: AECOM 2019

"--" Vegetation type not present, * Are considered agricultural types

Table 3.6-24: Vegetation Impacts by Houston Terminal Station Options (acres)						
Vegetation Types (EMST Code)	**Industrial Site**		**Northwest Mall**		**Northwest Transit Center**	
	Temp	**Perm**	**Temp**	**Perm**	**Temp**	**Perm**
Barren (9000)	--	0	1	2	4	2
Pineywoods: Disturbance or Tame (9197)	--	0	--	--	--	--
Urban High Intensity (9410)	0	84	26	73	8	84
Urban Low Intensity (9411)	--	8	0	1	--	1
Total Acreage of Impacts	**0**	**92**	**28**	**76**	**12**	**87**

Source: AECOM 2019

"--" Vegetation type not present

Table 3.6-25 presents acreages of temporary and permanent impacts to modeled habitat for three of the five federally listed species with potential to occur in the Study Area. As previously stated, impacts to the interior least tern and whooping crane are not presented in **Table 3.6-25** due to the variability of the species habitat. Impacts and mitigation for the interior least tern and whooping crane will be assessed through the BA, BO, and the incidental take statement (if necessary) issued by USFWS. Build Alternatives A, B, D and E would have the same temporary and permanent impacts to listed species' modeled habitats at 328 and 1,058 acres, respectively. Build Alternatives C and F would have the same temporary and permanent impacts to listed species' modeled habitat at 325 and 1,452 acres, respectively.

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 3.6-25: 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/ *Anaxyrus houstonensis*	63	245	63	245	20	237	63	245	63	245	20	237
Large-fruited sand verbena/ *Abronia macrocarpa*	14	112	14	112	12	148	14	112	14	112	12	148
Navasota ladies'-tresses/ *Spiranthes parksii*	251	701	251	701	293	1067	251	701	251	701	293	1067
Protected Species Habitat	**328**	**1,058**	**328**	**1,058**	**325**	**1,452**	**328**	**1,058**	**328**	**1,058**	**325**	**1,452**

Source: AECOM 2019

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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 Project.

3.7.2 Regulatory Context

Federal

Section 404 of the Clean Water Act

For the purposes of the CWA,[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 CWA. 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. Any permission the USACE Fort Worth District and Galveston District renders for the Project would be conditioned such that construction of each phase of the Project that impacts jurisdictional waters would not be allowed to occur until such time that each phase of the Project is designed, submitted for review and subsequently approved by the USACE.

The USACE (Fort Worth District and Galveston District) is a cooperating agency on the Project and will use the EIS and its appendices as a base document for their review and supplemental analysis of USACE impacts.

Section 401 of the Clean Water Act

As part of Section 404 compliance, Section 401 of the CWA regulates the discharge of pollutants into waters of the U.S. and is enforced by TCEQ. Tier I projects, as defined by TCEQ, 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 linear feet of

[1] 33 U.S.C. 1251 et seq.
[2] 33 C.F.R. 328.3; U.S.C. 1251.

streams. Tier I and Tier II projects require the use of TCEQ-approved BMPs, whereas Tier II projects also require 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 waterbody.[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 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 1165-2-220, *Policy and Procedural Guidance for Processing Requests to Alter US 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 General Land Office (GLO) may need to be contacted to determine whether the state claims a streambed. The Project would be required to acquire a land use easement from the Texas GLO for stream crossings of state-owned streambeds.

[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 USC 408*, U.S. Army Corps of Engineers: Washington, D.C., September 10, 2018, https://www.publications.usace.army.mil/Portals/76/Publications/EngineerCirculars/EC_1165-2-220.pdf?ver=2018-09-07-115729-890.
[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 for waters of the U.S. is defined as the LOD (See **Appendix D, Natural Resources Mapbook**).

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. 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[10]
- 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[11]
- NHD, which represents the drainage network, including rivers, streams, canals, lakes, ponds, coastline and dams[12]

To determine soil associations, which are taxonomic soil units occurring together in individual and characteristic patterns within the same geographical area, NRCS Soil Surveys were reviewed for each county within the Study Area.[13, 14, 15, 16, 17, 18, 19, 20, 21, 22] In addition, the Digital General Soils Map of the U.S., also referred to as STATSGO2, was reviewed for each Build Alternative and Houston Terminal Station Option.[23] Soils are an important factor when analyzing the potential presence of waters of the U.S. because certain areas mapped by the soil survey indicate a general likelihood that hydric soils may be found within the given area. Hydric soils are a technical parameter for wetland determination and may indicate the presence of wetlands.

Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) 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,[24] 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 that is susceptible to being inundated by water from any natural source.[25] These areas, if inundated or saturated frequently enough, may provide a hydrologic environment sufficient to support wetland vegetation and hydric soil conditions. See **Section**

[9] USFWS, "National Wetlands Inventory," Last modified October 9, 2019, accessed December 2019, http://www.fws.gov/wetlands/Data/Mapper.html.
[10] NAIP, Aerial Imagery, 2016.
[11] National Oceanic and Atmospheric Administration, "What is lidar?," Last modified June 25, 2018, accessed December 2019, http://oceanservice.noaa.gov/facts/lidar.html.
[12] USGS, "National Hydrography," Last modified December 5, 2019, accessed December 2019, http://nhd.usgs.gov/data.html.
[13] NRCS, *Soil Survey of Dallas County, Texas,* U.S. Department of Agriculture, 1980.
[14] NRCS, *Soil Survey of Ellis County, Texas,* U.S. Department of Agriculture, 1964.
[15] NRCS, *Soil Survey of Navarro County, Texas,* U.S. Department of Agriculture, 1974.
[16] NRCS, *Soil Survey of Freestone County, Texas*, U.S. Department of Agriculture, 2002.
[17] NRCS, *Soil Survey of Limestone County, Texas,* U.S. Department of Agriculture, 1997.
[18] NRCS, *Soil Survey of Leon County, Texas,* U.S. Department of Agriculture, 1989.
[19] NRCS, *Soil Survey of Madison County, Texas,* U.S. Department of Agriculture, 1994.
[20] NRCS, *Soil Survey of Grimes County, Texas,* U.S. Department of Agriculture, 1996.
[21] NRCS, *Soil Survey of Austin and Waller Counties*, Texas, U.S. Department of Agriculture, 1984.
[22] NRCS, *Soil Survey of Harris County, Texas,* U.S. Department of Agriculture, 1976.
[23] NRCS, "STATSGO Data by County," 2006.
[24] FEMA, "Floodplain Insurance Rate Map," accessed December 2019, http://www.fema.gov/flood-insurance-rate-map-firm.
[25] B. Wayne Blanchard, *Guide to Emergency Management and Related Terms, Definitions, Concepts, Acronyms, Organizations, Programs, Guidance, Executive Orders & Legislation*, October 22, 2008, accessed December 2019, https://training.fema.gov/hiedu/docs/terms%20and%20definitions/terms%20and%20definitions.pdf.

3.8, Floodplains, for Project-specific analysis of existing floodplains in the Study Area and their potential impacts as a result of the Project.

In addition, TPWD EMST was used to determine vegetation types within the Study Area.[26] These mapped vegetation types were useful in identifying areas that may require further investigation for the presence of potential waters of the U.S. 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 by the USACE. FRA conducted surveys concurrent with the USACE and TCRR, and data collected through June 1, 2018, are presented in this EIS (**Appendix E, Waters of the U.S. Technical Memorandum**). Field assessments completed by FRA were conducted on property where access was granted, as the entire LOD was not accessible for field assessment. Approximately 42 percent of the LOD for Build Alternative A was surveyed by FRA (see **Section 3.1, Affected Environment and Environmental Consequences, Introduction,** for additional details on focused methodology on Build Alternative A for the Final EIS). The analysis for this Final EIS assumes wetlands and waterbodies within the LOD are waters of the U.S. The ongoing USACE fieldwork for the Section 404 Permit 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 Final 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 equipment, where possible. Potentially jurisdictional waters of the U.S. are determined following the procedures outlined in the USACE *Wetlands Delineation Manual*,[27] *Regional Supplement to the Corps of Engineers Wetland Delineation Manual*; Great Plains Region,[28] Atlantic and Gulf Coast Region[29] and subsequent Regulatory Guidance Letters.[30, 31]

Streams are classified as: [32]

- **Artificial/Man-made stream**: A stream that has been altered from their natural state as a result of artificial/unnatural hydrologic changes.
- **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

[26] TPWD, Ecological Mapping Systems of Texas Data, 2014.

[27] USACE, *Corps of Engineers Wetland Delineation Manual.* Vicksburg, Mississippi: U.S. Army Corps of Engineers Waterways Experiment Station, 1987, accessed December 2019, https://www.lrh.usace.army.mil/Portals/38/docs/USACE%2087%20Wetland%20Delineation%20Manual.pdf.

[28] 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, accessed December 2019, https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1046493.pdf.

[29] 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, accessed December 2019, https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1046490.pdf.

[30] USACE, Regulatory Guidance Letter No. 05-05: Ordinary high water mark identification, 2005, accessed December 2019, https://www.nap.usace.army.mil/Portals/39/docs/regulatory/rgls/rgl05-05.pdf.

[31] 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.

[32] USACE, "Texas Rapid Assessment Method (TXRAM), Wetlands and Streams Modules, Version 2.0 Final," U.S. Army Corps of Engineers, 2015.

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 streambed 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.

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.[33] For the purposes of this analysis, freshwater ponds and lakes are separately considered.

Wetland types 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[34]

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 was incorporated into the preliminary design.

3.7.4 Affected Environment

The following section describes the existing water resources, USACE federally authorized civil works projects (USACE 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 <u>Water Resources</u>

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 begins in North Texas approximately 3 miles south of the Texas-Oklahoma border, and from the confluence of the Trinity River with its Elm and West Forks near Dallas, flows south to Trinity Bay.[35] The streams, wetlands and waterbodies located within the Study Area in Dallas County are provided in **Tables 3.7-1** through **3.7-3**.

[33] New Hampshire Department of Environmental Services, “Environmental Fact Sheet – Lake or Pond, What’s the Difference,” New Hampshire Department of Environmental Services, 2003.
[34] Lewis M. Cowardin, 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 Service, 1979.
[35] TWDB, “Trinity River Basin,” accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/trinity/index.asp.

Table 3.7-1: Streams within the Study Area – Dallas County	
Stream Type	**Length within Segment 1 (linear feet)**
Perennial	3,320
Intermittent	2,684
Ephemeral	596
Artificial/Man-made	418
Total	**7,018**

Source: USGS 2018; FNI 2018

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	7.5
Freshwater Forested/Shrub Wetland	PFO	9.7
	PSS1/EM1A	0.85
	PSS	0.88
	PFO1A	1.6
	PFO1C	0.14
	Total	**20.7**

Source: USFWS 2018; FNI 2018

A – Temporarily Flooded
C – Seasonally Flooded
EM – Emergent
EM1 – Persistent Emergent
FO – Forested
FO1 – Broad-leaved Deciduous Forested
P – Palustrine
SS1 – Broad-leaved Deciduous Scrub-Shrub

Table 3.7-3: Waterbodies within the Study Area – Dallas County	
Type	**Area of Segment 1 (acres)**
Lake	2.1
Freshwater Pond	2.9
Total	**5.0**

Source: USFWS 2018; FNI 2018

In addition, Mooreland Lake is located within the Study Area in Dallas County.[36] Based on the FEMA FIRMs and Digital FIRMs, approximately 80 acres of the Study Area in Dallas County are located within a 500-year floodplain (Zone X – shaded) and approximately 203 acres are located within a 100-year floodplain (Zones A and AE).

3.7.4.1.2 USACE Projects

USACE projects subject to Section 408 approval located within Dallas County include the Dallas Floodway–East Dallas Levee Trinity Left Bank, Dallas Floodway Extension–Upper/lower Chain of Wetlands, Dallas Floodway Extension–Central Wastewater Treatment Plant Trinity Right Bank and Dallas Floodway Extension–Future Lamar Levee.[37]

[36] USGS, "National Hydrography," Last modified December 5, 2019, accessed December 2019, http://nhd.usgs.gov/data.html.
[37] USACE, "USACE-Owned Properties Fort Worth District," 2014.

3.7.4.1.3 Hydric Soils

Based on the 2015 NRCS National Hydric Soil List, three hydric soils are located within the Study Area in Dallas County.[38, 39] **Table 3.7-4** includes the area in acres for each of these hydric soils.

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	51.6
Trinity clay, occasionally flooded	72	7.9
Trinity clay, frequently flooded	73	27.2
	Total	**86.7**

Source: NRCS 2017; NRCS 2015

3.7.4.1.4 Vegetation

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*).[40]

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.[41]

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	9.4
Central Texas: Floodplain Herbaceous Vegetation	1.7
Open Water	0.63
Central Texas: Floodplain Hardwood / Evergreen Forest	0.59
Central Texas: Riparian Hardwood Forest	0.48
Swamp	<0.01
Central Texas: Riparian Herbaceous Vegetation	<0.01
Total Percent	12.8

Source: TPWD 2014

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.[42] The streams, wetlands and waterbodies located within this Study Area in Ellis County are provided in **Tables 3.7-6** through **3.7-8**.

[38] NRCS, "SSURGO data by County," 2017.
[39] NRCS, "National Hydric Soils List 2015: Texas," 2015.
[40] Ibid.
[41] Ibid.
[42] TWDB, "River Basins," accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp.

There are no wetlands within Segments 1, 3A, 3B or 3C in Ellis County. In addition, there are no waterbodies within Segments 3A and 3C in Ellis County.

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	118	1,390	1,670	--	--	--
Intermittent	--	5,082	10,188	486	152	486
Ephemeral	--	4,197	--	--	--	--
Artificial/Man -made	--	4	867	386	386	386
Total	**118**	**10,673**	**12,725**	**872**	**538**	**872**

Source: USGS 2018; FNI 2018

'--' - not present

Notable streams within the Study Area within Ellis County include the perennial Bear Creek, Big Onion Creek, Red Oak Creek and Waxahachie Creek and the intermittent Bone Branch, Brushy Creek, Clear Creek, Cottonwood Creek, Elm Branch, Grove Creek and Mustang Creek.

Based on the FEMA FIRMs and Digital FIRMs, less than 1 acre of Segment 1, approximately 1 acre of the Segment 2A and approximately 1 acre of Segment 2B within Ellis County are located within a 500-year floodplain (Zone X – shaded). Approximately 1 acre of Segment 1, approximately 65 acres of the Segment 2A and approximately 79 acres of Segment 2B within Ellis County are located within a 100-year floodplain (Zones A and AE). Segments 3A, 3B and 3C within Ellis County are not located within mapped floodplain boundaries.[43]

Table 3.7-7: Wetlands within the Study Area – Ellis County

Wetland Type	Classification	Area of Segment 2A (acres)	Area of Segment 2B (acres)
Freshwater Emergent Wetland	PEM	1.0	--
	PEM1Fh	0.40	--
Freshwater Forested/Shrub Wetland	PFO1A	2.1	4.1
	PFO1C	0.42	1.6
	Total	**3.9**	**5.7**

Source: USFWS 2018; FNI 2018
Note: There are no wetlands within Segments 3A, 3B or 3C.

'--' - not present

A – Temporarily Flooded
C – Seasonally Flooded
EM – Emergent
EM1 – Persistent Emergent
F – Semi permanently Flooded
FO1 – Broad-leaved Deciduous Forested
h – Diked/Impounded
P – Palustrine

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)	Area of Segment 3B (acres)
Freshwater Pond	0.01	5.1	4.3	0.29
Total	0.01	7.1	4.3	0.29

Source: USFWS 2018; FNI 2018
Note: There are no wetlands within Segments 3A or 3C.

[43] FEMA, "Floodplain Insurance Rate Map," accessed December 2019, http://www.fema.gov/flood-insurance-rate-map-firm.

3.7.4.2.2 *USACE Projects*

One USACE project subject to Section 408 approval is located within Segment 2B in Ellis County, Lake Bardwell.[44] 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.[45] No USACE projects subject to Section 408 approval are located within Segments 1, 2A, 3A, 3B and 3C in Ellis County.[46]

3.7.4.2.3 *Hydric Soils*

Based on the 2015 NRCS National Hydric Soil List, one hydric soil is located within Segment 1, three hydric soils are located within Segments 2A and 2B, and none are located within Segments 3A, 3B or 3C in Ellis County.[47, 48] **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	--	5.1	3.6
Trinity clay, frequently flooded	Tc	0.71	29.1	34.4
Trinity clay, occasionally flooded	To	--	10.2	13.7
	Total	**0.71**	**44.4**	**51.7**

Source: NRCS 2015, 2017

'--' - not present

3.7.4.2.4 *Vegetation*

The most common wetland types within the Study Area in Ellis County are the Central Texas: Floodplain Hardwood Forest and Central Texas: Floodplain Herbaceous Vegetation types, as previously described in this section, followed by Central Texas: Riparian Hardwood Forest and Central Texas: Riparian Herbaceous Vegetation, as described below. A complete list of wetland vegetation types that comprise the Study Area is provided in **Table 3.7-10**.

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	1.0	3.0	3.3	--	--	--
Central Texas: Riparian Hardwood Forest	0.04	1.2	1.7	2.9	0.57	2.9
Central Texas: Riparian Herbaceous Vegetation	--	1.0	0.74	--	0.08	--

[44] USACE, "USACE-Owned Properties Fort Worth District," 2014
[45] TWDB, "Bardwell Lake (Trinity River Basin)," accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/reservoirs/bardwell/index.asp.
[46] USACE, "USACE-Owned Properties Fort Worth District," 2014.
[47] NRCS, "SSURGO data by County," 2017.
[48] 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 Herbaceous Vegetation	--	0.74	1.5	--	--	--
Central Texas: Floodplain Deciduous Shrubland	--	--	0.30	--	--	--
Open Water	--	0.11	0.10	--	--	--
Central Texas: Riparian Deciduous Shrubland	--	0.07	0.23	--	--	--
Central Texas: Floodplain Live Oak Forest	--	0.04	--	--	--	--
Swamp	--	0.03	0.03	--	--	--
Total Percent	**1.0**	**6.2**	**7.9**	**2.9**	**0.65**	**2.9**

Source: TPWD 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.[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**.

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	117	151	117
Intermittent	7,794	15,363	10,831
Ephemeral	2,186	--	--
Artificial/Man-made	136	2,278	136
Total	**10,233**	**17,792**	**11,084**

Source: USGS 2018; FNI 2018

'--' - not present

[49] Ibid.
[50] TWDB, "River Basins," accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp.

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	3.3	--	--
	PEM1A	--	0.01	--
	PEM1C	--	0.20	--
	PEM1Ch	--	0.17	--
	PEM1Fh	--	0.62	--
Freshwater Forested/Shrub Wetland	PFO	0.10	--	--
	PFO1A	5.4	5.6	5.9
	PFO1C	0.31	1.2	0.51
Total		**9.1**	**7.8**	**6.4**

Source: USFWS 2018; FNI 2018

'--' - not present

A – Temporarily Flooded
C – Seasonally Flooded
EM – Emergent
EM1 – Persistent Emergent
F – Semi permanently Flooded
FO – Forested
FO1 – Broad-leaved Deciduous Forested
h – Diked/Impounded
P – Palustrine
SS1 – Broad-leaved Deciduous Scrub-Shrub

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	6.9	7.4	3.1
Total	**6.9**	**9.1**	**3.1**

Source: USFWS 2018; FNI 2018

'--' - not present

Notable streams within the Study Area in Navarro County include the intermittent Briar Creek, Cedar Creek, Cryer Creek, Little Pin Oak Creek, Mesquite Creek, Pin Oak Creek and Richland Creek and the artificial/man-made Chambers Creek.

In addition, the NRCS Site 138 reservoir is mapped within Segment 3B in Navarro County.[51] Based on the FEMA FIRMs and Digital FIRMs, approximately 137 acres of Segment 3A, approximately 81 acres of Segment 3B and approximately 145 acres of Segment 3C within Navarro County are located within a 100-year floodplain (Zone A).[52]

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]

[51] USFWS, "National Wetlands Inventory," Last modified October 9, 2019, accessed December 2019, http://www.fws.gov/wetlands/Data/Mapper.html.
[52] FEMA, "Floodplain Insurance Rate Map," accessed December 2019, http://www.fema.gov/flood-insurance-rate-map-firm.
[53] USACE, "USACE-Owned Properties Fort Worth District." 2014.

3.7.4.3.3 Hydric Soils

Based on the 2015 NRCS National Hydric Soil List, two hydric soils are located within Segment 3A, one hydric soil is located within Segment 3B and three hydric soils are 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	19.8	--	9.9
Kaufman clay, frequently flooded	Kc	--	--	12.2
Trinity clay, frequently flooded	Tr	29.8	38.6	32.8
Total		**49.6**	**38.6**	**54.9**

Source: NRCS 2017; NRCS 2015

'--' - not present

3.7.4.3.4 Vegetation

The most common wetland types within the Study Area in Navarro County are Central Texas: Floodplain Herbaceous Vegetation type, Central Texas: Floodplain Hardwood Forest and Central Texas: Riparian Herbaceous Vegetation, as previously described.[56] A complete list of wetland vegetation types that comprise this Study Area in Navarro County 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	8.8	2.5	7.5
Central Texas: Floodplain Hardwood Forest	2.7	2.7	2.6
Central Texas: Riparian Herbaceous Vegetation	0.59	1.2	0.50
Central Texas: Floodplain Deciduous Shrubland	0.37	0.52	0.05
Central Texas: Riparian Hardwood Forest	0.29	0.49	0.25
Marsh	--	--	0.06
Open Water	--	0.16	--
Swamp	0.04	<0.01	0.04
Total Percent	**12.8**	**7.6**	**11.0**

Source: TPWD 2014

'--' - not present

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 in Freestone County are provided in **Tables 3.7-16** through **3.7-18**. There are streams, wetlands and waterbodies within Segments 3A and 3B in Freestone County.

[54] NRCS, "SSURGO data by County," 2017.
[55] NRCS, "National Hydric Soils List 2015: Texas," 2015.
[56] TPWD, Ecological Mapping Systems of Texas Data, 2014.
[57] TWDB, "River Basins," accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp.

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	306
Intermittent	18,596	4,897
Ephemeral	--	5,258
Artificial/Man-made	372	151
Total	**19,715**	**10,612**

Source: USGS 2018; FNI 2018

'--' - not present

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	--	0.98
	PEM1A	0.06	0.32
	PEM1F	0.11	--
	PEM1C	0.19	1.3
	PEM1Ch	0.37	--
Freshwater Forested/ Shrub Wetland	PFO	--	0.06
	PFO1A	6.0	1.7
	PFO1C	1.4	0.47
	PSS1/EM1A	4.6	--
	PSS	--	0.02
Total		**12.7**	**4.9**

Source: USFWS 2018; FNI 2018

'--' - not present

A – Temporarily Flooded
C – Seasonally Flooded
EM – Emergent
EM1 – Persistent Emergent
F – Semi permanently Flooded
FO – Forested
FO1 – Broad-leaved Deciduous Forested
h – Diked/Impounded
P – Palustrine
SS – Scrub-Shrub
SS1 – Broad-leaved Deciduous Scrub-Shrub

Table 3.7-18: Waterbodies within the Study Area – Freestone County		
Type	**Area of Segment 3C (acres)**	**Area of Segment 4 (acres)**
Freshwater Pond	3.9	7.2
Total	**3.9**	**7.2**

Source: USFWS 2018; FNI 2018

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, Dry Creek, Fulks Dugout, Hog Creek, Little Tehuacana, Patton Creek, Tehuacana Creek, Upper Keechi Creek, Whitney Branch and Wilkerson Spring Branch.

Based on the FEMA FIRMs and Digital FIRMs, approximately 57 acres of Segment 3C and approximately 29 acres of Segment 4 are located within a 100-year floodplain (Zone A). Segments 3A and 3B are not located within mapped floodplain boundaries. [58]

[58] FEMA, "Floodplain Insurance Rate Map," accessed December 2019, http://www.fema.gov/flood-insurance-rate-map-firm.

3.7.4.4.2 USACE Projects

No USACE projects subject to Section 408 approval are located within the Study Area in Freestone County.[59]

3.7.4.4.3 Hydric Soils

Based on the 2015 NRCS National Hydric Soil List, no hydric soils are located within Segments 3A and 3B in Freestone County; however, nine hydric soils are located within Segment 3C and seven hydric soils are located within Segment 4.[60, 61] **Table 3.7-19** includes the area in acres for each hydric soil**.**

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	--	16.9
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	0.18
Nahatche clay loam, frequently flooded	Na	10.3	--
Nahatche-Hatliff Association, frequently flooded	NH	74.1	15.1
Pluck loam, frequently flooded	Pu	6.2	1.0
Rader fine sandy loam, 0 to 3 percent slopes	RaB	3.8	--
Tabor-Lufkin complex, 0 to 1 percent slopes	TfA	16.3	42.4
Whitesboro clay loam, frequently flooded	Wm	3.9	14.1
Wilson silty clay loam, 0 to 1 percent slopes	WnA	--	15.2
	Total	128.6	104.9

Source: NRCS 2015, 2017

'--' - 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 Vegetation, as previously described.[62] 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	5.2	4.2
Central Texas: Floodplain Herbaceous Vegetation	2.3	3.2
Central Texas: Riparian Herbaceous Vegetation	0.31	0.61
Central Texas: Riparian Hardwood Forest	0.09	0.61
Central Texas: Floodplain Deciduous Shrubland	0.08	--
Central Texas: Riparian Deciduous Shrubland	0.02	0.03
Central Texas: Floodplain Seasonally Flooded Hardwood Forest	0.02	--
Central Texas: Riparian Hardwood / Evergreen Forest	<0.01	--

[59] USACE, "USACE-Owned Properties Fort Worth District," 2014.
[60] NRCS, "SSURGO data by County," 2017.
[61] NRCS, "National Hydric Soils List 2015: Texas," 2015.
[62] TPWD, Ecological Mapping Systems of Texas Data, 2014.

Table 3.7-20: Wetland Vegetation Types within the Study Area – Freestone County		
Vegetation Types	**Percent of Segment 3C**	**Percent of Segment 4**
Open Water	<0.01	--
Total Percent	**8.0**	**8.7**

Source: TPWD 2014
'--' - not present

3.7.4.5 Limestone County

3.7.4.5.1 Water Resources

Within Limestone County, the Study Area is located within the Trinity River Basin and Brazos River Basin.[63] The streams, wetlands and waterbodies located within the Study Area in Limestone County 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	191
Intermittent	4,812
Ephemeral	1,957
Artificial/Man-made	58
Total	**7,018**

Source: USGS 2018; FNI 2018

Table 3.7-22: Wetlands within the Study Area – Limestone County		
Wetland Type	**Classification**	**Area of Segment 4 (acres)**
Freshwater Emergent Wetland	PEM	1.9
	PEM1C	0.12
	PFO	0.08
Freshwater Forested/Shrub Wetland	PFO1A	0.56
	PFO1C	0.68
	Total	**3.3**

Source: USFWS 2018; FNI 2018

A – Temporarily Flooded
C – Seasonally Flooded
EM – Emergent
EM1 – Persistent Emergent
FO – Forested
FO1 – Broad-leaved Deciduous Forested
P – Palustrine

Table 3.7-23: Waterbodies within the Study Area – Limestone County	
Type	**Area of Segment 4 (acres)**
Freshwater Pond	1.1
Total	**1.1**

Source: USFWS, 2018; FNI, 2018

Notable streams within Segment 4 within Limestone County include the intermittent Coots Branch, Lambs Creek, Lies Branch and Sanders Creek.

[63] TWDB, "River Basins," accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp.

Based on the FEMA FIRMs and Digital FIRMs, approximately 21 acres of the Study Area in Limestone County are located within a 100-year floodplain (Zone A).[64]

3.7.4.5.2 USACE Projects

No USACE projects subject to Section 408 approval are located within the Study Area in Limestone County.[65]

3.7.4.5.3 Hydric Soils

Based on the 2015 NRCS National Hydric Soil List, two hydric soils are located within the Study Area in Limestone County.[66, 67] **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	7.7
Uhland fine sandy loam, frequently flooded	Uh	12.4
	Total	**20.1**

Source: NRCS 2015; NRCS 201

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. A complete list of wetland vegetation types that comprise the Study Area in Limestone County 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	3.4
Central Texas: Floodplain Herbaceous Vegetation	3.1
Central Texas: Riparian Herbaceous Vegetation	0.65
Central Texas: Riparian Hardwood Forest	0.53
Open Water	0.08
Total Percent	**7.8**

Source: TPWD 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.[68, 69] The streams, wetlands and waterbodies located within the Study Area in Leon County are provided in **Tables 3.7-26** through **3.7-28**.

[64] FEMA, "Floodplain Insurance Rate Map," accessed December 2019, http://www.fema.gov/flood-insurance-rate-map-firm.
[65] USACE, "USACE-Owned Properties Fort Worth District," 2014.
[66] NRCS, "SSURGO data by County," 2015.
[67] NRCS, "National Hydric Soils List 2015: Texas," 2015.
[68] TWDB, "River Basins," accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp.
[69] Ibid.

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	2,069	681
Intermittent	15,218	12,328
Ephemeral	--	1,390
Artificial/Man-made	1,030	324
Total	**18,317**	**14,723**

Source: USGS 2018; FNI 2018
'--' - not present

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	--	0.56
	PEM/FO1F	0.33	--
	PEM1A	1.4	0.65
	PEM1F	0.86	--
	PEM1Fh	--	--
	PEM1C	1.3	0.09
	PEM1Ch	--	0.45
Freshwater Forested/ Shrub Wetland	PFO	--	0.03
	PFO1A	2.5	0.23
	PFO/EM1F	0.59	--
	PFO1F	0.25	--
	PFO1C	1.1	1.0
	PSS1/EM1A	0.09	--
	PSS1C	0.06	--
	Total	**8.5**	**3.0**

Source: USFWS 2018; FNI 2018
'--' - not present

A – Temporarily Flooded
C – Seasonally Flooded
EM – Emergent
EM1 – Persistent Emergent
F – Semi permanently Flooded
FO – Forested
FO1 – Broad-leaved Deciduous Forested
h – Diked/Impounded
P – Palustrine
SS1 – Broad-leaved Deciduous Scrub-Shrub

Table 3.7-28: Waterbodies within the Study Area – Leon County

Type	Area of Segment 3C (acres)	Area of Segment 4 (acres)
Lake	--	1.5
Freshwater Pond	3.8	7.3
Total	**3.8**	**8.8**

Source: USFWS 2018; FNI 2018
'--' - not present

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 Bain Creek, Cane Creek, Cedar Creek, Copper Copeland Branch, Creek, East Caney Creek, Leona Branch, Little Brushy Creek, Mill Branch, Right Branch, Smith Branch, Spring Branch, Tiger Branch and Yellow Branch.

Based on the FEMA FIRMs and Digital FIRMs, less than 1acre of Segment 3C is located within a 500-year floodplain (Zone X). Approximately 62 acres of Segment 3C and approximately 9 acres of Segment 4 within Leon County are located within a 100-year floodplain (Zones A and AE).[70]

3.7.4.6.2 USACE Projects

No USACE projects subject to Section 408 approval are located within the Study Area in Leon County.[71]

3.7.4.6.3 Hydric Soils

Based on the 2015 NRCS National Hydric Soil List, four hydric soils are located within Segment 3C and five hydric soils are located within Segment 4.[72, 73] **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	5.5
Lufkin fine sandy loam, 0 to 1 percent slopes	LfA	1.7	28.1
Melhomes loamy fine sand, 0 to 1 percent slopes	Ms	2.7	4.1
Nahatche loam, frequently flooded	Na	46.0	22.4
Rader-Derly complex, gently undulating	Rd	--	2.0
	Total	**54.4**	**62.1**

Source: NRCS 2017; NRCS 2015
'--' - not present

3.7.4.6.4 Vegetation

According to the EMST, the most common wetland vegetation types within the Study Area are Central Texas: Floodplain Herbaceous Vegetation, Central Texas: Floodplain Hardwood Forest, Central Texas: Riparian Hardwood Forest and Central Texas: Riparian Herbaceous Vegetation, as previously described. A complete list of wetland vegetation types that comprise the Study Area within Leon County is provided in **Table 3.7-30.**

[70] FEMA, "Floodplain Insurance Rate Map," accessed December 2019, http://www.fema.gov/flood-insurance-rate-map-firm.
[71] USACE, "USACE-Owned Properties Fort Worth District," 2014.
[72] NRCS, "SSURGO data by County," 2017.
[73] NRCS, "National Hydric Soils List 2015: Texas," 2015.

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	3.2	1.8
Central Texas: Floodplain Hardwood Forest	2.0	1.9
Central Texas: Riparian Hardwood Forest	--	0.49
Central Texas: Riparian Herbaceous Vegetation	0.14	0.64
Central Texas: Riparian Deciduous Shrubland	--	<0.01
Marsh	0.02	0.06
Open Water	<0.01	0.13
Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest	--	0.17
Pineywoods: Small Stream and Riparian Wet Prairie	--	0.05
Total Percent	**5.4**	**5.2**

Source: TPWD 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.[74] The streams, wetlands and waterbodies located within the Study Area are provided in **Table 3.7-31** through **Table 3.7-33**.

Notable streams within the Study Area for Madison County include the perennial Bedias Creek and intermittent Brushy Creek, Caney Creek, Ferry Branch, Greenbriar Creek, Iron Creek, Kickapoo Creek, Larrison Creek, Pooles Branch Salt Creek and Twomile Creek.

Based on the FEMA FIRMs and Digital FIRMs, approximately 14 acres of Segment 3C and approximately 58 acres of Segment 4 within Madison County are located within a 100-year floodplain (Zone A).[75]

Table 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	1,351
Intermittent	8,788	9,186
Ephemeral	--	3,285
Artificial/Man-made	1,482	216
Total	**10,398**	**14,038**

Source: USGS 2018; FNI 2018
'--' - not present

[74] TWDB, "River Basins," accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp.
[75] FEMA, "Floodplain Insurance Rate Map," accessed December 2019, http://www.fema.gov/flood-insurance-rate-map-firm.

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	--	0.84
	PEM1A	1.6	--
	PEM1Ah	--	0.23
	PEM1C	0.49	0.17
Freshwater Forested/Shrub Wetland	PFO	--	0.28
	PFO1A	11.9	18.2
	PFO1C	0.19	0.17
	PFO1F	--	0.51
	PFO1Fh	--	0.04
	Total	**14.2**	**20.4**

Source: USFWS 2018; FNI 2018

'--' - not present

A – Temporarily Flooded
C – Seasonally Flooded
EM – Emergent
EM1 – Persistent Emergent
F – Semi permanently Flooded
FO – Forested
FO1 – Broad-leaved Deciduous Forested
h – Diked/Impounded
P – Palustrine

Table 3.7-33: Waterbodies within the Study Area – Madison County		
Type	**Area of Segment 3C (acres)**	**Area of Segment 4 (acres)**
Swamp	1.9	--
Freshwater Pond	3.9	1.8
Total	**5.8**	**1.8**

Source: USFWS 2018; FNI 2018

'--' - not present

3.7.4.7.2 USACE Projects

No USACE projects subject to Section 408 approval are located within the Madison County Study Area.[76]

3.7.4.7.3 Hydric Soils

Based on the 2015 NRCS National Hydric Soil List, four hydric soils are located within Segment 3C and three hydric soils are located within Segment 4 in Madison County.[77,78] **Table 3.7-34** includes the area in acres for each hydric soil.

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	38.1	40.2
Nahatche loam, frequently flooded	Na	26.4	16.8
Rader-Derly complex, 0 to 2 percent slopes	RbA	38.8	13.2
	Total	**113.4**	**70.2**

Source: NRCS 2015, 2017

'--' - not present

[76] USACE, "USACE-Owned Properties Fort Worth District," 2014.
[77] NRCS, "SSURGO data by County," 2017.
[78] NRCS, "Hydric Soils List 2015: Texas," 2015.

3.7.4.7.4 Vegetation

According to the EMST, the most common wetland vegetation types within the Study Area are Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest and Pineywoods: Small Stream and Riparian Wet Prairie, described below.[79] 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 Temporarily Flooded Hardwood Forest	7.3	7.7
Pineywoods: Small Stream and Riparian Wet Prairie	4.3	1.8
Marsh	0.06	--
Open Water	<0.01	--
Pineywoods: Small Stream and Riparian Seasonally Flooded Hardwood Forest	--	0.18
Total Percent	**11.7**	**9.7**

Source: TPWD 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.[80]

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.[81]

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.[82] The streams, wetlands and waterbodies located within the Study Area in Grimes County are provided in **Tables 3.7-36** through **3.7-38.**

Notable streams within the Study Area in Grimes County include the intermittent Bums Creek, Caney Creek, Haynie Creek, Hurricane Creek, Kickapoo Creek, Panky Creek, Rocky Creek, South Bedias Creek, Sulphur Creek and Turkey Creek.

[79] NRCS, "Hydric Soils List 2015: Texas," 2015.
[80] TPWD. Texas Vegetation Classification Project: Interpretive Booklet for Phase II. Austin, Texas: Texas Parks and Wildlife Department. 2014.
[81] Ibid.
[82] TWDB, "River Basins," accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp.

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	--	--	955
Intermittent	3,373	643	14,721
Ephemeral	--	773	10,779
Artificial/Man-made	137	214	2,539
Total	**3,510**	**1,630**	**28,994**

Source: USGS 2018; FNI 2018

'--' - not present

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	--	0.84	0.80
	PEM1F	--	--	0.37
	PEM1A	--	--	0.11
	PEM1C	--	--	0.56
Freshwater Forested/Shrub Wetland	PFO	--	1.1	1.7
	PFO1A	0.21	1.0	0.74
	PFO1C	--	--	0.24
	PSS	--	--	0.10
Total		**0.21**	**2.9**	**4.6**

Source: USFWS 2018; FNI 2018

'—' not present

A – Temporarily Flooded
C – Seasonally Flooded
EM – Emergent
EM1 – Persistent Emergent
F – Semi permanently Flooded
FO – Forested
FO1 – Broad-leaved Deciduous Forested
P – Palustrine
SS – Shrub-Shrub

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)	--	--	0.19
Freshwater Pond	1.1	0.94	14.2
Total	**1.1**	**0.94**	**14.4**

Source: USFWS 2018; FNI 2018

'--' - not present

Based on the FEMA FIRMs and Digital FIRMs, approximately 28 acres of Segment 3C, approximately 22 acres of Segment 4 and approximately 27 acres of Segment 5 within Grimes County are located within a 100-year floodplain (Zone A).[83]

[83] FEMA, "Floodplain Insurance Rate Map," accessed December 2019, http://www.fema.gov/flood-insurance-rate-map-firm.

3.7.4.8.2 USACE Projects

No USACE projects subject to Section 408 approval are located within the Grimes County Study Area.[84]

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 three hydric soils located within Segment 5 in Grimes County.[85,86] **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	--	--	35.6
Nahatche clay loam, frequently flooded	Na	10.9	3.3	53.7
Tinn clay, 0 to 1 percent slopes, frequently flooded	Tn	--	--	11.1
Total		**10.9**	**3.3**	**100.4**

Source: NRCS 2015, 2017

'--' - 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 Temporarily Flooded Hardwood Forest, Pineywoods: Small Stream and Riparian Wet Prairie and Central Texas: Floodplain Hardwood Forest, as previously described.[87] A complete list of wetland vegetation types within the Study Area in Grimes County is provided in **Table 3.7-40**.

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	6.5	10.1	1.5
Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest	4.4	23.5	1.5
Central Texas: Floodplain Hardwood Forest	--	--	1.3
Central Texas: Floodplain Herbaceous Vegetation	--	--	0.71
Central Texas: Riparian Herbaceous Vegetation	--	--	0.63
Central Texas: Riparian Hardwood - Evergreen Forest	--	--	0.11
Central Texas: Riparian Hardwood Forest	--	--	0.21
Pineywoods: Small Stream and Riparian Temporarily Flooded Mixed Forest	--	--	0.06
Open Water	--	--	0.43
Marsh	--	--	0.02
Total	**10.9**	**33.6**	**6.5**

Source: TPWD 2014

'--' - not present

84 USACE, "USACE-Owned Properties Fort Worth District," 2014.
85 NRCS, "SSURGO data by County," 2017.
86 NRCS, "Hydric Soils List 2015: Texas," 2015.
87 TWDB, "River Basins," accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp.

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.[88] The streams, wetlands and waterbodies located within the Study Area in Waller County 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	291
Intermittent	1,962
Ephemeral	--
Artificial/Man-made	184
Total	**2,437**

Source: USGS 2018; FNI 2018

Table 3.7-42: Wetlands within the Study Area – Waller County

Wetland Type	Classification	Area of Segment 5 (acres)
Freshwater Emergent Wetland	PEM	1.9
	PEM1A	0.56
	PEM1C	0.13
Freshwater Forested/Shrub Wetland	PFO	0.45
	PFO1A	0.17
	PFO1C	0.29
Total		**3.5**

Source: USFWS 2018; FNI 2018

A – Temporarily Flooded
C – Seasonally Flooded
EM – Emergent
EM1 – Persistent Emergent
FO – Forested
FO1 – Broad-leaved Deciduous Forested
P – Palustrine

Table 3.7-43: Waterbodies within the Study Area – Waller County

Type	Area of Segment 5 (acres)
Freshwater Pond	0.67
Total	**0.67**

Source: USFWS 2018; FNI 2018

Notable streams within the Study Area in Waller County include the perennial Walnut Creek and the intermittent Brushy Creek.

Based on the FEMA FIRMs and Digital FIRMs, approximately five acres of the Study Area in Waller County are located within a 500-year floodplain (Zone X) and approximately 17 acres of the Study Area in Waller County are located within a 100-year floodplain (Zone AE).[89]

3.7.4.9.2 USACE Projects

No USACE projects subject to Section 408 approval are located within the Study Area in Waller County.[90]

[88] Ibid.
[89] FEMA, "Floodplain Insurance Rate Map," accessed December 2019, http://www.fema.gov/flood-insurance-rate-map-firm.
[90] USACE, "USACE-Owned Properties Fort Worth District," 2014.

3.7.4.9.3 *Hydric Soils*

Based on the 2015 NRCS National Hydric Soil List, 10 hydric soils are located within the Study Area in Waller County.[91,92] **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	20.2
Edna loam, 0 to 1 percent slopes	EdA	6.0
Hatliff-Pluck-Kian complex, 0 to 1 percent slopes, frequently flooded	HatA	0.12
Katy fine sandy loam, 0 to 1 percent slopes	KaA	11.3
Katy fine sandy loam, 1 to 3 percent slopes	KaB	3.3
Nahatche loam, frequently flooded	Na	7.9
Splendora fine sandy loam, 0 to 2 percent slopes	SpB	60.3
Gessner fine sandy loam, 0 to 1 percent slopes, occasionally ponded	Wa	0.21
Wockley fine sandy loam, 0 to 1 percent slopes	WoA	47.3
Wockley fine sandy loam, 1 to 3 percent slopes	WoB	8.0
	Total	**164.6**

Source: NRCS 2015, 2017

3.7.4.9.4 *Vegetation*

According to the EMST, the most common wetland vegetation type in the Study Area in Waller County is Gulf Coast: Coastal Prairie, described below. A complete list of wetland vegetation types within the Study Area in Waller County is 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	29.0
Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest	1.8
Pineywoods: Small Stream and Riparian Wet Prairie	0.46
Total Percent	**31.3**

Source: TPWD 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.[93] The streams, wetlands and waterbodies located within the Study Area in Harris County are provided in **Tables 3.7-46** through **3.7-48**.

[91] NRCS, "SSURGO data by County," 2017.
[92] NRCS, "Hydric Soils List 2015: Texas," 2015.
[93] TWDB, "River Basins," accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp.

Table 3.7-46: Streams within the Study Area – Harris County	
Stream Type	**Length within Segment 5 (linear feet)**
Perennial	647
Intermittent	5,700
Ephemeral	2,829
Artificial/Man-made	6,520
Total	**15,969**

Source: USGS 2018; FNI 2018

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	11.0	1.6
	PEM1A	6.4	--
	PEM1Cx	2.9	--
	PEM1F	0.25	--
	PEMF	--	--
	PEM1C	6.1	--
Freshwater Forested/ Shrub Wetland	PFO	0.02	--
	PFO1A	0.08	--
	PFO1Ad	0.01	--
	PFO1C	0.21	--
	PSS1A	0.16	--
	PSS1Cx	0.76	--
	PSS	0.09	--
Other	Pf	6.4	
Total		**34.4**	**1.6**

Source: USFWS, 2018; FNI, 2018
'--' - not present

A – Temporarily Flooded
C – Seasonally Flooded
d – Partly Drained/Ditched
EM – Emergent
EM1 – Persistent Emergent
f – Farmed
F – Semi permanently Flooded
FO – Forested
FO1 – Broad-leaved Deciduous Forested
P – Palustrine
SS – Scrub-Shrub
SS1 – Broad-leaved Deciduous Scrub-Shrub
x – Excavated

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)**
Reservoir (unnamed)	0.61	--
Swamp	4.3	--
Freshwater Pond	4.4	0.10
Total	**9.3**	**0.10**

Source: USFWS 2018; FNI 2018
'--' - not present

As previously discussed, there are three Houston Terminal Station options: Houston Industrial Site Terminal Station Option, Houston Northwest Mall Terminal Station Option and Houston Northwest Transit Center Terminal Station Option. There are no streams within the LOD of the three Houston Terminal Station options. In addition, there are no wetlands or waterbodies within the Houston Northeast Mall Terminal Station or the Houston Industrial Site Terminal Station Options.

Notable streams within Segment 5 within Harris County include the intermittent Cole Creek, Little Mounty Creek and Spring Creek.

Based on the FEMA FIRMs and Digital FIRMs, within the Study Area in Harris County, approximately 48 acres of Segment 5 and less than one acre of the Houston Industrial Site Terminal Station Option are located within a 500-year floodplain (Zone X) and approximately 34 acres of Segment 5 are located within a 100-year floodplain (Zones AE and AO).[94] There are no mapped floodplains within the Northwest Mall Terminal Station or Northwest Transit Center Terminal Station options.

3.7.4.10.2 USACE Projects

No USACE projects subject to Section 408 approval are located within the Study Area in Harris County.[95]

3.7.4.10.3 Hydric Soils

Based on the 2015 NRCS National Hydric Soil List, within the Study Area in Harris County 11 hydric soils are located within Segment 5 and 2 hydric soils are located within the Houston Industrial Site Terminal, Northwest Mall Terminal Station and Northwest Transit Center Terminal Station options.[96, 97] **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	65.2	--	--	--
Addicks-Urban land complex	Ak	71.4	4.7	16.2	3.0
Aris fine sandy loam	Ap	6.7	--	--	--
Aris-Gessner complex	Ar	120.5	--	--	--
Aris-Urban land complex	As	--	46.1	3.2	7.5
Clodine fine sandy loam, 0 to 1 percent slopes	Cd	60.4	--	--	--
Clodine-Urban land complex	Ce	34.5	--	--	--
Gessner fine sandy loam, 0 to 1 percent slopes	Ge	110.3	--	--	--
Hatliff-Pluck-Kian complex, 0 to 1 percent slopes	HatA	0.76	--	--	--
Katy fine sandy loam, 0 to 1 percent slopes	Kf	17.4	--	--	--
Nahatche loam, frequently flooded	Na	0.50	--	--	--
Wockley fine sandy loam, 0 to 1 percent slopes	Wo	523.2	--	--	--
Total		**1,010.9**	**50.8**	**19.4**	**10.5**

Source: NRCS 2015, 2017

'--' - not present

[94] FEMA, "Floodplain Insurance Rate Map," accessed December 2019, http://www.fema.gov/flood-insurance-rate-map-firm.
[95] USACE, "USACE-Owned Properties Galveston District," 2014.
[96] NRCS, "SSURGO data by County," 2017.
[97] NRCS, "Hydric Soils List 2015: Texas," 2015.

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. A complete list of wetland vegetation types that comprise the Study Area in Harris County is provided in **Table 3.7-50**.

Table 3.7-50: Wetland Vegetation Types within the Study Area – Harris County

Vegetation Types	Percent of Segment 5
Gulf Coast: Coastal Prairie	63.3
Gulf Coast: Coastal Prairie Pondshore	0.18
Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest	0.05
Marsh	<0.01
Open Water	0.01
Total Percent	**63.5**

Source: TPWD 2014

Note: There are no wetland vegetation types located within the LOD of the three Houston Terminal Station options.

3.7.5 Environmental Consequences

3.7.5.1 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 without the contribution of the Project. Impacts to water quality, waters of the U.S. and floodplains would be expected as a result of other planned projects, such as the IH-35 East roadway improvement project in Dallas County, Waxahachie Line rail project in Dallas and Ellis Counties, and Integrated Pipeline Project in Navarro and Ellis Counties. The impacts of these projects are discussed in **Section 4.4, Indirect and Cumulative Impacts, Cumulative Impacts**.

3.7.5.2 Build Alternatives

Impacts would occur within waters of the U.S. during the construction and operation of the Project. TCRR, in coordination with the USACE, are developing the final design to avoid and minimize impacts to waters of the U.S., as practicable. However, 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. 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 analysis of impacts, see **Appendix E, Waters of the U.S. Technical Memorandum**. The crossing types for wetlands and waters of the U.S. are defined as the following:

- **Viaduct/Bridge:** It is anticipated that 55 percent of the Project would be placed on viaduct or bridges, resulting in many waters of the U.S., including wetlands, being spanned. Pier spacing would range from 80 to 140 feet, with a typical pier spacing of 110 feet (see **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports**). If the width of the regulatory floodplain is less than 110 feet, the entire span would be designed and constructed with no in channel piers, 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 the Project 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 crossings of water features.
- **Excavation:** Includes areas that would be excavated or regraded to redirect stormwater flow within the LOD.
- **Fill:** Placement of fill to support the permanent footprint of the Project on embankment or ancillary facilities.
- **Conversion:** The permanent conversion of forested or scrub/shrub wetlands to emergent wetlands due to the removal of woody vegetation during construction and permanent maintenance of herbaceous vegetation within the HSR ROW.
- **Overhead:** The temporary clearing of vegetation and temporary crossings for the construction or replacement of overhead utility lines.

Permanent impacts would occur for the placement of viaduct and bridge support structures and culverts, and within the permanent footprint of access roads, stations, MOW facilities, TMFs and where the Project would be on embankment. All areas where the Project would be on viaduct are being treated as temporary impacts for this Final EIS. Permanent impacts as a result of viaduct support structures would be determined during design development. Temporary 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 waters of the U.S. would require permits and approvals from the USACE and TCEQ that would include permit provisions to avoid, minimize and mitigate impacts, as described in **Section 3.7.6, Avoidance, Minimization and Mitigation Measures**.

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** through **3.7-53.**

USACE Projects

Estimated impacts to streams, wetlands and waterbodies as a result of Segment 1 in Dallas County include impacts to USACE projects identified in **Section 3.7.4.1.2, Affected Environment, 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 Projects Technical Memorandum**.

Table 3.7-51: Estimated Stream Impacts – Dallas County				
Classification	Crossing Type	Segment 1		
		Number of Crossings[a]	Temp	Perm
			linear feet	
Artificial/Man-made	Bridge/Viaduct	1	110.7	0.00
	Fill	1	0.00	126.8
	Overhead	1	84.2	0.00
Ephemeral	Bridge/Viaduct	4	297.2	0.00
	Overhead	2	299.2	0.00
Intermittent	Bridge/Viaduct	3	728.6	0.00
	Culvert	3	0.00	290.1
	Excavation	2	0.00	81.0
	Overhead	4	1,583.2	0.00
Perennial	Bridge/Viaduct	9	1,728.5	0.00
	Excavation	1	0.00	55.0
	Overhead	7	1,463.3	0.00
	Total	**38**	**6,294.9**	**552.9**

Source: USGS 2018; FNI 2018

[a] 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		
		Number of Crossings [a]	Temp	Perm
			acres	
Emergent	Bridge/Viaduct	5	4.4	0.00
	Excavation	3	0.00	1.3
	Overhead	2	1.9	0.00
Forested	Conversion	14	0.00	7.0
	Excavation	6	0.15	0.13
	Fill	3	0.00	0.66
	Overhead	8	3.2	0.00
Shrub/Scrub	Conversion	2	0.00	0.61
	Fill	1	0.00	0.17
	Overhead	3	0.95	0.00
	Total	**47**	**10.6**	**9.9**

Source: USFWS 2018; FNI 2018

[a] 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 3.7-53: Estimated Waterbody Impacts – Dallas County

Waterbody Type	Crossing Type	Segment 1		
		Number of Crossings [a]	Temp	Perm
			acres	
Freshwater Pond	Bridge/Viaduct	7	2.3	0.00
	Excavation	5	0.00	0.40
	Fill	2	<0.01	0.10
	Overhead	3	0.11	0.00
Lake (Mooreland Lake)	Bridge/Viaduct	1	2.1	0.00
Total		**18**	**4.5**	**0.50**

Source: USGS 2018; USFWS 2018; FNI 2018

[a] 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.

3.7.5.2.2 Ellis County

Estimated impacts to waters of the U.S. resulting from the construction of Segments 1, 2A, 2B, 3A, 3B or 3C within Ellis County are provided in **Tables 3.7-54** through **3.7-56.** There are no wetlands within Segments 3A, 3B or 3C in Ellis County.[98]

USACE Projects

Estimated impacts to streams, wetlands, and waterbodies of Segment 2B in Ellis County would include impacts to the USACE Project Lake Bardwell. Impacts of Segment 2B (Build Alternatives D, E and F) would require Section 408 permission that TCRR shall request from the USACE. 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.**

[98] USFWS, "National Wetlands Inventory," Last modified October 9, 2019, accessed December 2019, http://www.fws.gov/wetlands/Data/Mapper.html.

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Table 3.7-54: Estimated Stream Impacts – Ellis County

Classification	Crossing Type	Segment 1			Segment 2A			Segment 2B			Segment 3A			Segment 3B			Segment 3C		
		Number of Crossings [a]	Temp	Perm	Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm	Number of Crossings a*	Temp	Perm	Number of Crossings[a]	Temp	Perm
			linear feet			linear feet			linear feet			linear feet			linear feet			linear feet	
Artificial/ Man-made	Bridge/ Viaduct	--	--	--	1	3.6	0.00	6	568.0	0.00	--	--	--	--	--	--	--	--	--
	Culvert	--	--	--	--	--	--	--	--	--	2	0.00	210.0	2	0.00	210.0	2	0.00	210.0
	Excavation	--	--	--	--	--	--	1	0.00	299.0	1	0.00	176.0	1	0.00	176.0	1	0.00	176.0
Ephemeral	Bridge/ Viaduct	--	--	--	10	1,356.4	0.00	--	--	--	--	--	--	--	--	--	--	--	--
	Culvert	--	--	--	2	0.00	422.9	--	--	--	--	--	--	--	--	--	--	--	--
	Excavation	--	--	--	2	0.00	329.2	--	--	--	--	--	--	--	--	--	--	--	--
	Overhead	--	--	--	5	2,088.4	0.00	--	--	--	--	--	--	--	--	--	--	--	--
Intermittent	Bridge/ Viaduct	--	--	--	25	3,090.6	0.00	59	7,537.7	0.00	--	--	--	2	86.4	0.00	--	--	--
	Culvert	--	--	--	2	0.00	678.4	2	0.00	400.4	1	0.00	389.1	--	--	--	1	0.00	389.1
	Excavation	--	--	--	--	--	--	3	346.8	299.0	1	0.00	97.0	1	0.00	65.2	1	0.00	97.0
	Fill	--	--	--	--	--	--	1	0.00	177.4	--	--	--	--	--	--	--	--	--
	Overhead	--	--	--	5	1,313.3	0.00	6	1,323.4	0.00	--	--	--	--	--	--	--	--	--
Perennial	Bridge/ Viaduct	1	118.0	0.00	9	1,013.9	0.00	8	690.4	0.00	--	--	--	--	--	--	--	--	--
	Overhead	--	--	--	5	359.5	0.00	3	980.0	0.00	--	--	--	--	--	--	--	--	--
	Total	**1**	**118.0**	**0.00**	**66**	**9,225.7**	**1,430.5**	**89**	**11,446.3**	**1,175.8**	**5**	**0.00**	**872.1**	**6**	**86.4**	**451.2**	**5**	**0.00**	**872.1**

Source: USGS 2018; FNI 2018

'--' - not present

[a] 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 3.7-55: Estimated Wetland Impacts – Ellis County

Wetland Type	Crossing Type	Segment 2A			Segment 2B		
		Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm
			acres			acres	
Emergent	Bridge/Viaduct	5	1.0	0.00	--	--	--
	Fill	2	0.00	0.05	--	--	--
	Excavation	1	0.00	0.03	--	--	--
	Overhead	6	0.31	0.00	--	--	--
Forested	Conversion	8	0.00	0.55	12	0.00	1.6
	Overhead	2	2.0	0.00	2	4.2	0.00
	Total	**24**	**3.3**	**0.63**	**14**	**4.2**	**1.6**

Source: USFWS 2018; FNI 2018

'--' - not present

[a] 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			Segment 3B		
		Number of Crossingsa	Temp	Perm	Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm
			acres			acres			acres			acres	
Freshwater Pond	Bridge/Viaduct	1	0.01	0.00	21	2.8	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**

Source: USGS 2016; FNI 2017

'--' - not present

[a] 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 3.7-57: Estimated Stream Impacts – Navarro County

Classification	Crossing Type	Segment 3A			Segment 3B			Segment 3C		
		Number of Crossings[a]	Temp (linear feet)	Perm (linear feet)	Number of Crossings[a]	Temp (linear feet)	Perm (linear feet)	Number of Crossings[a]	Temp (linear feet)	Perm (linear feet)
Artificial/Man-made	Bridge/Viaduct	1	135.7	0.00	9	1,707.7	0.00	1	135.7	0.00
	Culvert	--	--	--	1	0.00	132.4	--	--	--
	Excavation	--	--	--	1	0.00	261.9	--	--	--
Ephemeral	Bridge/Viaduct	1	135.6	0.00	--	--	--	--	--	--
	Culvert	2	0.00	448.5	--	--	--	--	--	--
	Overhead	4	1,602.0	0.00	--	--	--	--	--	--
Intermittent	Bridge/Viaduct	25	4,383.2	0.00	44	4,636.5	0.00	42	6,425.6	0.00
	Culvert	7	0.00	1,490.2	29	0.00	7,488.0	10	31.6	1,820.0
	Excavation	8	0.00	1,101.3	12	0.00	2,312.0	11	9.4	1,356.0
	Overhead	4	725.1	0.00	3	848.8	0.00	6	1,094.7	0.00
Perennial	Bridge/Viaduct	1	117.1	0.00	2	151.2	0.00	1	117.1	0.00
Total		**53**	**7,098.7**	**3,040.0**	**101**	**7,344.2**	**10,194.3**	**71**	**7,814.1**	**3,176.0**

Source: USGS 2018; FNI 2018

'--' - not present

[a] 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 3.7-58: Estimated Wetland Impacts – Navarro County

Wetland Type	Crossing Type	Segment 3A			Segment 3B			Segment 3C		
		Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm
			acres			acres			acres	
Emergent	Bridge/Viaduct	5	0.30	0.00	6	0.88	0.00	--	--	--
	Excavation	2	0.00	0.04	--	--	--	--	--	--
	Fill	6	1.2	1.7	1	0.00	0.12	--	--	--
Forested	Conversion	8	0.00	5.7	17	0.00	4.2	10	0.00	6.3
	Fill	--	--	--	4	0.00	0.47	--	--	--
	Excavation	--	--	--	2	0.00	0.15	--	--	--
	Overhead	1	0.02	0.00	2	0.37	0.00	1	0.14	0.00
Total		**22**	**1.5**	**7.4**	**32**	**1.3**	**4.9**	**11**	**0.14**	**6.3**

Source: USFWS 2018; FNI 2018

'--' - not present

[a] 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		
		Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm
			acres			acres			acres	
Freshwater Pond	Bridge/Viaduct	13	1.3	0.00	21	1.7	0.00	12	1.8	0.00
	Excavation	6	0.00	2.1	14	0.00	1.5	2	0.00	0.36
	Fill	16	0.18	2.9	21	0.15	3.2	5	0.18	0.35
	Overhead	3	0.34	0.00	2	0.76	0.00	4	0.35	0.00
Lake (Soil Conservation Service Site 138)	Bridge/Viaduct	--	--	--	1	1.7	0.00	--	--	--
Total		**38**	**1.8**	**5.0**	**59**	**4.3**	**4.7**	**23**	**2.3**	**0.71**

Source: USGS 2018; USFWS 2018; FNI 2018

'--' - not present

[a] 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**. No mapped streams, wetlands or waterbodies are located within Segments 3A and 3B in Freestone County.

Table 3.7-60: Estimated Stream Impacts – Freestone County

Classification	Crossing Type	Segment 3C			Segment 4		
		Number of Crossings[a]	Temp (linear feet)	Perm (linear feet)	Number of Crossings[a]	Temp (linear feet)	Perm (linear feet)
Artificial/Man-made	Bridge/Viaduct	--	--	--	2	133.2	0.00
	Culvert	1	0.00	224.2	--	--	--
	Excavation	1	0.00	147.4	--	--	--
	Fill	--	--	--	1	0.00	17.8
Ephemeral	Bridge/Viaduct	--	--	--	9	1,861.7	0.00
	Culvert	--	--	--	10	0.00	2,224.1
	Excavation	--	--	--	8	0.00	900.2
	Overhead	--	--	--	1	271.9	0.00
Intermittent	Bridge/Viaduct	71	14,047.3	0.00	21	3,113.8	0.00
	Culvert	8	0.00	2,303.8	8	0.00	1,030.7
	Excavation	5	126.1	800.3	6	0.00	749.5
	Fill	2	0.00	905.8	--	--	--
	Overhead	2	412.5	0.00	1	3.4	0.00
Perennial	Bridge/Viaduct	5	747.1	0.00	3	306.4	0.00
	Total	**95**	**15,333.0**	**4,381.5**	**70**	**5,690.4**	**4,922.3**

Source: USGS 2018; FNI 2018

'--' - not present

[a] 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 3.7-61: Estimated Wetland Impacts – Freestone County

Wetland Type	Crossing Type	Segment 3C			Segment 4		
		Number of Crossings[a]	Temp (acres)	Perm (acres)	Number of Crossings[a]	Temp (acres)	Perm (acres)
Emergent	Bridge/Viaduct	6	0.61	0.00	16	1.8	0.00
	Excavation	--	--	--	2	0.02	0.06
	Fill	1	0.00	0.11	14	0.44	0.22
Forested	Conversion	15	0.00	4.6	10	0.00	2.1
	Fill	3	2.5	0.07	2	0.00	0.17
	Excavation	1	0.00	0.12	1	<0.01	0.00
	Overhead	1	0.14	0.00	--	--	--
Shrub/Scrub	Conversion	2	0.00	4.6	--	--	--
	Fill	--	--	--	1	0.00	0.02
	Total	**29**	**3.3**	**9.5**	**46**	**2.3**	**2.6**

Source: USFWS 2018; FNI 2018

'--' - not present

[a] 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		
		Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm
			acres			acres	
Freshwater Pond	Bridge/Viaduct	15	1.0	0.00	20	1.2	0.00
	Excavation	3	0.07	0.10	8	0.00	0.38
	Fill	15	1.1	1.6	28	1.9	3.6
	Overhead	--	--	--	2	0.11	0.00
Total		**33**	**2.2**	**1.7**	**58**	**3.2**	**4.0**

Source: USGS 2018; USFWS 2018; FNI 2018

'--' - not present

[a] 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		
		Number of Crossings[a]	Temp	Perm
			Linear feet	
Artificial/Man-made	Bridge/Viaduct	1	57.8	0.00
Ephemeral	Bridge/Viaduct	8	812.9	0.00
	Culvert	2	0.00	921.2
	Excavation	1	0.00	223.0
Intermittent	Bridge/Viaduct	24	2,955.1	0.00
	Culvert	7	0.00	1,483.8
	Excavation	3	0.00	373.6
Perennial	Bridge/Viaduct	1	191.4	0.00
Total		**47**	**4,017.2**	**3,001.6**

Source: USGS 2018; FNI 2018

[a] 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		
		Number of Crossings[a]	Temp	Perm
			acres	
Emergent	Bridge/Viaduct	9	2.0	0.00
Forested	Conversion	12	0.00	1.3
Total		**21**	**2.0**	**1.3**

Source: USFWS 2018; FNI 2018

a 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		
		Number of Crossings[a]	Temp	Perm
			acres	
Freshwater Pond	Bridge/Viaduct	9	0.74	0.00
	Excavation	2	<0.01	0.11
	Fill	5	0.00	0.28
	Total	**16**	**0.74**	**0.39**

Source: USGS 2018; USFWS 2018; FNI 2018

[a] 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		
		Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm
			linear feet			linear feet	
Artificial/Man-made	Bridge/Viaduct	4	803.0	0.00	--	--	--
	Culvert	--	--	--	1	0.00	248.2
	Excavation	--	--	--	1	0.00	75.5
	Overhead	1	227.4	0.00	--	--	--
Ephemeral	Culvert	--	--	--	6	0.00	1,041.1
	Excavation	--	--	--	5	0.00	348.5
Intermittent	Bridge/Viaduct	65	9,797.8	0.00	29	5,389.4	0.00
	Culvert	8	0.00	1,419.4	12	949.7	2,896.2
	Excavation	8	0.00	902.3	7	21.1	1,589.3
	Fill	12	0.00	2,958.4	2	0.00	553.4
	Overhead	1	140.2	0.00	3	833.0	0.00
Perennial	Bridge/Viaduct	10	1,851.2	0.00	3	600.7	0.00
	Culvert	--	--	--	1	0.00	79.9
	Fill	1	0.00	217.8	--	--	--
	Total	**110**	**12,819.6**	**5,497.9**	**70**	**7,793.9**	**6,832.1**

Source: USGS 2018; FNI 2018

'--' - not present

[a] 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 3.7-67: Estimated Wetland Impacts – Leon County

Wetland Type	Crossing Type	Segment 3C			Segment 4		
		Number of Crossings[a]	Temp (acres)	Perm (acres)	Number of Crossings[a]	Temp (acres)	Perm (acres)
Emergent	Bridge/Viaduct	15	3.9	0.00	10	1.3	0.00
	Fill	1	0.02	0.00	2	0.00	0.45
Forested	Conversion	13	0.00	4.0	12	0.00	1.2
	Fill	3	0.00	0.49	1	0.00	0.03
	Excavation	--	--	--	1	0.00	0.01
Shrub/Scrub	Conversion	3	0.00	0.16	--	--	--
Total		**35**	**3.9**	**4.7**	**26**	**1.3**	**1.7**

Source: USFWS 2018; FNI 2018

'--' - not present

[a] 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		
		Number of Crossings[a]	Temp (acres)	Perm (acres)	Number of Crossings[a]	Temp (acres)	Perm (acres)
Freshwater Pond	Bridge/Viaduct	12	2.8	0.00	17	3.8	0.00
	Excavation	5	0.00	0.26	6	0.00	0.71
	Fill	5	0.00	0.29	17	0.00	2.3
	Overhead	2	0.51	0.00	3	0.38	0.00
Lake	Bridge/Viaduct	--	--	--	1	1.5	0.00
Total		**24**	**3.3**	**0.55**	**44**	**5.7**	**3.0**

Source: USGS 2018; USFWS 2018; FNI 2018

'--' - not present

[q] 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 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		
		Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm
			linear feet			linear feet	
Artificial/Man-made	Bridge/Viaduct	3	441.9	0.00	1	216.0	0.00
	Culvert	1	0.00	170.7	--	--	--
	Excavation	1	0.00	338.5	--	--	--
Ephemeral	Bridge/Viaduct	--	--	--	10	1,697.7	0.00
	Culvert	--	--	--	2	0.00	1,003.3
	Excavation	--	--	--	6	358.7	199.5
	Fill	--	--	--	1	0.00	27.0
Intermittent	Bridge/Viaduct	40	5,687.3	0.00	21	3,927.6	0.00
	Culvert	6	0.00	2,397.6	2	0.00	620.4
	Excavation	1	0.00	49.9	15	1,380.8	1,444.5
	Overhead	--	--	--	4	1,812.3	0.00
Perennial	Bridge/Viaduct	2	128.1	0.00	3	667.0	0.00
	Excavation	--	--	--	3	257.6	0.00
	Overhead	--	--	--	2	425.9	0.00
Total		**54**	**6,257.3**	**2,956.7**	**70**	**10,743.6**	**3,294.7**

Source: USGS 2018; FNI 2018

'--' - not present

[a] 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 3.7-70: Estimated Wetland Impacts – Madison County							
Wetland Type	Crossing Type	Segment 3C			Segment 4		
		Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm
			acres			acres	
Emergent	Bridge/Viaduct	3	0.11	0.00	7	0.72	0.00
	Excavation	1	0.02	0.00	4	0.31	0.00
	Fill	2	0.00	1.7	3	0.00	0.06
	Overhead	--	--	--	2	0.14	0.00
Forested	Conversion	12	0.00	11.6	7	0.00	5.5
	Excavation	--	--	--	5	3.5	0.00
	Overhead	1	0.49	0.00	4	10.1	0.00
Total		**19**	**0.62**	**13.3**	**32**	**14.8**	**5.6**

Source: USFWS 2018; FNI 2018

'--' - not present

[a] 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		
		Number of Crossings[a]	Temp (acres)	Perm (acres)	Number of Crossings[a]	Temp (acres)	Perm (acres)
Freshwater Pond	Bridge/Viaduct	14	2.0	0.00	9	1.3	0.00
	Excavation	6	0.00	0.45	3	0.06	0.00
	Fill	9	0.00	1.2	1	0.00	0.02
	Overhead	--	--	--	3	0.47	0.00
Swamp	Bridge/Viaduct	3	0.29	0.00	--	--	--
	Fill	1	0.00	1.5	--	--	--
Total		**33**	**2.3**	**3.2**	**16**	**1.8**	**0.02**

Source: USGS 2018; USFWS 2018; FNI 2018

'--' - not present

[a] 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		
		Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm
			linear feet			linear feet			linear feet	
Artificial/Man-made	Bridge/Viaduct	--	--	--	--	--	--	1	119.9	0.00
	Culvert	2	0.00	136.6	2	0.00	136.6	2	0.00	659.9
	Excavation	--	--	--	1	0.00	77.2	6	0.00	1,636.2
	Fill	--	--	--	--	--	--	1	0.00	122.8
Ephemeral	Bridge/Viaduct	--	--	--	7	746.3	0.00	19	5,334.1	0.00
	Culvert	--	--	--	--	--	--	17	205.2	2,849.9
	Excavation	--	--	--	1	26.5	0.00	13	0.00	1,849.3
	Fill	--	--	--	--	--	--	2	0.00	422.1
Intermittent	Bridge/Viaduct	18	1,920.8	0.00	6	640.7	0.00	50	8,811.9	0.00
	Culvert	--	--	--	2	0.00	2.6	14	15.8	3,718.3
	Excavation	5	0.00	1,357.5	--	--	--	8	68.3	1,003.8
	Fill	--	--	--	--	--	--	2	0.00	969.7
	Overhead	1	95.1	0.00	--	--	--	1	100.3	0.00
Perennial	Bridge/Viaduct	--	--	--	--	--	--	2	739.5	0.00
	Overhead	--	--	--	--	--	--	1	215.6	0.00
Total		**26**	**2,015.9**	**1,494.1**	**19**	**1,413.5**	**216.4**	**139**	**15,610.6**	**13,232.0**

Source: USGS 2018; FNI 2018

'--' - not present

[a] 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 3.7-73: Estimated Wetland Impacts – Grimes County

Wetlands Type	Crossing Type	Segment 3C			Segment 4			Segment 5		
		Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm
			acres			acres			acres	
Emergent	Bridge/Viaduct	--	--	--	3	0.84	0.00	9	0.91	0.00
	Fill	--	--	--	--	--	--	7	0.47	0.17
	Excavation	--	--	--	--	--	--	4	0.00	0.28
Forested	Conversion	2	0.00	0.10	5	0.00	1.8	15	0.00	2.5
	Excavation	1	0.00	0.06	1	0.33	0.00	3	<0.01	0.18
	Overhead	1	0.05	0.00	--	--	--	--	--	--
Scrub/Shrub	Excavation	--	--	--	--	--	--	1	0.00	0.10
	Total	**4**	**0.05**	**0.16**	**9**	**1.2**	**1.8**	**39**	**1.4**	**3.2**

Source: USFWS 2018; FNI 2018

'--' - not present

[a] 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		
		Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm
			acres			acres			acres	
Freshwater Pond	Bridge/Viaduct	2	0.21	0.00	1	0.06	0.00	22	1.9	0.00
	Excavation	2	0.00	0.20	3	0.00	0.20	37	0.20	7.2
	Fill	3	0.00	0.67	4	0.00	0.67	20	<0.01	4.0
	Overhead	--	--	--	--	--	--	5	0.90	0.00
Reservoir (Unnamed)	Bridge/Viaduct	--	--	--	--	--	--	1	0.19	0.00
	Total	**7**	**0.21**	**0.87**	**8**	**0.06**	**0.87**	**85**	**3.2**	**11.2**

Source: USGS 2018; USFWS 2018; FNI 2018

'--' - not present

[a] 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		
		Number of Crossings[a]	Temp	Perm
			linear feet	
Artificial/Man-made	Bridge/Viaduct	1	183.9	0.00
Intermittent	Bridge/Viaduct	8	1,299.8	0.00
	Culvert	2	0.00	297.6
	Excavation	1	0.00	365.0
Perennial	Bridge/Viaduct	2	290.6	0.00
	Total	**14**	**1,774.3**	**662.6**

Source: USGS 2018; FNI 2018

[a] 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 3.7-76: Estimated Wetland Impacts – Waller County

Wetland Type	Crossing Type	Segment 5		
		Number of Crossings[a]	Temp	Perm
			acres	
Emergent	Bridge/Viaduct	3	0.19	0.00
	Excavation	2	0.00	0.03
	Fill	3	0.00	0.45
	Overhead	4	1.9	0.00
Forested	Conversion	10	0.00	0.82
	Overhead	2	0.09	0.00
	Total	**24**	**2.2**	**1.3**

Source: USFWS 2018; FNI 2018

[a] 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		
		Number of Crossings[a]	Temp	Perm
			acres	
Freshwater Pond	Bridge/Viaduct	5	0.16	0.00
	Excavation	8	0.03	0.22
	Fill	1	0.00	0.02
	Overhead	3	0.24	0.00
	Total	**17**	**0.43**	**0.24**

Source: USGS 2018; USFWS 2018; FNI 2018

[a] 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**. No stream crossings, wetlands or waterbodies are located within the LODs of the Houston Northwest Mall Terminal Station Option and Houston Industrial Site Terminal Station Option.

Table 3.7-78: Estimated Stream Impacts – Harris County

Classification	Crossing Type	Segment 5		
		Number of Crossings[a]	Temp	Perm
			linear feet	
Artificial/Man-made	Bridge/Viaduct	14	3,933.3	0.00
	Excavation	1	177.3	0.00
	Overhead	3	1,236.2	0.00
Ephemeral	Bridge/Viaduct	3	2,323.6	0.00
	Excavation	2	0.00	227.4
	Fill	2	0.00	277.6
Intermittent	Bridge/Viaduct	14	5,085.9	0.00
	Culvert	1	0.00	187.6
	Excavation	1	0.00	66.0
	Overhead	1	355.7	0.00
Perennial	Bridge/Viaduct	6	568.0	0.00
	Fill	1	0.00	79.0
	Total	**49**	**13,680.0**	**837.6**

Source: USGS 2018; FNI 2018

[a] 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 3.7-79: Estimated Wetland Impacts – Harris County

Wetland Type	Crossing Type	Segment 5			Northwest Transit Center Terminal Station Option		
		Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm
			acres			acres	
Emergent	Bridge/Viaduct	34	15.8	0.00	1	0.55	0.00
	Fill	18	1.2	6.6	--	--	--
	Excavation	12	0.12	1.2	--	--	--
	Overhead	5	1.6	0.00	1	1.0	0.00
Forested	Conversion	4	0.00	0.12	--	--	--
	Fill	1	0.01	0.00	--	--	--
	Excavation	1	0.19	0.00	--	--	--
Other	Bridge/Viaduct	8	6.4	0.00	--	--	--
Scrub/Shrub	Conversion	2	0.00	0.09	--	--	--
	Excavation	2	<0.01	0.16	--	--	--
	Total	**87**	**25.3**	**8.2**	**2**	**1.6**	**0.00**

Source: USFWS 2018; FNI 2018

'--' - not present

[a] 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 Station Option		
		Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm
			acres			acres	
Reservoir	Overhead	1	0.61	0.00	--	--	--
Freshwater Pond	Bridge/Viaduct	9	3.2	0.00	1	0.06	0.00
	Excavation	6	<0.01	0.53	--	--	--
	Fill	3	0.09	0.22	1	0.00	0.04
	Overhead	1	0.34	0.00	--	--	--
Swamp	Bridge/Viaduct	2	0.92	0.00	--	--	--
	Excavation	1	0.00	0.54	--	--	--
	Fill	4	0.06	0.92	--	--	--
	Overhead	1	1.6	0.00	--	--	--
Total		**28**	**6.8**	**2.2**	**2**	**0.06**	**0.04**

Source: USGS 2018; USFWS 2018; FNI 2018

'--' - not present

[a] 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

TCRR consulted with the USACE Fort Worth and Galveston Districts to document the expected impacts, permits and mitigation needs in conjunction with this EIS. When evaluating TCRR's application for a CWA Section 404 permit, the USACE shall evaluate the HSR system for impacts to waters of the U.S. and verify 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

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, 48 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 55 percent of the Project would be on viaduct to minimize impacts to waters of the U.S. Impacts to wetlands would also be avoided or minimized with pier spacing that would range from 80 to 140 feet (as noted in **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports**). If the width of the regulatory floodplain is less than 110 feet, the entire span would be designed and constructed with no in channel piers 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 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.

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 July 2019. 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, Avoidance,**

Minimization and Mitigation Measures, Compliance Measures and Permitting, would be obtained by TCRR prior to initiating construction.

3.7.6.1 Compliance Measures and Permitting

TCRR would be required to comply with the following Compliance Measures (CM).

WW-CM#1: Avoidance and Minimization: In accordance with Section 404 (b)(1) guidelines and pursuant to the Final Mitigation Rule,[99] TCRR shall take appropriate and practicable steps to avoid and minimize adverse impacts to waters of the U.S. during construction. Measures to avoid and minimize impacts may include:

- Heavy equipment working in wetlands or mudflats will be placed on mats, or other measures must be taken to minimize soil disturbance.
- Temporary fills will consist of materials that will not be eroded by expected high flows.
- Temporary fills will be removed in their entirety and the affected areas returned to pre-construction elevations as soon as practicable after construction.
- No activity will be permitted to use unsuitable material (trash, debris, car bodies, asphalt, etc.). Material used for construction or discharged must be free from toxic pollutants in toxic amounts.
- The areas affected by temporary fills will be revegetated as soon as practicable after construction.
- Access roads will be constructed so that the length of each road crossing minimizes adverse effects on waters of the U.S. (e.g., is the shortest distance across the waterbody) and will be as near as possible to pre-construction contours and elevations.
- The placement of drainage swales in waters of the U.S. will be avoided and, if unavoidable, minimized and constructed to not drain waters of the U.S.
- In wetland areas disturbed by construction, a minimum of 12 inches of topsoil material from the wetland will be stockpiled and used as backfill material to restore preconstruction contours.
- Open bottom culverts will be used in place of closed culverts where practicable.
- Construction detention basins will be off channel.

WW-CM#2: Maintain Low Flow. In compliance with the CWA 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 CWA and under USACE general permit conditions, TCRR shall require the construction contractor to restore preconstruction contours and remove temporary fills from all temporarily impacted waters of the U.S. (e.g., temporary equipment crossings or temporary disturbances in construction areas around and beneath the HSR system) to pre-construction conditions. TCRR shall provide post-construction monitoring of temporarily impacted waters of the U.S. and provide reports to USACE in accordance with the final terms and conditions of the Section 404 permit (see **WW-CM#4: CWA Section 404, Individual Permit**).

WW-CM#4: CWA Section 404, Individual Permit. Where avoidance of impacts to waters of the U.S. is not 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 is based on a number of considerations, including conservation, economics,

[99] 40 C.F.R. 230.91

aesthetics and several other factors. The USACE is evaluating the Project under the provisions of one standard Individual Permit within each District's Area of Responsibility. TCRR, under the oversight of the USACE, shall comply with all the conditions required in the Section 404 permit during construction and operation of the Project. Section 10 compliance would be incorporated into the Individual Permit from both the Fort Worth and Galveston Districts.

WW-CM#5: Waters of the U.S. Mitigation Plan. To mitigate unavoidable impacts to waters of the U.S and as part of **WW-CM#4: CWA Section 404, Individual Permit**, TCRR shall develop a mitigation plan to provide compensatory mitigation for permanent impacts exceeding district thresholds (0.1 acre or 300 linear feet of waters of the U.S. at each single and complete crossing within the Fort Worth and Galveston Districts) in accordance with the requirements of the CWA and as agreed upon by the respective the USACE Districts, including specific mitigation guidelines within each district. TCRR developed and submitted a draft mitigation plan with the October 2017 Section 404 submittal packet to the USACE Fort Worth and Galveston Districts. Prior to construction, TCRR shall submit a final 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 the Project.

WW-CM#6: Section 408 Permission. TCRR shall prepare a Section 408 request to the USACE to alter USACE Projects (the Dallas Floodway–East Dallas Levee Trinity Left Bank, Dallas Floodway Extension–Upper/lower Chain of Wetlands, Dallas Floodway Extension–Central Wastewater Treatment Plant Trinity Right Bank and Dallas Floodway Extension–Future Lamar Levee in Dallas County and Bardwell Lake in Ellis County), as needed depending on the Build Alternatives and as determined by the USACE. All Build Alternatives (A through F) would require Section 408 permission from the USACE Fort Worth District for the Dallas Floodway. Build Alternatives D, E and F would require Section 408 permission from the USACE Fort Worth District for Bardwell Lake. A separate 408 submittal led by the utility owners would be required for two overhead electric crossing adjacent to the 408 boundary. For additional information see **Section 3.7.5.2.1, Environmental Consequences, Dallas County** and **Section 3.7.5.2.2, Environmental Consequences, Ellis County**. 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, Regulatory Context**, 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. TCRR developed and submitted a Section 408 Permission Request to the USACE Fort Worth and Galveston Districts in September 2019. The USACE will not issues a decision on TCRR’s Section 404, Individual Permit (**WW-CM#4: CWA Section 404, Individual Permit**) until TCRR’s Section 408 Permission request has been approved.

See also **WQ-CM#1: Section 401 Water Quality Certification,** and **WQ-MM#7: Wildlife Friendly Control Measures,** discussed further in **Section 3.3.6, Water Quality,** and **WW-CM#4: CWA Section 404, Individual Permit,** discussed above.

3.7.6.2 Mitigation Measures

TCRR would be required to implement the following Mitigation Measures (MM).

WW-MM#1: Compensatory Mitigation. As a result of **WW-CM#4: CWA Section 404, Individual Permit,** and **WW-CM#5: Waters of the U.S. Mitigation Plan**, the USACE will determine the amount of compensatory mitigation that TCRR shall be required to implement. 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).

If credits are unavailable, TCRR shall develop permittee responsible mitigation sites as required by the USACE. Mitigation banks identified in the mitigation strategy that are currently available that will be utilized by the Project are included in **Table 3.7-81**.

Table 3.7-81: Mitigation Banks

Bank Name	County/Segments
Rockin' K on Chambers Creek	Dallas (Segments 1, 2A, 2B); Ellis (Segments 2A, 2B, 3A, 3B); Navarro (Segments 3A, 3B, 3C)
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)
Bunker Sands Mitigation Bank	Dallas (Segments 1, 2A, 2B); Ellis (Segments 1, 2A, 2B, 3A, 3B); Navarro (Segments 3A, 3B, 3C)
Trinity River Mitigation Bank	Dallas (Segments 1, 2A, 2B); Ellis (Segments 1, 2A, 2B)
Mill Branch Mitigation Bank	Dallas (Segments 1, 2A, 2B); Ellis (Segments 1, 2A, 2B, 3A, 3B); Navarro (Segments 3A, 3B, 3C)
Bill Moore Mitigation Bank	Navarro (Segments 3A, 3B, 3C)
Tarkington Bayou Mitigation Bank	Grimes (Segment 5); Waller (Segment 5); Harris (Segment 5)
Hebert Mitigation Bank	Grimes (Segment 5); Waller (Segment 5); Harris (Segment 5)
Katy Prairie Stream	Harris (Segment 5)
Greens Bayou	Harris (Segment 5)

Source: RES 2019.

See also **WQ-CM#1: Section 401 Water Quality Certification,** and **WQ-CM#2: TPDES General Construction Permit (TXR150000) and Multi-Sector General Permit (TXR050000)** detailed in **Section 3.3.6, Water Quality, Avoidance, Minimization and Mitigation**.

3.7.7 Build Alternative Comparison

The Build Alternatives comparison was completed using the LOD for each Build Alternative. Qualitative analysis of waters of the U.S. is being conducted by TCRR and will be assessed by USACE during the permitting process. This analysis will be documented by 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 B would impact the greatest number of streams with 45,631.0 linear feet of permanent impacts and Build Alternative F would impact the least number of streams with 34,839.0 linear feet of permanent impacts total.
- Build Alternative F would impact the greatest number of wetlands with 64.4 acres of permanent impacts and Build Alternative B would impact the least number of wetlands with 47.4 acres of permanent impacts.
- Build Alternative D would impact the greatest number of waterbodies with 29.3 acres of permanent impacts and Build Alternative C would impact the least number of waterbodies with 21.1 acres permanent impacts.
- Build Alternative B would have the greatest impact on waters of the U.S., while Build Alternative F would have the least impact on waters of the U.S.

Table 3.7-85 provides a summary of wetland and waterbody impacts within each Houston Terminal Station option. No stream impacts are anticipated with any of the Houston Terminal Station options. No waters of the U.S. impacts are anticipated as a result of the Houston Industrial Site Terminal Station or Houston Northwest Mall Terminal Station options. The Houston Northwest Transit Center Terminal Station Option would temporarily impact 1.6 acres of wetlands and 0.10 acre of waterbodies.

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Table 3.7-82: Estimated Impacts to Streams by Build Alternative

Type	Crossing Type	Length of Potential Impacts (linear feet)																	
		Alternative A			Alternative B			Alternative C			Alternative D			Alternative E			Alternative F		
		Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm
Artificial/Man-made	Bridge/Viaduct	21	4,783.5	0.00	28	6,321.2	0.00	24	5,621.6	0.00	26	5,347.9	0.00	33	6,885.6	0.00	29	6,186.0	0.00
	Culvert	7	0.00	1,254.7	8	0.00	1,387.1	8	0.00	1,401.3	7	0.00	1,254.7	8	0.00	1,387.1	8	0.00	1,401.3
	Excavation	10	177.3	1,964.9	11	177.3	2,226.8	10	177.3	2,298.0	11	177.3	2,263.9	12	177.3	2,525.8	11	177.3	2,597.0
	Fill	5	110.5	267.5	6	144.9	267.5	4	110.5	249.6	5	110.5	267.5	6	144.9	267.5	4	110.5	249.6
	Overhead	4	1,320.5	0.00	4	1,320.5	0.00	5	1,547.9	0.00	4	1,320.5	0.00	4	1,320.5	0.00	5	1,547.9	0.00
Ephemeral	Bridge/Viaduct	67	11,938.4	0.00	65	11,797.5	0.00	31	6,679.2	0.00	57	10,582.1	0.00	55	10,441.1	0.00	21	5,322.9	0.00
	Culvert	40	0.00	8,910.8	38	0.00	8,462.4	18	0.00	3,272.7	38	0.00	8,488.0	36	0.00	8,039.5	16	0.00	2,849.9
	Excavation	38	385.1	4,077.3	38	385.1	4,077.3	17	0.00	2,405.9	36	385.1	3,748.1	36	385.1	3,748.1	15	0.00	2,076.7
	Fill	11	2,837.2	726.7	11	2,837.2	726.7	10	2,837.2	699.7	11	2,837.2	726.7	11	2,837.2	726.7	10	2,837.2	699.7
	Overhead	11	4,256.2	0.00	8	2,659.6	0.00	7	2,387.7	0.00	6	2,167.8	0.00	3	571.1	0.00	2	299.2	0.00
Intermittent	Bridge/Viaduct	220	34,828.1	0.00	241	35,167.9	0.00	328	49,169.7	0.00	254	39,277.2	0.00	275	39,617.0	0.00	362	53,618.8	0.00
	Culvert	59	0.00	13,085.2	80	0.00	18,693.8	53	0.00	13,502.1	59	0.00	12,807.1	80	0.00	18,415.7	53	0.00	13,224.0
	Excavation	52	1,470.1	6,871.2	56	1,470.1	8,050.1	43	203.7	6,078.7	55	1,817.0	7,170.2	59	1,817.0	8,349.1	46	550.6	6,377.7
	Fill	12	5,561.7	1,525.4	12	5,561.7	1,525.4	26	7,771.1	4,836.2	13	5,564.0	1,700.5	13	5,564.0	1,700.5	27	7,773.4	5,011.3
	Overhead	23	6,727.4	0.00	22	6,851.0	0.00	21	5,096.0	0.00	24	6,737.5	0.00	23	6,861.2	0.00	22	5,106.1	0.00
Perennial	Bridge/Viaduct	41	6,348.0	0.00	42	6,382.1	0.00	48	7,308.8	0.00	39	6,017.6	0.00	40	6,051.7	0.00	46	6,978.5	0.00
	Culvert	1	0.00	79.9	1	0.00	79.9	--	--	--	1	0.00	79.9	1	0.00	79.9	--	--	--
	Excavation	4	257.6	55.0	4	257.6	55.0	1	0.00	55.0	4	257.6	55.0	4	257.6	55.0	1	0.00	55.0
	Fill	1	0.00	79.0	1	0.00	79.0	2	0.00	296.8	1	0.00	79.0	1	0.00	79.0	2	0.00	296.8
	Overhead	14	2,457.5	0.00	14	2,457.5	0.00	12	2,031.6	0.00	13	3,084.9	0.00	13	3,084.	0.00	11	2,658.9	0.00
Total Potential Stream Impacts		**641**	**83,459**	**38,898**	**690**	**83,791**	**45,631**	**668**	**90,942**	**35,096**	**664**	**85,684**	**38,641**	**713**	**86,015**	**45,374**	**691**	**93,167**	**34,839**

Source: USGS 2018; FNI 2018

Note: The Houston Northwest Transit Center Terminal Station Option, the Houston Northwest Mall Terminal Station Option and the Houston Industrial Site Terminal Station Option are not anticipated to impact streams.

[a] 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 3.7-83: Estimated Impacts to Wetlands by Build Alternative

		Area of Potential Impacts (acres)																	
		Alternative A			Alternative B			Alternative C			Alternative D			Alternative E			Alternative F		
Type	Crossing Type	Number of Crossings*	Temp	Perm	Number of Crossings*	Temp	Perm	Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm
Emergent	Bridge/Viaduct	106	29.4	0.0	107	29.9	0.0	80	26.9	0.0	101	28.3	0.0	102	28.9	0.0	75	25.9	0.0
	Excavation	30	0.5	2.9	28	0.4	2.8	23	0.1	2.8	29	0.5	2.9	27	0.5	3.1	22	0.1	2.8
	Fill	55	3.4	9.7	50	2.1	8.1	34	1.7	9.1	53	4.2	8.9	48	2.1	8.1	32	1.7	9.1
	Overhead	19	5.8	0.0	19	5.8	0.0	17	5.7	0.0	13	5.5	0.0	13	5.5	0.0	11	5.4	0.0
Forested	Conversion	105	0.0	28.6	114	0.0	27.1	103	0.0	37.5	109	0.0	29.7	118	0.0	28.2	107	0.0	39.0
	Excavation	18	4.1	0.4	20	4.1	0.6	12	0.3	0.5	18	4.1	0.4	20	4.1	0.6	12	0.3	0.5
	Fill	7	0.0	0.9	11	0.0	1.3	10	2.5	1.3	7	0.0	0.9	11	0.0	1.3	10	2.5	1.3
	Overhead	17	15.4	0.0	18	15.7	0.0	16	6.1	0.0	17	17.6	0.0	18	18.0	0.0	16	8.3	0.0
Shrub/ Scrub	Conversion	4	0.0	0.7	4	0.0	0.7	9	0.0	5.4	4	0.0	0.7	4	0.0	0.7	9	0.0	5.4
	Excavation	3	0.0	0.3	3	0.0	0.3	3	0.0	0.3	3	0.0	0.3	3	0.0	0.3	3	0.0	0.3
	Fill	2	0.0	0.2	2	0.0	0.2	1	0.0	0.2	2	0.0	0.2	2	0.0	0.2	1	0.0	0.2
	Overhead	3	1.0	0.0	3	1.0	0.0	3	1.0	0.0	3	1.0	0.0	3	1.0	0.0	3	1.0	0.0
Other	Bridge/Viaduct	8	0.0	6.4	8	0.0	6.4	8	0.0	6.4	8	0.0	6.4	8	0.0	6.4	8	0.0	6.4
Total Potential Wetland Impacts		**377**	**59.5**	**50.0**	**387**	**59.0**	**47.4**	**319**	**44.3**	**63.4**	**367**	**61.2**	**50.4**	**377**	**60.1**	**48.9**	**309**	**45.2**	**65**

Source: USFWS 2018 and FNI 2018

'--' – Not Present

[a] 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 3.7-84: Estimated Impacts to Waterbodies by Build Alternative

		Area of Potential Impacts (acres)																	
		Alternative A			Alternative B			Alternative C			Alternative D			Alternative E			Alternative F		
Type	Crossing Type	Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm	Number of Crossings[a]	Temp	Perm
Freshwater Pond	Bridge/Viaduct	134	19.0	0.0	144	19.7	0.0	120	18.3	0.0	132	17.9	0.0	142	18.6	0.0	118	17.3	0.0
	Excavation	89	0.56	11.8	97	0.6	11.2	79	0.6	9.6	90	0.6	11.8	98	0.6	11.3	80	0.6	9.7
	Fill	99	2.2	14.3	104	2.2	14.5	65	1.4	8.6	101	2.2	16.1	106	2.2	16.3	67	1.4	10.3
	Overhead	32	4.8	0.0	31	5.2	0.0	27	4.3	0.0	25	3.2	0.0	24	3.7	0.0	20	2.8	0.0
Lake	Bridge/Viaduct	2	3.6	0.0	2	3.6	0.0	1	2.1	0.0	2	3.6	0.0	2	3.6	0.0	1	2.1	0.0
Reservoir	Bridge/Viaduct	1	0.2	0.0	2	1.9	0.0	1	0.2	0.0	1	0.2	0.0	2	1.9	0.0	1	0.2	0.0
	Overhead	1	0.6	0.0	1	0.6	0.0	1	0.6	0.0	1	0.6	0.0	1	0.6	0.0	1	0.6	0.0
Swamp	Bridge/Viaduct	2	0.9	0.0	2	0.9	0.0	5	1.2	0.0	2	0.9	0.0	2	0.9	0.0	5	1.2	0.0
	Excavation	1	0.0	0.5	1	0.0	0.5	1	0.0	0.5	1	0.0	0.5	1	0.0	0.5	1	0.0	0.5
	Fill	4	0.1	0.9	4	0.1	0.9	5	0.1	2.4	4	0.1	0.9	4	0.1	0.9	5	0.1	2.4
	Overhead	1	1.6	0.0	1	1.6	0.0	1	1.6	0.0	1	1.6	0.0	1	1.6	0.0	1	1.6	0.0
Total Potential Open Water Impacts		**366**	**33.5**	**27.6**	**389**	**36.4**	**27.2**	**306**	**30.4**	**21.1**	**360**	**30.8**	**29.3**	**383**	**33.8**	**29.0**	**300**	**27.9**	**22.9**

Source: USGS 2018; USFWS 2018; FNI 2018

[a] 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 Station Option			Northwest Mall Terminal Station Option			Industrial Site Terminal Station Option		
Wetland Type	**Crossing Type**	**Number of Crossings [a]**	**Temp**	**Perm**	**Number of Crossings [a]**	**Temp**	**Perm**	**Number of Crossings [a]**	**Temp**	**Perm**
Emergent	Bridge/Viaduct	1	0.6	0.0	--	--	--	--	--	--
	Overhead	1	1.0	0.0	--	--	--	--	--	--
Total Potential Wetland Impacts		2	1.6	0.0	--	--	--	--	--	--
Waterbody Type	**Crossing Type**	**Number of Crossings [a]**	**Temp**	**Perm**	**Number of Crossings [a]**	**Temp**	**Perm**	**Number of Crossings [a]**	**Temp**	**Perm**
Freshwater Pond	Bridge/Viaduct	1	0.1	0.0	--	--	--	--	--	--
	Fill	1	<0.1	0.0	--	--	--	--	--	--
Total Potential Open Water Impacts		2	0.1	0.0	--	--	--	--	--	--

Source: USFWS 2018; FNI 2018

[a] 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 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 (refer to **Section 3.3.3.2, Water Quality, Surface Water Quality,** and **Appendix D, Surface Water Resources Mapbook**). Counties and segments are referenced to better describe these subwatersheds and their relationship to the Project.

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. Refer to **Section 3.7, Waters of the U.S.**, for a discussion of Sections 404 and 408 of the CWA.

Federal

FRA's updated *Procedures for Considering Environmental Impacts* states that this EIS shall assess impacts of the Project on floodplains.[4] The FRA procedure 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 (HUD) floodplain maps or best available data. An EIS is required to discuss alternatives located in the base floodplain, risks associated with the Project, impacts on natural and beneficial floodplain values and the adequacy of the proposed methods to minimize harm.

Additional regulations and policies that guide the assessment of impacts to floodplains are as follows:

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[1] Wayne B. Blanchard, *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 December 2019, https://www.fema.gov/floodplain-management-definition.
[3] Ro Charlton, *Fundamentals of Fluvial Geomorphology*, 2008.
[4] FRA, "Procedures for Considering Environmental Impacts," 64 Federal Register 28545, May 26, 1999, as updated in 78 Federal Register 2713 (January 14, 2013).

Rivers and Harbors Appropriations Act of 1899

Under Section 408 of the Rivers and Harbors Appropriations Act of 1899 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."[5] The Project includes levee crossings; therefore, a Section 408 request for approval was submitted by TCRR on October 16, 2017, to the USACE Fort Worth District. TCRR shall comply with any mitigation measures reflected in the approval issued by USACE.

Department of Transportation Order 5650.2

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.[6] 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.[7] Encroachment, defined for the purposes of floodplain management, includes new construction, improvements, fill and other activities within the regulated floodplain boundary.[8]

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 (SFHA), 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.[9]

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.[10] FEMA defines floodplains as "Any land area susceptible to being inundated by flood waters from any source."[11] The National Flood Insurance Program was established pursuant to the National Flood Insurance Act of 1968, as amended, and the Flood Disaster Protection Act of 1973, as amended, 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".[12] Regulations promulgated by the act[13] also contain the basic policies and procedures to regulate floodplain management and analyze, identify and map floodplains for flood insurance purposes.

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[5] 33 U.S.C. 408.
[6] USDOT, *Floodplain Management and Protection*, DOT 5650.2, 1979.
[7] USDOT, "Floodplains, Planning and Environment/NEPA," accessed December 2019, http://www.fta.dot.gov/12347_2237.html.
[8] FEMA, "Encroachments," accessed December 2019, https://www.fema.gov/encroachments.
[9] Ibid.
[10] 42 U.S.C. 4001 et seq.
[11] 44 C.F.R. 59.1.
[12] 44 C.F.R. 59.1.
[13] 44 C.F.R. 59 to 80.

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 to require that construction of new or substantially improved buildings will minimize or prevent flood damage.[14] The National Flood Insurance Program regulatory standards are minimum requirements for floodplain management.[15] Any state or community can adopt more comprehensive and restrictive floodplain management regulations to protect life and property from flooding. Within Texas, TWDB is tasked as a state agency responsible for coordinating the National Flood Insurance Program. [16, 17]

Executive Order 11988

Federal agencies are regulated under EO 11988, *Floodplain Management*.[18] This EO requires that federal agencies avoid adverse impacts on floodplains to the extent possible, determine whether reasonable alternatives exist that avoid impacts to floodplains, and avoid situations that would support floodplain development if a practicable alternative exists.

Federal Highway Administration Hydraulic Engineering

FHWA Hydraulic Engineering Circular (HEC) No. 20 defines qualitative and quantitative methods to evaluate channel stability[19] and HEC-18 defines procedures used to estimate scour depth at piers and abutments of proposed structures.[20] 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.[21] 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 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 3 years, which is also provided to FEMA.[22] The plan addresses natural hazards including flooding. In addition to identifying strategies to prevent flooding and mitigate future damages, TWDB serves as the

[14] FEMA, *Unit 2: The National Flood Insurance Program*, 2007, accessed December 2019, https://www.fema.gov/pdf/floodplain/nfip_sg_unit_2.pdf.
[15] 44 C.F.R. 60, Criteria for Land Management and Use, 2002.
[16] State of Texas, *State of Texas Hazard Mitigation Plan: 2013 Update*, 2013.
[17] Ibid.
[18] 44 C.F.R. 9, Floodplain Management and Protection of Wetlands, 2003.
[19] FHWA, *Hydraulic Engineering Circular No. 20 - Stream Stability at Highway Structures, Fourth Edition,* April 2012, accessed December 2019, https://www.fhwa.dot.gov/engineering/hydraulics/pubs/hif12004.pdf.
[20] FHWA, *Hydraulic Engineering Circular No. 18 – Evaluting Scour at Bridges, Fifth Edition,* April 2012, accessed December 2019, https://www.fhwa.dot.gov/engineering/hydraulics/pubs/hif12003.pdf.
[21] TxDOT, "Sediment Control," July 2002, accessed December 2019, https://resources.nctcog.org/envir/SEEclean/stormwater/BMP/docs/TXDOT_5.0sedimentationcontrol.pdf.
[22] State of Texas, *State of Texas Hazard Mitigation Plan: October 2018*, 2018.

National Flood Insurance Program State Coordinator acting as a liaison between the federal National Flood Insurance Program and local communities.[23]

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.[24] The *Hydraulic Design Manual* (HDM)[25] provides guidance on selecting the appropriate method for runoff computations, 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 Project.

Local

Groundwater Conservation Districts (GCDs)

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.[26] Groundwater management areas are geologic areas suitable for groundwater management.[27] 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 water wells within its geographic boundary.[28] 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 **Appendix D, Groundwater Resources Mapbook**.

Table 3.8-1: Groundwater Conservation Districts

Name	General Location	Segments	Status of Regulations
Prairielands GCD	Ellis County	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, Limestone, 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).

[23] Ibid.
[24] TxDOT, *Hydraulic Design Manual,* TxDOT Manual System, August 31, 2015, accessed December 2019, http://onlinemanuals.txdot.gov/txdotmanuals/hyd/manual_notice.htm.
[25] Ibid.
[26] TWDB, "Groundwater Management Areas," accessed December 2019, http://www.twdb.texas.gov/groundwater/management_areas/index.asp.
[27] Texas A & M University, "Groundwater Conservation Districts," 2014, accessed December 2019, http://texaswater.tamu.edu/groundwater/groundwater-conservation-districts.
[28] Texas Commission on Water Quality, "Texas Groundwater Conservation Districts," November 2019, accessed December 2019, http://www.tceq.texas.gov/assets/public/permitting/watersupply/groundwater/maps/gcdmap.pdf.

Table 3.8-1: Groundwater Conservation Districts			
Name	**General Location**	**Segments**	**Status of Regulations**
Bluebonnet GCD	Grimes, Madison, Waller and Harris, 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.
Harris-Galveston Coastal Subsidence District	Waller and Harris Counties	5	Established in 1975. The District was created to provide for the regulation of groundwater withdrawal throughout Harris and Galveston counties for the purpose of preventing land subsidence, which leads to increased flooding.

Source: Bluebonnet GCD 2016

Floodplain Development Permit

A floodplain development permit is required for development within the SFHAs of communities that participate in the National Flood Insurance Program.[29] Dallas, Ellis, Freestone, Grimes, Harris, Leon, Limestone, Madison, Navarro and Waller Counties participate in the National Flood Insurance Program.[30] 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.[31, 32, 33] Other ordinances for site development and construction may also prohibit development in floodplains. **Table 3.8-2** lists local floodplain regulators.

Table 3.8-2: Floodplain Regulators		
Name	**General Location**	**Status of Regulations**
City of Dallas – Trinity Watershed Management Department	City of Dallas	The floodplain administrator/director is responsible for administering the federal flood insurance program.
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.
North Central Texas Council of Governments	City of Dallas	A Trinity River Corridor Development Certificate is required for development within the floodplain of the Trinity River Corridor.
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.

[29] 44 C.F.R. 2, Criteria for Land Management and Use, 2002.
[30] FEMA, "Special Flood Hazard Area," May 23, 2019, accessed December 2019, https://www.fema.gov/special-flood-hazard-area.
[31] 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.
[32] Harris County, "Regulations of Harris County, Texas for Flood Plain Management," January 1, 2018.
[33] 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**
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 Engineering Department	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 2018; FEMA 2015

Fill elevations within the 1 percent annual exceedance probability floodplain, often referred to as the 100-year floodplain, in the City of Dallas must be placed no more than 5 feet above the design flood elevation, except where necessary to match the existing elevation of the adjacent property as determined by the Trinity Watershed Management Department. First floor elevations must be constructed at least 3 feet above the design flood elevation. In addition, no loss of valley storage, the stream's ability to store water as it moves downstream, is permitted along a stream with a drainage area of three square miles or more and for streams with a drainage area of between 130 acres and 3 square miles valley storage losses may not exceed 15 percent. For streams with drainage areas of less than 130 acres, loss of valley storage is not limited. Specifically, fill elevations and first floor elevations within the 100-year floodplain of the main stem of the Trinity River in Dallas must be constructed at a minimum of 1 foot above the design flood and encroachment into the floodway is prohibited unless FEMA issues a Conditional Letter of Map Revision.[34]

As coordinated by the North Texas Central Texas Council of Governments, a Trinity River Corridor Development Certificate is required for any floodplain alteration within the Trinity River Corridor.[35]

The City of Houston requires that structures constructed in the SFHAs be elevated to at least the minimum flood protection elevation measured at the lowest floor, which is equal to the base flood elevation plus 24 inches. In Zone AO, the lowest floor shall be elevated at least 36 inches above the depth number in feet specified on the FIRM and in Zone A, where no depth number is specified, the lowest floor shall be elevated at least 6 feet above the highest adjacent grade (natural ground).[36] Development that is dangerous to health, safety or property during flooding or that would cause excessive increases in flood heights or velocities within the SFHAs is restricted or prohibited.[37]

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 elevation more than a designated height in Dallas, Harris County, and Houston.[38] Structures constructed within a floodway must be elevated to 18 inches or more above the base flood elevation.[39]

[34] City of Dallas, "Floodplain and Escarpment Zone Regulations Article V Division 51A-5.100," Dallas, Texas: City of Dallas, n.d.
[35] City of Dallas, "Floodplain and Escarpment Zone Regulations Article V Division 51A-5.100," Dallas, Texas: City of Dallas, n.d.
[36] Harris County, "Regulations of Harris County, Texas for Flood Plain Management," January 1, 2018.
[37] City of Dallas, "Floodplain and Escarpment Zone Regulations Article V Division 51A-5.100," Dallas, Texas: City of Dallas, n.d.
[38] Ibid.; Harris County, "Regulations of Harris County, Texas for Flood Plain Management," January 1, 2018; City of Houston, "Rules and Regulations for Chapter 19, Guidelines Houston City Code: Floodplai*n*," City of Houston, February 1, 2009.
[39] Ibid.

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, different requirements and analysis methods apply to smaller development areas (e.g., less than 200 acres) and larger development areas (e.g., greater than 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.[40] 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. **Table 3.8-3** lists local drainage criteria manuals applicable to the Project and a general description of requirements. Counties and cities may periodically update drainage criterial manuals; TCRR shall consult the current version of the manual during final design.

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 ensure 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.[41]
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.

[40] *Drainage Criteria Manual for Chambers County Texas*, "Chapter 7.0 Detention Analysis," August 9, 2005, accessed December 2019, https://co.chambers.tx.us/upload/page/0139/docs/Drainage_Criteria_Manual.pdf.

[41] City of Wilmer Code of Ordinances Article 3.09 Drainage and Stormwater Control, Sec. 3.09.005 Engineering Design, March 21, 2019, accessed December 2019, https://z2.franklinlegal.net/franklin/Z2Browser2.html?showset=wilmerset.

Table 3.8-3: Drainage Criteria Manuals

Name	General Location	Detention Requirements
Waller County Subdivision and Development Regulations – Drainage Criteria Manual	Waller County	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 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 <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 2018

Harris-Galveston Subsidence District

HGSD 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 and can lead to increased flooding.[42] 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. HGSD enforces a permitting and registration requirement for 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.

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

[42] HGSD, accessed December 2019, http://hgsubsidence.org/.

Houston Terminal Station options for direct impacts and the Study Area includes subwatersheds intersected by the Project 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 FIRM under the National Flood Insurance Program. A FIRM generally shows an area's base flood elevations, flood zones that 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 were not readily available. Flood Hazard Boundary Maps from HUD were digitized for Freestone County (1978) and Madison County (1991).[43]

TCRR performed hydrologic and hydraulic analysis to assist in the development of the conceptual design. FRA compared the conceptual design against digital FEMA DFIRM and FIRM maps, where available, to calculate the acreage of floodplains that the Project would cross.

3.8.3.2 Geohydrology

Groundwater and surface water are physically connected by the hydrologic cycle and are functionally interdependent.[44] 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 that 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, Water Quality, Groundwater Quality**) were 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.

3.8.3.3 Surface Water Hydrology

Precipitation and stormwater runoff discharge to Texas rivers, streams and reservoirs and provide water supply.[45] 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.

[43] FEMA 2014 (digitized from US. Department of Housing and Urban Development 1978 and 1991).
[44] Thomas C. Winter, Judson W. Harvey, O. Lehn Franke, and William M. Alley, *Ground Water and Surface Water: A Single Resource,* U.S. Geological Survey, 1999, accessed December 2019, https://pubs.usgs.gov/circ/1998/1139/report.pdf.
[45] Ibid.

GIS data on topography, subwatersheds, streams, lakes and reservoirs within the Study Area were 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 previously stated, TCRR also elected to rely on TxDOT's HDM[46] during the concept design and final design of the Project to compute hydrologic runoff data and 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.[47] 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.[48] 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, man-made 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.[49]

In addition to hydraulic factors, soil data, including highly erodible soils, were collected to assess the floodplain Study Area and identify areas that may be vulnerable to channel erosion or sedimentation during construction and operation.

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 SFHAs,[50] are identified on FIRM with the following designations:

- Zone A, 1 percent annual chance of flooding or 26 percent chance of flooding over the life of a 30-year mortgage

[46] Ibid.
[47] FHWA, *Stream Stability at Highway Structures*, Third Edition, March 2001, accessed December 2019, https://www.fhwa.dot.gov/engineering/hydraulics/pubs/hec/hec20ed3.pdf.
[48] Ibid.
[49] Janine Castro, *Geomorphologic Impacts of Culvert Replacement and Removal: Avoiding Channel Incision*. Portland, Oregon: U.S. Fish and Wildlife Service, 2003.
[50] FEMA, "Special Flood Hazard Area Defenition," May 23, 2019, accessed December 2019, https://www.fema.gov/special-flood-hazard-area.

- Zone AE, 1 percent annual exceedance probability (AEP) flood where base flood elevations are provided
- Zone AO, river or stream flood hazards areas or areas with a 1 percent or greater chance of shallow flooding[51]

The SFHAs for a 1 percent annual exceedance probability flood is also referred to as a 100-year flood and represents the base flood elevation for regulatory purposes. FIRM 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.[52] 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 SFHAs and higher in land surface elevation of the 0.2 percent chance annual flood area.[53] 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 133 acres of each Build Alternative 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 567 acres under Build Alternative B to 664 acres under Build Alternative F. 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 Project segment and county within the LOD is provided in **Table 3.8-4**.

The Houston Industrial Site Terminal Station Option would have 0.1 acre located within the 500-year floodplain (Zone X – shaded) in Harris County within the Buffalo-San Jacinto watershed. The Houston Northwest Mall Terminal Station Option and Houston Northwest Transit Center Terminal Station Option would not be located within a designated FEMA floodplain.

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 declines in groundwater levels due to heavy pumping.[54] The Woodbine Minor Aquifer, Nacatoch Minor Aquifer and Queen City Minor Aquifer have also been extensively pumped and suffer groundwater level declines.[55] 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.[56] Portions of the Gulf Coast Aquifer underlie the Study Area within Regulatory Area Three of the HGSD. Additional minor aquifers in the floodplain Study Area include the Sparta Minor Aquifer and the Yegua Jackson Minor Aquifer.

[51] State of Texas, *State of Texas Hazard Mitigation Plan: October 2018*, 2018.
[52] Ibid.
[53] Wayne B. Blanchard, *Guide to Emergency Management and Related Terms, Definitions, Concepts, Acronyms, Organizations, Programs, Guidance, Executive Orders and Legislation*, FEMA, October 22, 2008.
[54] Peter G. George, Ph.D., P.G., Robert E. Mace, Ph.D., P.G. and Rima Petrossian, P.G. *Aquifers of Texas,* Austin, TX: Texas Water Development Board, 2011.
[55] Ibid.
[56] Bureau of Economic Geology, *Aquifers of Texas*, 2004, accessed December 2019, http://www.beg.utexas.edu/UTopia/images/pagesizemaps/aquifer.pdf.

Table 3.8-4: Floodplain by Basin and Build Alternative Segment within the Floodplain Study Area

Basin/Build Alternative Segment	Area (acres) of Intersected Floodplain														County
	ALT A		ALT B		ALT C		ALT D		ALT E		ALT F		Houston Industrial Site Terminal Station Option		
	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	198.9	77.3	198.9	77.3	198.9	77.3	198.9	77.3	198.9	77.3	198.9	77.3	--	--	Dallas
Segment 1	0.79	0.45	0.79	0.45	0.79	0.45	0.79	0.45	0.79	0.45	0.79	0.45	--	--	Ellis
Segment 2A	21.7	1	21.7	1	21.7	1	--	--	--	--	--	--	--	--	Ellis
Segment 2B	--	--	--	--	--	--	23.9	1.4	23.9	1.4	23.9	1.4	--	--	Ellis
Chambers															
Segment 2A	41.63	0	41.63	0	41.63	0	--	--	--	--	--	--	--	--	Ellis
Segment 2B	--	--	--	--	--	--	54.5	0	54.5	0	54.5	0	--	--	Ellis
Segment 3A	17.1	0	--	--	--	--	17.1	0	--	--	--	--	--	--	Navarro
Segment 3B	--	--	33.1	0	--	--	--	--	33.1	0	--	--	--	--	Navarro
Segment 3C	--	--	--	--	17.1	0	--	--	--	--	17.1	0	--	--	Navarro
Richland															
Segment 3A	118.6	0	--	--	--	--	118.6	0	--	--	--	--	--	--	Navarro
Segment 3B	--	--	43.5	0	--	--	--	--	43.5	0	--	--	--	--	Navarro
Segment 3C	--	--	--	--	123.8	0	--	--	--	--	123.8	0	--	--	Navarro
Lower Trinity-Tehuacana															
Segment 3C	--	--	--	--	60.2	0	--	--	--	--	60.2	0	--	--	Freestone and Leon
Segment 4	18.9	0	18.9	0	--	--	18.9	0	18.9	0	--	--	--	--	Freestone
Lower Trinity-Kickapoo															
Segment 3C	--	--	--	--	100.1	0.63	--	--	--	--	100.1	0.63	--	--	Leon, Madison and Grimes
Segment 4	79.7	0	79.7	0	--	--	79.7	0	79.7	0	--	--	--	--	Madison and Grimes
Segment 5	5.8	0	5.8	0	5.8	0	5.8	0	5.8	0	5.8	0	--	--	Grimes

Table 3.8-4: Floodplain by Basin and Build Alternative Segment within the Floodplain Study Area															
Basin/Build Alternative Segment	**Area (acres) of Intersected Floodplain**														**County**
	ALT A		**ALT B**		**ALT C**		**ALT D**		**ALT E**		**ALT F**		**Houston Industrial Site Terminal Station Option**		
	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**	
Navasota															
Segment 4	40.5	0	40.5	0	--	--	40.5	0	40.5	0	--	--	--	--	Freestone, Limestone and Leon
Segment 5	10.5	0	10.5	0	10.5	0	10.5	0	10.5	0	10.5	0	--	--	Grimes
West Fork San Jacinto															
Segment 5	7.9	0	7.9	0	7.9	0	7.9	0	7.9	0	7.9	0	--	--	Grimes
Spring															
Segment 5	36.1	10.1	36.1	10.1	36.1	10.1	36.1	10.1	36.1	10.1	36.1	10.1	--	--	Grimes, Waller and Harris
Buffalo-San Jacinto															
Segment 5	17.8	43	17.8	43	17.8	43	17.8	43	17.8	43	17.8	43	--	--	Harris
Segment 5: Houston Industrial Site Terminal Station Option	--	--	--	--	--	--	--	--	--	--	--	0	0	0.11	Harris
Total Acreage	**615.9**	**131.9**	**566.9**	**131.9**	**649.7**	**132.5**	**637.6**	**132.3**	**581.5**	**132.3**	**664**	**132.9**	**0**	**0.11**	

Source: FEMA 2014 (digitized from US. Department of Housing and Urban Development 1978 and 1991)

Note: Due to rounding, acres presented in each table may not match.

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.[57] The yearly average rainfall by county and basin within the floodplain Study Area is provided in **Table 3.8-5**.[58] 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 man-made water storage. A discussion on the hydrologic characteristics of large river basins is provided below.

Table 3.8-5: Yearly Average Rainfall

County	Basin	Average Yearly Rainfall (inches)
Dallas	Upper Trinity	37.6
Ellis	Upper Trinity, Chambers	39.1
Navarro	Chambers, Richland	39.8
Freestone	Lower Trinity-Tehuacana, Navasota	43.1
Limestone	Navasota	40.3
Leon	Lower Trinity-Tehuacana, Navasota; Lower Trinity-Kickapoo	42.3
Madison	Navasota; Lower Trinity-Kickapoo	45.1
Grimes	Navasota; Lower Trinity-Kickapoo; West Fork San Jacinto; Spring	43.5
Waller	Spring	45.5
Harris	Spring, Buffalo-San Jacinto	56.8

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.[59] 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.[60, 61, 62] The basin has an average flow volume of 5,727,000 acre-feet per year.[63] 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 inches (upper basin) to 52 inches (lower basin).

[57] George Guillen, Ph.D., Jenny Wrast, M.S., and Dianna Ramirez, 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, accessed December 2019, https://www.uhcl.edu/environmental-institute/research/publications/documents/09-003finalreporttrinitybiologicaloverlayv2.pdf.

[58] TSHA, "Texas Almanac," accessed December 2019, http://texasalmanac.com/.

[59] TWDB, "River Basins," accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp.

[60] TCEQ Water Availability Division, "Basins with Adopted Environmental Flow Standards (map)," September 1, 2015, accessed December 2019, http://www.tceq.texas.gov/assets/public/comm_exec/images/enviro-flows-LG-map09022015.jpg.

[61] TWDB, "River Basins." accessed December 2019. http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp.

[62] TWDB, "Trinity River Basin," accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/trinity/index.asp.

[63] TWDB, "River Basins," accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp.

The Trinity River Basin contains 32 major reservoirs, of which 23 are monitored water supply reservoirs and 13 are used for flood control.[64, 65, 66] 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.[67] In addition to the major reservoirs, there are hundreds of smaller reservoirs constructed by 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.[68]

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,** and **Section 3.3.4.2, Water Quality, Groundwater Quality**).[69] Lake Livingston is located approximately 6 miles southwest of Livingston, in Walker, Polk, Trinity and San Jacinto Counties, and is fed from the main stem of the Trinity River.[70] 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.[71]

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,** and **Section 3.3.4.2, Water Quality, Groundwater Quality**).[72] The Richland-Chambers Reservoir is owned and operated by Tarrant Regional Water District and used for water supply, flood control, irrigation and recreation purposes.[73]

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,** and **Section 3.3.4.2, Water Quality, Groundwater Quality**).[74] This reservoir is owned and operated by USACE for municipal water supply, flood control and recreation.

[64] TWDB, "Trinity River Basin – Reservoir Pages," accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/trinity/index.asp.
[65] TWDB Water Data for Texas, "Trinity River Basin Reservoirs," accessed December 2019, http://www.waterdatafortexas.org/reservoirs/basin/trinity.
[66] TWDB, "Lakes in Trinity River Basin," accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/trinity/index.asp.
[67] TWDB Water Data for Texas, "Trinity River Basin Reservoirs," accessed December 2019, http://www.waterdatafortexas.org/reservoirs/basin/trinity.
[68] Larry F. Land, J. Bruce Moring, Peter C. Van Metre, David C. Reutter, Barbara J. Mahler, Allison A. Shipp, and Randy L. Ulery, "Water Quality in the Trinity River Basin, Texas, 1992-1995," USGS Circular 1171, 1998, accessed December 2019, http://pubs.usgs.gov/circ/circ1171/circ1171.pdf.
[69] TWDB, "Lake Limestone (Brazos River Basin)," accessed December 2019, https://www.twdb.texas.gov/surfacewater/rivers/reservoirs/limestone/index.asp.
[70] USGS, "Environmental Setting and Hydrologic Conditions in the Trinity River Basin," accessed December 2019, http://pubs.usgs.gov/circ/circ1171/html/envhyd.htm.
[71] TWDB, "Lake Livingston (Trinity River Basin)," accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/reservoirs/livingston/index.asp.
[72] TWDB, "Richland-Chambers Dam and Reservoir (Trinity River Basin)," accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/reservoirs/richland_chambers/index.asp.
[73] Ibid.
[74] TWDB, "Bardwell Lake (Trinity River Basin)," accessed December 2019, https://www.twdb.texas.gov/surfacewater/rivers/reservoirs/bardwell/index.asp.

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.[75] The river extends 840 miles from Stonewall County southeast to the Gulf of Mexico.[76,77,78] 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.[79] The middle and lower portions of the Brazos River, which includes the Navasota River, experience infrequent, high-magnitude flows in the floodplain that have the potential to transport sediment, erode banks and cause flooding.[80]

The Brazos River Basin contains 42 major reservoirs, of which 27 are monitored water supply reservoirs and 11 are used for flood control.[81, 82] 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.[83]

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.[84, 85] The river headwaters are located in Walker County, and it flows southeast to Galveston Bay.[86] 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.[87] 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.[88] 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.[89]

The San Jacinto River Basin contains six major reservoirs, of which two are water supply reservoirs and two are used for both water supply and flood control.[90] Two of the major large water supply reservoirs –

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[75] TWDB, "River Basins," accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp.
[76] TCEQ Water Availability Division, "Basins with Adopted Environmental Flow Standards (map)," September 1, 2015, accessed December 2019, http://www.tceq.texas.gov/assets/public/comm_exec/images/enviro-flows-LG-map09022015.jpg.
[77] TWDB, "River Basins," accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp.
[78] TWDB, "Brazos River Basin," accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/brazos/index.aspp.
[79] Ibid.
[80] TWDB, *Technical Study Summaries: Middle and Lower Brazos River,* accessed December 2019, http://www.twdb.texas.gov/surfacewater/flows/instream/middle_lower_brazos/doc/BrazosHydroSummarySheet.pdf.
[81] TWDB, "Brazos River Basin – Reservoir Pages," accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/brazos/index.asp.
[82] TWDB Water Data for Texas, "Brazos River Basin Reservoirs," accessed December 2019, http://www.waterdatafortexas.org/reservoirs/basin/brazos.
[83] Ibid.
[84] TCEQ Water Availability Division, "Basins with Adopted Environmental Flow Standards (map)," September 1, 2015, accessed December 2019, http://www.tceq.texas.gov/assets/public/comm_exec/images/enviro-flows-LG-map09022015.jpg.
[85] TWDB, "River Basins," accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp.
[86] TWDB, "San Jacinto River Basin," accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/sanjacinto/index.asp.
[87] Ibid.
[88] TCEQ, *San Jacinto River Basin Narrative Summary*, 2016, accessed December 2019, https://www.tceq.texas.gov/assets/public/waterquality/swqm/assess/02twqi/basin10.pdf.
[89] AECOM, *Characterization of the San Jacinto Watershed*, 2012.
[90] TWDB, "Lakes in San Jacinto River Basin," accessed December 2019, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/sanjacinto/index.asp.

Lake Conroe in the north and Lake Houston in the south – are located in this subwatershed.[91] 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 that can further affect floodplains. These features are identified in **Appendix D, Mineral Resources Mapbook**.

3.8.5 Environmental Consequences

3.8.5.1 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 without the contribution of the Project. Minor impacts to floodplains would be expected as a result of other planned projects, such as the IH-35 East roadway improvement project in Dallas County, Waxahachie Line rail project in Dallas and Ellis Counties, and Integrated Pipeline Project in Navarro and Ellis Counties. The impacts of these projects are discussed in **Section 4.4, Indirect Effects and Cumulative Impacts, Cumulative Impacts**.

3.8.5.2 Build Alternatives

3.8.5.2.1 Floodplains

Construction of the Project would traverse mapped Zone A, Zone AE, Zone AO and Zone X floodplains, as denoted in **Appendix D, Natural Resources Mapbook**. During the planning and conceptual engineering of the Project, the alignments were designed to avoid and minimize crossings of mapped stream channels (refer to **Section 3.7, Waters of the U.S.**). However, the Project 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, Zone AO, and Zone X floodplains would be Build Alternative B, with 479 acres, while the largest permanent impacts would be under Build Alternative F, with 589 acres. Additionally, temporary impacts by the Project would range from 196 acres (under Build Alternatives C) to 225 acres (under Build Alternatives D) of Zone A, Zone AE, Zone AO, and Zone X floodplains.

The Houston Industrial Site Terminal Station Option would have 0.11 acre of permanent impact. The Houston Northwest Mall Terminal Station Option and Houston Northwest Transit Center Terminal Station Option 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.

[91] AECOM, "Characterization of the San Jacinto Watershed," Houston, Texas, 2012; Bluebonnet GCD, "Regulations," 2016, accessed December 2019, http://www.bluebonnetgroundwater.org/regulations/.

Table 3.8-6: Floodplain Impacts by Build Alternative within the Floodplain Study Area

Segment	County	Acres Impacted of Zone A, Zone AE, Zone AO and Zone X Combined													
		ALT A		ALT B		ALT C		ALT D		ALT E		ALT F		Houston Industrial Site Terminal Station Option	
		Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.
Segment 1	Dallas and Ellis	163.4	114.0	163.4	114.0	163.4	114.0	163.4	114.0	163.4	114.0	163.4	114.0	--	--
Segment 2A	Ellis	44.5	19.9	44.5	19.9	44.5	19.9	--	--	--	--	--	--	--	--
Segment 2B	Ellis	--	--	--	--	--	--	54.6	25.2	54.6	25.2	54.6	25.2	--	--
Segment 3A	Navarro	104.4	31.4	--	--	--	--	104.4	31.4	--	--	--	--	--	--
Segment 3B	Navarro	--	--	54.5	22.1	--	--	--	--	54.5	22.1	--	--	--	--
Segment 3C	Navarro, Freestone, Leon, Madison, and Grimes	--	--	--	--	261.2	40.7	--	--	--	--	261.2	40.7	--	--
Segment 4	Freestone, Limestone, Leon, Madison, and Grimes	106.0	33.1	106.0	33.1	--	--	106.0	33.1	106.0	33.1	--	--	--	--
Segment 5	Grimes, Waller, and Harris	110.2	21.0	110.2	21.0	110.2	21.0	110.2	21.0	110.2	21.0	110.2	21.0	--	--
Segment 5: Houston Industrial Site Terminal Station Option	Harris	--	--	--	--	--	--	--	--	--	--	--	--	0.11	0.00
Total		528.5	219.4	478.6	210.1	579.3	195.6	538.6	224.7	488.7	215.4	589.4	200.9	0.11	0.00
Total by Build Alternative		747.9		688.7		774.9		763.3		704.1		790.3		0.11	

Note – Due to rounding, acres presented in each table may not match.

The Project would also include bridge/viaduct stream crossings ranging from 442, under Build Alternative A, to 552 bridge/viaduct stream crossings under Build Alternative F,[92] as shown in **Table 3.8-7** and **Table 3.8-8**. The Houston Terminal Station Options are not presented in **Table 3.8-7** and **Table 3.8-8** because they do not have identified bridge/viaduct stream crossings.

As shown in **Table 3.8-7** and **Table 3.8-8**, the Build Alternatives with the fewest crossings would include 189 crossings over FEMA Zone A or Zone AE identified floodplains under Build Alternative A, while the most numerous crossings would be 226 crossings under Build Alternative F. Based on the conceptual design of the Project, all the identified FEMA floodplain crossings would be fully spanned with a viaduct segment and include a minimum of 3 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 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.[93] By incorporating this design into the construction of the Project, TCRR would ensure compliance with applicable FEMA regulations, including EO 11988 and Federal Flood Risk Management Standard.[94, 95, 96] 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.[97, 98, 99, 100]

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 253 crossings under Build Alternative A, to 326 crossings under Build Alternative F. These stream crossings would be spanned with viaducts in a similar manner as the FEMA-digitized crossings (refer to **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports**). 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 Project. Adding additional freeboard above the 100-year level would ensure compliance with EO 11988 and Federal Flood Risk Management Standard.

[92] TCRR, *Texas Central Partners Texas High Speed Rail Final Conceptual Engineering Report-FCERv2*, July 1, 2019.
[93] Personal email communication between Monica Wedo (AECOM) and Cory Stull (FNI), June 6, 2016.
[94] 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 December 2019, https://www.whitehouse.gov/the-press-office/2015/01/30/executive-order-establishing-federal-flood-risk-management-standard-and-.
[95] 44 C.F.R. 9, Floodplain Management and Protection of Wetlands, 2003.
[96] Ibid.
[97] 44 C.F.R. 2, Criteria for Land Management and Use, 2002.
[98] 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.
[99] Harris County, "Regulations of Harris County, Texas for Floodplain Management," Houston, Texas: Harris County Public Infrastructure Department Engineering Division, 2017.
[100] City of Houston, "Rules and Regulations for Chapter 19, Guidelines Houston City Code: Floodplain," City of Houston, February 1, 2009.

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 and Ellis	31	0	4	31	0	4	31	0	4
Segment 2A	Ellis	11	28	18	11	28	18	11	28	18
Segment 2B	Ellis	--	--	--	--	--	--	--	--	--
Segment 3A	Ellis and Navarro	0	24	10	--	--	--	--	--	--
Segment 3B	Ellis and Navarro	--	--	--	0	40	29	--	--	--
Segment 3C	Ellis, Navarro, Freestone, Leon, Madison, Grimes	--	--	--	--	--	--	8	91	192
Segment 4	Freestone, Limestone, Leon, Madison, Grimes	0	56	124	0	56	124	--	--	--
Segment 5	Grimes, Waller and Harris	21	18	97	21	18	97	21	18	97
Total		**63**	**126**	**253**	**63**	**142**	**272**	**71**	**137**	**311**
Total by Build Alternative		**442**			**477**			**519**		

Source: TCRR, *Texas Central Partners Texas High Speed Rail Final Conceptual Engineering Report-FCERv2*, July 1, 2019.

Table 3.8-8: 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	31	0	4	31	0	4	31	0	4
Segment 2A	Ellis	--	--	--	--	--	--	--	--	--
Segment 2B	Ellis	16	41	33	16	41	33	16	41	33
Segment 3A	Ellis and Navarro	0	24	10	--	--	--	--	--	--
Segment 3B	Ellis and Navarro	--	--	--	0	40	29	--	--	--
Segment 3C	Ellis, Navarro, Freestone, Leon, Madison, and Grimes	--	--	--	--	--	--	8	91	192
Segment 4	Freestone, Limestone, Leon, Madison, and Grimes	0	56	124	0	56	124	--	--	--
Segment 5	Grimes, Waller, and Harris	21	18	97	21	18	97	21	18	97
Total		**68**	**139**	**268**	**68**	**155**	**287**	**76**	**150**	**326**
Total by Build Alternative		**475**			**510**			**552**		

Source: TCRR, *Texas Central Partners Texas High Speed Rail Final Conceptual Engineering Report-FCERv2, July 1, 2019FCE Report v1*, December 19, 2018.

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:

- Ensure the minimum low chord viaduct crossings would be at least 3 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 would follow the latest FHWA HEC-18 procedures (refer to **FP-CM#5: Channel Stability**)

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, Avoidance, Minimization and 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 regulated under TPDES Permit No. TXR150000, which is a general permit in Texas for the discharge of stormwater during construction (refer to **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports**). Erosion and sedimentation control would include a variety of water quality controls, discussed in **Section 3.3, Water Quality**.

The design of the Project 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.

3.8.5.2.2 Geohydrology

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.

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 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**.[101]

The viaduct sections of the Project 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

[101] USGS, *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," Prepared in Cooperation with the Harris-Galveston Coastal Subsidence District, 1996.

by currently available geotechnical data and future geotechnical investigations performed during final design of the Project.

It is anticipated that the water needs of the Project, including the stations, would be supplied by local, existing public water supplies and groundwater. Use of existing 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 the majority of its water supply from the City of Houston; however, groundwater withdrawal is anticipated to be necessary. The City of Houston is in compliance with HGSD regulations, which minimizes the potential impacts of the Project on ground subsidence from groundwater pumping.

TCRR would implement temporary and permanent erosion, sediment and water quality controls, as outlined in **WQ-CM#3: Stormwater Management/Stormwater Pollution Prevention Plan**, **WQ-MM#1: Maintenance and Inspection of Temporary Erosion and Sediment Controls,** and **WQ-MM#6: Total Suspended Solids/Stormwater Runoff Control (Permanent),** in **Section 3.3.6, Water Quality, Avoidance Minimization and Mitigation** during the construction period and long-term operations to minimize changes to geohydrology. In addition, impacts to geohydrology as a result of the Project would be minimized with the implementation of BMPs 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 man-made drainage feature on the other side. Cross-drainage structures include the use of cross culverts, bridge class culverts or bridge spans.

Per the TCRR stream crossing design approach (refer to **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports**), 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. There are no cross-drainage locations using culverts or bridge class culverts (BCC) located within the 100-year or 500-year floodplains.

Lake Bardwell and Dam is owned and operated by USACE.[102] USACE holds flowage easements, or the right to occasionally flood private land in connection with operation of the reservoir, up to an elevation

[102] USACE, "Guidelines for Property Adjacent to Public Land," January 17, 2013, accessed December 2019, https://www.swf-wc.usace.army.mil/canyon/Realestate/Adjland.asp.

of 440 feet above mean sea level, and regulates construction below this level around the lake.[103] Only structures that do not reduce flood storage capacity and are not meant for human habitation may be 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. In addition to the approximately 24.8 acres of Lake Bardwell fee property crossed by Segment 2B, Segments 2A and 2B would both cross flowage easements (approximately 12.7 and 5.3 acres, respectively) maintained by USACE. 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., Avoidance, Minimization and Avoidance.** Impacts to Lake Bardwell are detailed in **Appendix E, Impacts to USACE Projects Technical Memorandum**.

As shown in **Table 3.8-7** and **Table 3.8-8**, Build Alternatives F would have the largest number of proposed bridge/viaduct sections (552) while Build Alternative A would have the least (442).

Impervious Cover and Detention

Construction of the Project 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, 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 Project to minimize the effects of increases in impervious cover and ground compaction during construction and operations, as outlined in **FP-CM#1: Floodplain Development Permit,** and **FP-CM#2: Construction Floodplain Best Management Practices**.

TCRR considered impervious cover and detention in the development of its conceptual engineering. Using typical section types, including roadway improvements for grade separations, TCRR calculated impervious cover per linear foot for each Build Alternative. TCRR used this data to estimate 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 Final Conceptual Engineering Design and Constructability Reports**). TCRR

[103] USACE – Fort Worth District, “CWLDM Lakes Bardwell, Easement.” Dated August, 29, 2019. Received via email February 21, 2020.

used this analysis to preliminarily design temporary and permanent drainage infrastructure, including detention basins, discussed in **Section 3.8.6, Avoidance Minimization and Mitigation**.

Per TCRR's conceptual design (refer to **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports**), permanent detention basins would be located adjacent to the railway in coordination with access roadway and rail-side conveyances. 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 conveyances (swales) to capture both on-site drainage and a portion of off-site drainage that flows towards the rail alignment.

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 the Project to ensure compliance with TCEQ's TPDES program, as discussed in **Section 3.3, Water Quality**.

3.8.5.3 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, as outlined in **FP-CM#5: Channel Stability**. 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 would follow HEC-20 procedures, as outlined in **FP-CM#5: Channel Stability**. **Table 3.8-9** 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 streams within the floodplain and with highly erodible soils would range by Build Alternatives from 36,468 feet (Build Alternatives A and D) to 41,324 feet (Build Alternatives B and E). Build Alternatives C and F would have the least (31,913 feet) permanent impacts, while Build Alternatives B and E (36,596 feet) would have the greatest permanent impacts.

Table 3.8-9: Streams Located in Highly Erodible Soils by Build Alternative within the Floodplain Study Area

Segment	County	Length of Impact (ft)											
		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	Navarro	1,632.8	0.00	--	--	--	--	1,632.8	0.00	--	--	--	--
Segment 3B	Navarro	--	--	3,665.9	0.00	--	--	--	--	3,665.9	0.00	--	--
Segment 3C	Navarro, Freestone, Leon, Madison and Grimes	--	--	--	--	11,596.2	0.00	--	--	--	--	11,596.2	0.00
Segment 4	Freestone, Limestone, Madison and Grimes	12,260.6	0.00	12,260.6	0.00	--	--	12,260.6	0.00	12,260.6	0.00	--	--
Segment 5	Grimes, Waller, Limestone, Madison and Harris	6,680.2	0.00	6,680.2	0.00	6,680.2	0.00	6,680.2	0.00	6,680.2	0.00	6,680.2	0.00
Total		20,573.6	0.00	22,606.8	0.00	18,276.4	0.00	20,573.6	0.00	22,606.7	0.00	18,276.4	0.00
Total by Build Alternative		20,573.6		22,606.8		18,276.4		20,573.6		22,606.7		18,276.4	

Source: NRCS. SSURGO data by County, 2013 and 2015

Perm. = Permanent Impact

Temp. = Temporary Impact

In addition to the cross-drainage design criteria in **Section 3.8.5.2.3, Hydrology – Cross Drainage Patterns**, 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**, as outlined in **FP-CM#1: Floodplain Development Permit,** and **FP-CM#2: Construction Floodplain Best Management Practices**. 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 would follow the latest FHWA HEC-18 procedures for design criteria of scour velocities at viaducts, as outlined in **FP-CM#5: Channel Stability**.[104, 105] Design features, including adequate pier depth, stream armoring, vegetation and flow deflectors, would be incorporated as necessary by TCRR into the final design plans to avoid or minimize adverse effect on channel stability.

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	10	--	--	10	--	--
Segment 3B	--	9	--	--	9	--
Segment 3C	--	--	35	--	--	35
Segment 4	32	32	--	32	32	--
Segment 5	31	31	31	31	31	31
Total	**73**	**72**	**66**	**73**	**72**	**66**

Source: NRCS. SSURGO data by County, 2013 and 2015

3.8.6 Avoidance, Minimization and Mitigation

During the conceptual design of the Project, 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 floodplain or an unregulated stream segment 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 Project, all the identified FEMA floodplain crossings would be fully spanned with a viaduct segment
- Included a minimum of 3 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 3 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

[104] TxDOT, "Manual Notice 2018-1," accessed December 2019, http://onlinemanuals.txdot.gov/txdotmanuals/geo/scour.htm.
[105] TxDOT, "Manual Notice 2019-1," accessed December 2019, http://onlinemanuals.txdot.gov/txdotmanuals/hyd/bridge_hydraulic_considerations.htm.

- 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 and as required by local, state, and federal regulations, 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 or groundwater resources, 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

TCRR would be required to comply with the following Compliance Measures (CM):

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. Natural events such as hurricanes (i.e., Hurricane Harvey in August 2017) that cause flooding events may result in floodplain boundary changes; therefore, TCRR shall monitor FEMA mapped floodplain boundaries during final design to ensure design components comply with local floodplain regulations.

FP-CM#2: Construction Floodplain Best Management Practices. During construction within floodplains, TCRR shall implement erosion and sedimentation controls in accordance with TPDES Permit No. TXR150000.[106] TCRR shall conduct periodic site inspections and maintenance when BMPs are in place to identify and address areas requiring maintenance. TCRR shall maintain records of all inspections as part of the SWPPP. Local regulatory entities listed in **Tables 3.8-2** and **3.8-3** have the authority to conduct additional inspections as they deem necessary.

To minimize disruption of natural flow patterns and to maintain floodplain benefits, TCRR shall construct temporary channels or coffer dams to reroute flows around work areas. At the conclusion of construction, site restoration, including vegetation replanting, shall be performed by TCRR in accordance with TCEQ CWA Section 401 water quality certification standards (refer to **Section 3.3.6, Waters Quality, Avoidance, Minimization and Mitigation**).

For all stream crossings temporarily impacted during construction, TCRR will implement BMPs in accordance with local regulating authorities (listed in **Tables 3.8-2** and **3.8-3**), any local site development permits and any USACE 404 permits. Typical BMPs may include:

[106] TxDOT, "Manual Notice 2019-1," accessed December 2019, http://onlinemanuals.txdot.gov/txdotmanuals/hyd/bridge_hydraulic_considerations.htm.

- Passage of normal or high downstream flows would be maintained 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.
- 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 that may include swales, vegetative strips and soil stabilization measures in combination with detention ponds to reduce peak flow rates in compliance with current applicable floodplain permit requirements.

FP-CM#4: Operational SWPPP: TCRR shall document specific post-construction control measures required by the local regulating authorities, defined in **Tables 3.8-2** and **3.8-3,** in the post-construction SWPPP and enforced by TCEQ and EPA, as discussed in **Section 3.3, Water Quality**, to ensure compliance with the CWA and Texas Water Code.[107]

FP-CM#5: Channel Stability: During final design, TCRR shall follow the latest FHWA HEC-20 and HEC-18 procedures to maintain stable stream channels and protect existing and planned infrastructure. These procedures would apply to hydraulic structures, outfalls, intakes, bridges, rail crossings of roads regulated by FHWA and TxDOT and rail crossings over waterbodies.

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**. The Houston Northwest Mall Terminal Station Option and Houston Northwest Transit Center Terminal Station Option are not presented in **Table 3.8-10** or discussed in the following summary because they would not be located within an existing floodplain and would neither require stream crossings nor have permanent or temporary floodplain impacts.

[107] Water Quality Control, Texas Water Code, Title II, Subtitle D, Chapter 26, accessed December 2019, https://statutes.capitol.texas.gov/Docs/WA/htm/WA.26.htm.

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	616	557	642	631	572	657
Impacts to 500-Year Floodplain	132	132	133	132	132	133
Total Acres of Intersected Floodplain	**748**	**689**	**775**	**763**	**704**	**790**
Permanent Impacts to 100-Year and 500-Year Floodplains	529	479	579	539	489	589
Temporary Impacts to 100-Year and 500-Year Floodplains	219	210	196	225	215	201
Total Acres of Impacted Floodplain	**748**	**689**	**775**	**764**	**704**	**790**
	Length of Streams with Highly Erodible Soils (feet)					
Impacts to Streams	20,574	22,607	18,276	20,574	22,607	18,276
	Number of Crossings					
Bridge/Viaduct Crossings at FEMA Zone AE Crossings	63	63	71	68	68	76
Bridge/Viaduct Crossings at FEMA Zone A Crossings	126	142	137	139	155	150
Bridge/Viaduct Crossings at Non-FEMA Stream Crossings	253	272	311	268	287	326
Total Number of Bridge/Viaduct Crossings	**442**	**477**	**519**	**475**	**510**	**552**
Stream Crossings Having Highly Erodible Soils	73	72	66	73	72	66

Source: AECOM 2019

Note – Due to rounding, acres presented in each table may not match.

The following is a summary of the impacts of Build Alternatives within the floodplain Study Area:

- Build Alternative F would impact the most acreage of floodplains at 790 acres of 100-year and 500-year floodplain combined with 589 of these acres identified as permanent impact, while Build Alternative B would impact the least acreage of floodplains at 689 acres of 100-year and 500-year floodplain combined with 479 of these acres identified as permanent impact.
- The Houston Industrial Site Terminal Station Option would have 0.11 acre of permanent impact located within the 500-year floodplain (Zone X – shaded) in Harris County.
- Build Alternative F would require the most bridges/viaducts installed at 552 combined crossings of FEMA Zone AE, Zone A and Non-FEMA streams, while Build Alternative A would require the least bridges/viaducts installed at 442 combined crossings of FEMA Zone AE, Zone A and Non-FEMA streams.
- Build Alternatives B and E would have the greatest stream length through highly erodible soils at 22,607 feet each. Build Alternatives C and F would have the least stream length through highly erodible soils at 18,276 feet each.
- Build Alternative A and D would have the highest number of stream crossings through highly erodible soils at 73 crossings each. Build Alternatives C and F would have the least number of stream crossings through highly erodible soils at 66 crossings each.

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 whether they can accommodate the energy demands of the HSR system.

3.9.2 Regulatory Context

Federal

FRA Procedures for Considering Environmental Impacts

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]

Federal Energy Regulatory Commission Responsibilities

Under the authority of Section 7 of the Natural Gas Act of 1938 (NGA)),[2] the Federal Energy Regulatory Commission (FERC) reviews applications for the construction and operation of interstate natural gas pipelines. The purpose of FERC's review is to ensure that applicants certify they will comply with USDOT safety standards. While FERC has no jurisdiction or decision-making authority over the construction or operation of the Project, FERC-regulated pipelines occur in the Study Area and relocation and/or maintenance activities of these utilities during construction of the Project may require FERC involvement.

Pipeline and Hazardous Materials Safety Administration Responsibilities

The Pipeline and Hazardous Materials Safety Administration (PHMSA), a USDOT agency, is responsible for regulating and ensuring the safety of the design, construction, operation, maintenance and spill response planning for natural gas and hazardous liquid transportation pipelines in the U.S. Additionally, PHMSA is responsible for setting and enforcing pipeline safety regulations and standards. While PHMSA has no jurisdiction or decision-making authority over the construction or operation of the Project, PHMSA requirements will be applicable to utility crossings, relocations and/or maintenance activities involving natural gas or hazardous liquid transportation pipelines impacted by the Project.

[1] FRA, *Procedures for Considering Environmental Impacts,* Notice of Updated Environmental Assessment Procedures, 64 Federal Register 28545, May 26, 1999, as updated in 78 Federal Register 2713 (January 14, 2013).
[2] 15 U.S.C. 717f.

State

Public Utility Regulatory Act

The purpose of the Public Utility Regulatory Act[3] is to establish a comprehensive and adequate regulatory system for public utilities to ensure 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 and implement respective legislation and offers customer assistance in resolving consumer complaints under the Act.

Texas Public Utility Commission Substantive Rule 25.101

Texas Public Utility Commission Substantive Rule 25.101 outlines the certification, licensing, and registration requirements for electric service providers. Electric utilities are required, with some exceptions, to obtain a Certificate of Convenience and Necessity from the Texas Public Utility Commission for any proposed transmission line project greater than 60 kilovolts (kV).

Texas Local Government Code 214.214

Texas Local Government Code 214.214 codifies the state's compliance with National Fire Protection Association (NFPA) 70 in response to the National Electrical Code. NFPA 70 codifies the requirements for safe electrical installations into a single, standardized source. NFPA 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)

Texas Statutes Title 9, Safety, Subtitle A, Chapter 752, Public Safety, establishes regulations for high voltage overhead lines.

3.9.3 Methodology

3.9.3.1 Data Collection

The evaluation of 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
- TWDB 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 (WWTP) capacity
- EIA data on Texas energy use, electrical generation, crude oil and natural gas and fuel consumption
- ERCOT statewide data for electrical demand and electrical generation
- Texas Railroad Commission (RRC) data for oil/gas wells

[3] Texas Utilities Code, Title 16, Title II.

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[4] 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 Project. The Project 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 to 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*[5] 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*[6] (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*[7] 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*[8] 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.
- The *2017 State Water Plan "Water for Texas"*[9] is a regional water plan developed every 5 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.[10] TCRR used the following criteria to identify the major utilities in the Study Area (see **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports)**:

- 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

[4] City of Dallas, Dallas Water Utilities, *2014 Dallas Long Range Water Supply Plan to 2070 and Beyond,* December 2015.
[5] Tarrant Regional Water District, 2013, *Integrated Water Supply Plan*, June 2014.
[6] City of Houston, *Houston Public Works - Water Conservation Plan*, Effective July 1, 2019-June 30, 2024, 2019.
[7] North Harris County Regional Water Authority, *Water Conservation Plan*, Adopted November 4, 2013.
[8] TWDB, *2016 Approved Regional Water Plans*, 2016.
[9] TWDB, *2017 State Water Plan - Water for Texas,* 2018.
[10] American Society of Civil Engineers, *Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data,* CI/ASCE 38-02, 2002.

- 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 MOW facilities. This data were 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 were 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. [11] TCRR also provided operational power consumption for trainset traction energy and energy consumption for stations and other facilities. Trainset traction power energy consumption was estimated by TCRR using a traction power load flow simulation. Energy demand for station operations and MOW facilities 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 2016 EIA data, as explained in **Section 3.2.3.2, Air Quality, Trainset Operation Emissions**. 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 Project.

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 one pound of water by one 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.[12] 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 1 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 Final Conceptual Engineering Design and**

[11] For the purposes of this analysis, Project mobilization was assumed to occur from January 2020 to March 2020. Regional building demolition and land grubbing for the embankment, elevated (viaduct) and retained-fill segments was anticipated to begin in March 2020 and conclude in December 2021. The major construction activities were anticipated to occur between 2021 and 2024, with construction of the TMFs, MOW facilities and stations completed between 2022 and 2024. Project demobilization would occur from September 2024 to December 2024. The years shown can be considered representative years for the purpose of the construction emissions analysis as detailed in the Summary Schedule in **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports**.

[12] EPA Office of Mobile Sources, *Fuel Economy Impact Analysis of Reformulated Gasoline (RFG),* August 1995.

Constructability Reports). 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 Project.
- 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 distance from Dallas to Houston is 239 miles and is assumed to be 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 Project on fuel and energy savings, the VMT that would have occurred in the absence of the Project was calculated. Using ridership information provided by TCRR[13], it was estimated to be 1,276,260,000 VMT. This is discussed in detail in **Section 3.2.3.2.2, Air Quality, 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 in one direction. 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.[14] This information was used along with the 2016 average Corporate Average Fuel Economy (CAFE) standard for passenger vehicles, promulgated by USDOT and EPA, to calculate fuel and energy savings shown in **Table 3.9-19**. Energy that would be used during the manufacturing of the trainset vehicles or with changes in the demand for automobiles or airplanes are not included in the analysis.

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**.

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**.

[13] TCRR, *Dallas to Houston High-Speed Rail Draft Environmental Impact Statement*, Appendix F: Dallas to Houston High-Speed Rail Final Draft Conceptual Engineering Report – FDCEv7 Set 1 of 2, September 15, 2017.
[14] USDOT, National Highway Traffic Safety Administration, *Corporate Average Fuel Economy Standards for MY 2012-MY 2016 Passenger Cars and Light Trucks, Final Regulatory Impact Analysis,* Office of Regulatory Analysis and Evaluation, National Center for Statistics and Analysis, 2010, accessed February 14, 2020.

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
Crude Oil	1	Sunoco Pipeline LP
Electric Transmission	11	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	7	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	5	ONCOR

Source: AECOM 2019
Note: OH – Overhead; UG – Underground
* Denotes that the utility will both be crossed and paralleled

Table 3.9-1: Summary of Utility Crossings		
Type	**Number Crossed**	**Owner**
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		
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
Crude Oil	2	Enterprise Crude Pipeline LLC
Electric Transmission	9	ONCOR
Natural Gas	4	Enbridge Pipelines LP
Natural Gas	2	Trend Gathering & Treating LLC
Natural Gas	1	Energy Transfer Company

Source: AECOM 2019
Note: OH – Overhead; UG – Underground
* Denotes that the utility will both be crossed and paralleled

Table 3.9-1: Summary of Utility Crossings

Type	Number Crossed	Owner
Madison County Segment 3C		
Electric Transmission	1	Entergy Texas
Natural Gas	1	Atmos Pipeline
Madison County Segment 4		
Crude Oil*	12	Enterprise Crude Pipeline LLC
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)*	10	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)*	36	AT&T Texas
Crude Oil	1	Enterprise Crude Pipeline LLC
Crude Oil	2	Magellan Pipeline Company LP
Crude Oil	1	Genesis Pipeline Texas LP
Electric Transmission	16	CenterPoint Energy
Natural Gas	1	Netco Pipeline
Natural Gas	3	Kinder Morgan Tejas Pipeline LLC
Natural Gas	2	Transcontinental Gas PL CO LLC
Natural Gas*	5	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*	12	City of Houston

Source: AECOM 2019
Note: OH – Overhead; UG – Underground
* Denotes that the utility will both be crossed and paralleled

Table 3.9-1: Summary of Utility Crossings

Type	Number Crossed	Owner
Houston Industrial Site Terminal Station Option		
Communication (UG)	4	AT&T Texas
Sanitary	1	City of Houston
Stormwater	1	City of Houston
Water	1	City of Houston
Houston Northwest Mall Terminal Station Option		
Communication (UG)	1	AT&T Texas
Sanitary	2	City of Houston
Water	2	City of Houston
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)	**399**	**--**

Source: AECOM 2019
Note: OH – Overhead; UG – Underground
* Denotes that the utility will be both crossed and paralleled

Source: AECOM 2019
Note: OH – Overhead; UG – Underground
* Denotes that the utility will both be crossed and paralleled

Table 3.9-2: Summary of Parallel Utilities

Type	Number Parallels	Owner
Dallas County Segment 1		
Sanitary	6	City of Dallas
Stormwater	7	City of Dallas
Water	7	City of Dallas
Ellis County Segment 2A		
Electric Transmission	2	ONCOR
Ellis County Segment 2B		
Electric Transmission	3	ONCOR
Ellis County Segment 3A		
None	--	--
Ellis County Segment 3B		
None	--	--
Ellis County Segment 3C		
None	--	--
Navarro County Segment 3A		
Electric Transmission	4	ONCOR
Navarro County Segment 3B		
Crude Oil	1	Sunoco Pipeline LP
Electric Transmission	1	ONCOR
Navarro County Segment 3C		
Crude Oil	8	Enterprise Crude Pipeline LLC
Crude Oil	1	Sunoco Pipeline LLC
Electric Transmission	6	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		
Crude Oil	1	Enterprise Crude Pipeline LLC
Natural Gas	1	Trend Gathering & Treating LLC
Madison County Segment 4		
Crude Oil*	3	Enterprise Crude Pipeline LLC
Electric Transmission	4	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	5	CenterPoint Energy
Waller County Segment 5		
Communication Line (UG)*	5	AT&T Texas
Harris County Segment 5		
Communication Line (UG)*	8	AT&T Texas
Natural Gas	2	Atmos

Table 3.9-2: Summary of Parallel Utilities		
Type	**Number Parallels**	**Owner**
Natural Gas*	7	Houston Pipeline Company LP
Stormwater	2	City of Houston
Wastewater	1	City of Houston
Water*	5	City of Houston
Houston Industrial Site Terminal Station Option		
Stormwater	2	City of Houston
Wastewater	1	City of Houston
Water	2	City of Houston
Houston Northwest Mall Terminal Station Option		
None	--	--
Houston Northwest Transit Center Terminal Station Option		
Stormwater	3	City of Houston
Wastewater	2	City of Houston
Water	3	City of Houston
Total (All Utilities)	**122**	**--**

Source: AECOM 2019
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 TWDB 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**.

Table 3.9-3: Current and Expected Water Demand and Shortages			
County	**2010/2011 Use (acre-feet/year)**	**2040 Expected Demand (acre-feet/year)**	**2040 Expected Shortage (acre-feet/year)**
Dallas	525,143	674,672	159,703
Ellis	36,349	58,626	14,495
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:
TWDB, *2016 Region C Water Plan for Texas Water Development Board, Volume 1 Main Report*, December 2015.
TWDB, *2016 Brazos G Regional Water Plan for Texas Water Development Board*, December 2015.
TWDB, *2016 Region H Water Planning Group for Texas Water Development Board*, November 2015.

Note: acre-feet is equivalent to 325,851 gallons.

As seen in **Table 3.9-3**, potable water demand is anticipated to increase for all 10 counties in the Study Area between 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.

A number of wholesale water providers could supply water to the stations, TMFs and MOW facilities. The major wholesale providers and their contracted supply through 2020[15, 16, 17, 18, 19] 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 Station 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 Intermediate 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 Station and TMF (5)	City of Houston	740,678

Sources: TWDB 2016; 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**. **Table 3.9-5** summarizes the capacities of the wastewater systems in the vicinities of the stations and facilities.[20, 21, 22] 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 WWTPs in some of the counties in the Study Area.

[15] Freese and Nichols, Inc., Alan Plumer Associates, Inc. CP&Y, Inc. and Cooksey Communications, Inc., *2016 Region C Water Plan – Volume I Main Report,* For Texas Water Development Board, December 2015.
[16] South Freestone WSC, personal communication, Permitted groundwater withdrawals, June 21, 2016.
[17] TWDB, *2016 Regional Water Plan,* Prepared by Region H Water Planning Group, November 2015.
[18] TWDB, *2016 Brazos G Regional Water Plan for Texas Water Development Board,* Volume I - Executive Summary and Regional Water Plan, December 2015.
[19] Bluebonnet Water Conservation District, personal communication, Permitted groundwater withdrawals, June 21, 2016.
[20] City of Dallas, *City of Dallas 2019 Water Conservation Plan,* Dallas Water Utilities, Adopted by Resolution of the Dallas City Council on April 24, 2019, accessed February 14, 2020. https://dallascityhall.com/departments/waterutilities/DCH%20Documents/pdf/Water%20Conservation%20Plan.pdf.
[21] City of College Station, "Wastewater (Sewer) Services," accessed February 10, 2020, https://www.cstx.gov/cms/one.aspx?portalId=12410917&pageId=13471254.
[22] City of Houston Public Works, "Plant Operations," accessed February 10, 2020, https://www.publicworks.houstontx.gov/pud/plant-operations.html.

Table 3.9-5: Wastewater Treatment Capacity

County	Facility (Segment)	Agency	WWTP Name	Capacity
Dallas	Dallas Terminal Station and TMF (1)	Dallas Water Utilities	Central WWTP	170 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 Intermediate Station (4)	City of College Station	Carter's Creek WWTP	9.5 MGD
Brazos	Brazos Valley Intermediate 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 Station and TMF	City of Houston Public Works	69th Street WWTP	200 MGD

Sources: City of Dallas 2019; City of College Station 2016; City of Houston 2016
Notes: mgd – million gallons per day; NA – Not Applicable; WWTP – wastewater treatment plant

The WWTP that would serve the Dallas Terminal Station has a capacity of 170 million gallons per day (mgd). The Central WWTP has a permit to expand to a future capacity of 200 mgd. The most recent available data indicate that the average annual flow for 2017-2018 was 88 mgd, or approximately 60 percent of existing plant capacity.[23]

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 WWTP to the Brazos Valley Intermediate 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.[24]

The City of Houston Public Works 69th Street WWTP would serve the Houston Terminal Station options; it has a capacity of 200 mgd. Information about average daily flows at individual WWTPs in Houston is not publicly available, but the City of Houston system, whose capacity is 564 mgd, treats a daily average flow of 250 mgd, representing 44 percent of the existing plant capacity.[25]

3.9.4.2 Energy

Texas leads the nation in energy production, primarily from crude oil and natural gas, but has also rapidly developed its wind energy resources and is experiencing relatively rapid growth in solar generation as well. 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 largest share of energy use, due to 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.[26] **Figure 3.9-1** illustrates Texas's energy use by sector in 2016.

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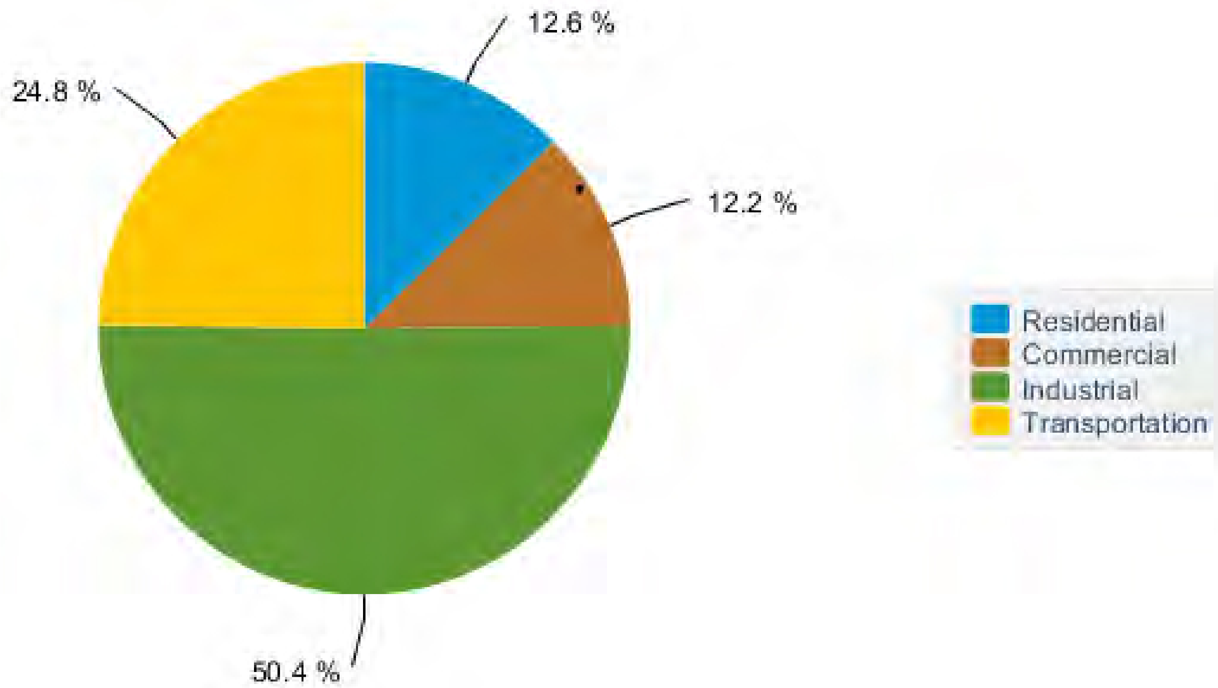
[23] City of Dallas, *City of Dallas 2019 Water Conservation Plan,* Dallas Water Utilities, Adopted by Resolution of the Dallas City Council on April 24, 2019, accessed February 14, 2020, https://dallascityhall.com/departments/waterutilities/DCH%20Documents/pdf/Water%20Conservation%20Plan.pdf.

[24] City of College Station, "Wastewater (Sewer) Services," accessed February 10, 2020, https://www.cstx.gov/cms/one.aspx?portalId=12410917&pageId=13471254.

[25] City of Houston Public Works, "Plant Operations," accessed February 10, 2020, https://www.publicworks.houstontx.gov/pud/plant-operations.html.

[26] EIA, "Texas State Energy Profile," accessed February 10, 2020, https://www.eia.gov/state/print.cfm?sid=TX.

Figure 3.9-1: Texas Energy Consumption by End Use in 2016



Source: EIA 2018

3.9.4.2.1 Electricity

Electrical Providers

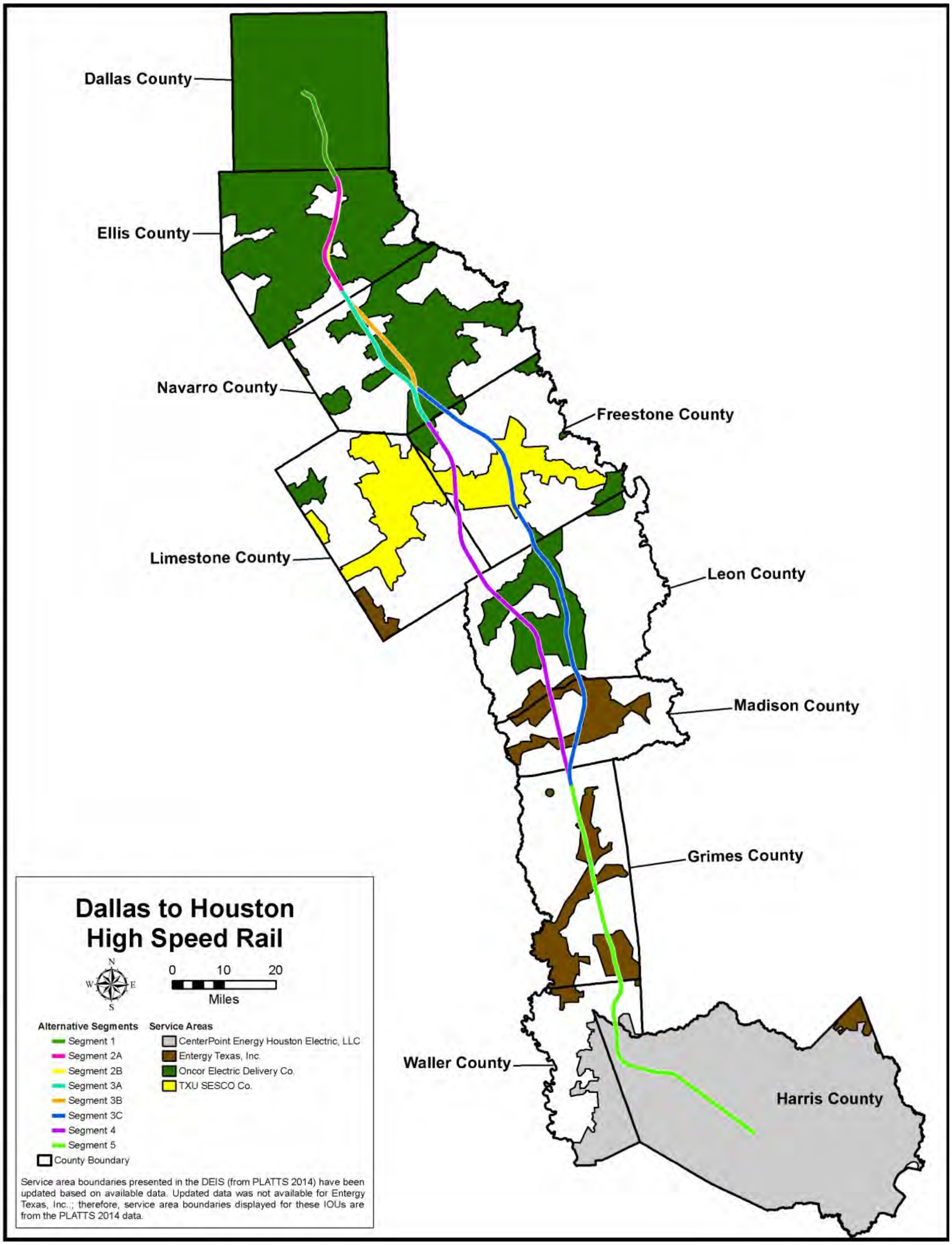
Figures 3.9-2 and **3.9-3** show the major and other smaller utility service providers, respectively, across the Study Area. As seen on **Figure 3.9-2**, the Study Area is served by four major utility service providers—Oncor Electric Delivery, TXU SESCO (TXU Energy), Entergy Texas and CenterPoint Energy. Oncor Electric Delivery is Texas' largest distribution and transmission system, delivering power to more than 3.45 million homes and businesses and operating approximately 134,000 miles of transmission and distribution lines.[27] Oncor Electric's service territory in the Study Area includes Dallas, Ellis, Navarro, Freestone, Limestone, and Leon Counties.

TXU SESCO (TXU Energy) delivers electricity across Texas to 1.7 million residential and business customers.[28] Overall TXU Energy's service area is comparable to Oncor Electric, but within the Study Area is limited to Freestone and Limestone Counties.

[27] Oncor Electric Delivery Company LLC 2019, "Who is Oncor?," accessed January 25, 2019, http://www.oncor.com/EN/Pages/Who-is-Oncor.aspx.

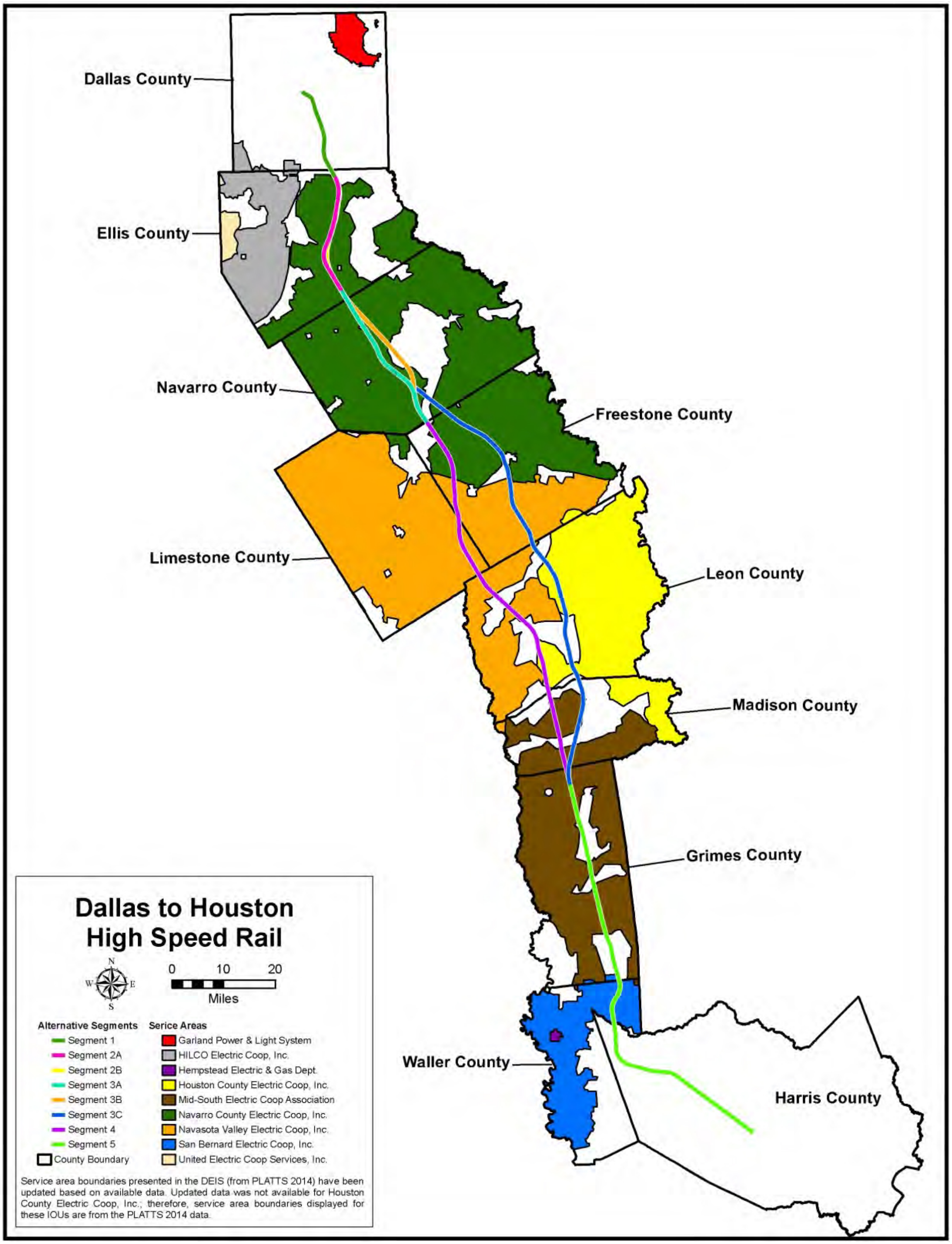
[28] TXU Energy, "TXU Energy Review," accessed February 14, 2020, https://electricitymatch.com/txu-energy/.

Figure 3.9-2: Major Electric Utility Providers



Source: AECOM 2019

Figure 3.9-3: Smaller Electric Utility Providers



Source: AECOM 2019

Entergy Texas delivers electricity to 448,000 customers across 27 counties and 15,320 square miles in central and eastern Texas.[29] 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 2.4 million customers in the Houston metropolitan area.[30] CenterPoint Energy's service territory in the Study Area is Harris and Waller Counties.

In addition to the four major utility service providers, there are nine other service providers across the Study Area, as seen on **Figure 3.9-3**. The service areas for these utility providers overlap with portions of the four major utility service providers shown on **Figure 3.9-2**. The nine other service providers 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 17 member-owner distribution cooperatives and one municipal system.[31]

ERCOT manages about 90 percent of the state's electric load, including for all counties in the Study Area, connecting more than 46,500 miles of transmission lines and more than 600 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.[32]

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.[33] Based on the ERCOT 2018 *Report on Existing and Potential Electric System Constraints and Needs*, the Houston area has seen a noteworthy decrease in congestion from the import of power into the Houston area from the north. This decrease in congestion occurred after the Houston Import Project went into service in April 2018.

[29] Entergy Texas, Inc., "About Entergy Texas," accessed February 14, 2020, https://www.entergy-texas.com/about-us/.
[30] CenterPoint Energy, "Electric Utility," accessed February 10, 2020, http://www.centerpointenergy.com/en-us/residential/services/electric-utility?sa=ho.
[31] Brazos Electric Cooperative, "About Brazos," accessed February 14, 2020, http://www.brazoselectric.com/.
[32] ERCOT, "About ERCOT," 2018, accessed February 14, 2020, http://www.ercot.com/about.
[33] ERCOT, *Report on Existing and Potential Electric System Constraints and Needs*, December 29, 2014.

The ERCOT *2014 Demand and Energy Report* 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 was generated and supplied in the ERCOT system to support the 2014 population of Texas.[34] Updated data for 2019 also indicate that power supply was sufficient to support demand, with the annual hourly demand at 59.9 percent of capacity, and the 15-minute demand at 59.8 percent of capacity.[35]

The ERCOT *2014 Regional Transmission Plan Report* addresses region-wide reliability and economic transmission needs for years 2015 through 2020, and the 2018 *Regional Transmission Plan Report* addresses reliability and transmission needs for years 2020 through 2024. ERCOT's transmission system is divided into eight 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.[36] 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 2024.[37]

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	23,048	2,343	2,589	1,589	25,917	11,882	6,346	1,945	75,659
2017	23,419	2,356	2,824	1,570	26,629	12,049	6,721	1,983	77,553
2019	23,853	2,369	3,056	1,551	27,322	12,210	7,087	2,022	79,470
2020	22,103	2,789	3,840	1,464	26,622	13,143	6,175	1,978	78,114
2021	22,419	2,809	4,139	1,467	26,888	13,269	6,317	2,006	79,313
2023	23,160	2,853	4,802	1,475	27,490	13,564	6,649	2,064	82,056
2024	23,482	2,871	5,100	1,478	27,746	13,695	6,791	2,091	83,255

Source: ERCOT 2014, 2018

Note: MW – megawatts

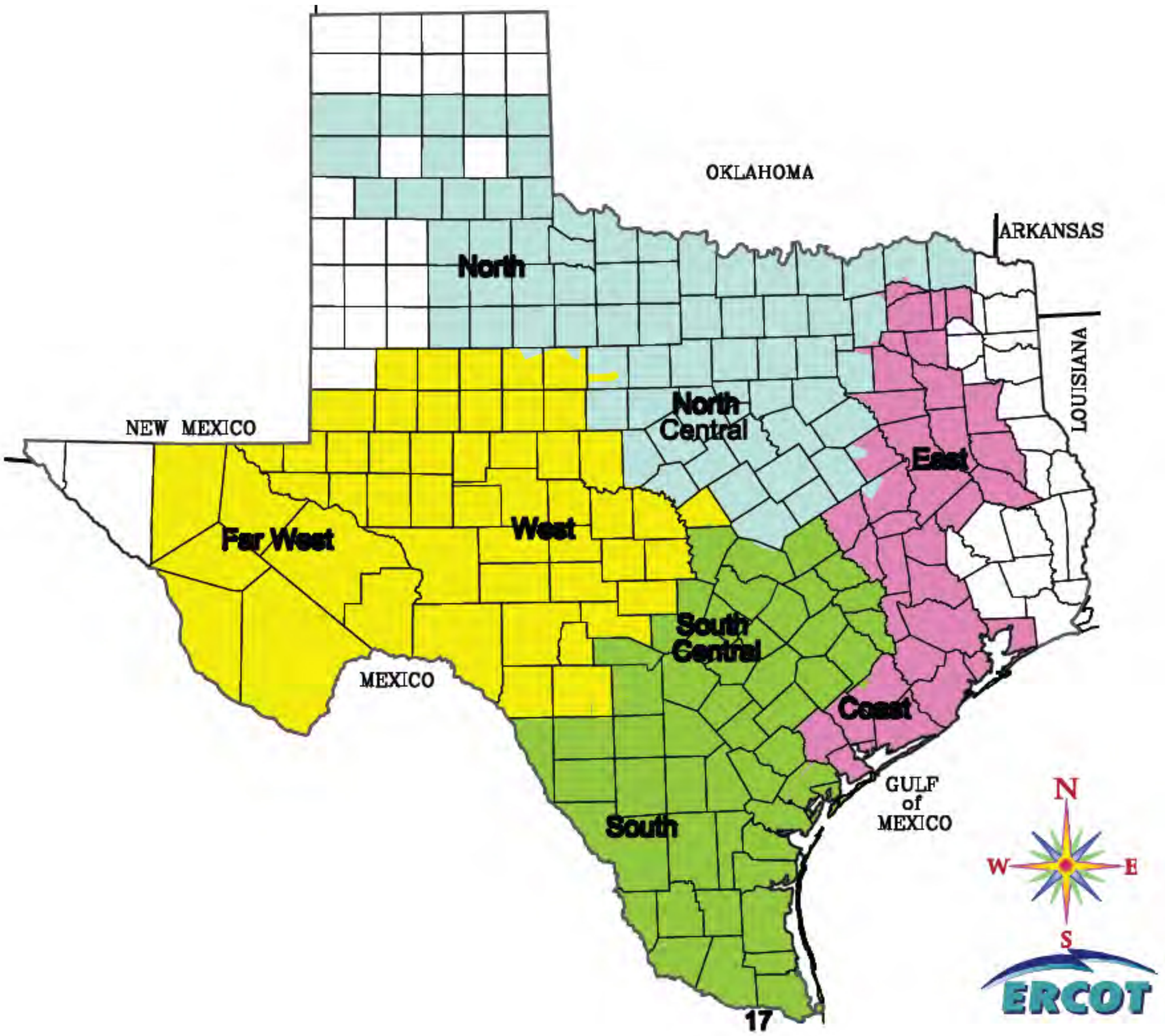
[34] ERCOT, *Demand and Energy Report*, File Updated February 8, 2016.

[35] ERCOT, *Demand and Energy Report*, November 2019.

[36] 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.

[37] ERCOT, *2018 Regional Transmission Plan, Version 1.0,* December 2018.

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.[38] The net added capacity, which subtracts the retired capacity, provides a peak capacity of 20,410 MW, which would provide an additional 489,840 MWh daily, or 178,791,600 MWh annually, under constant generation. Updated data from the 2018 *Long-Term System Assessment for the ERCOT Region* indicate that by 2033 net added capacity is estimated to be 21,850 MW.[39]

[38] ERCOT, *2014 Long-Term System Assessment for the ERCOT Region*, ERCOT System Planning, December 2014.
[39] ERCOT, *ERCOT System Planning: 2018 Long-Term System Assessment for the ERCOT Region*, December 2018.

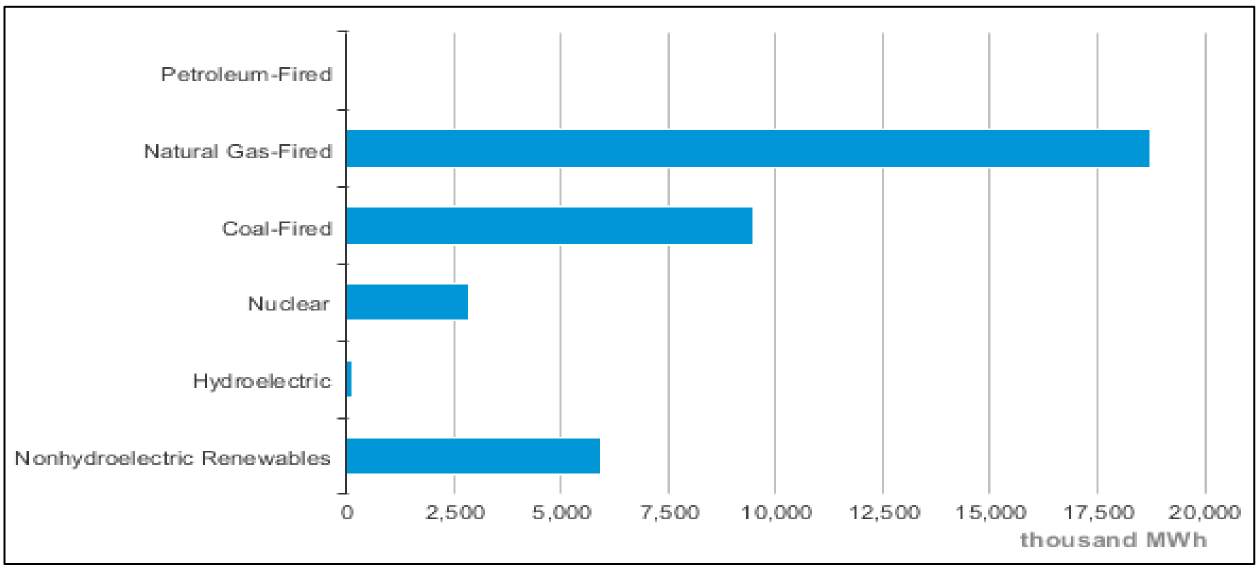
Table 3.9-7: Expected Electricity Growth						
	2018	**2021**	**2024**	**2027**	**2029**	**2033**
Annual Capacity Additions (MW)	1,350	5,790	4,780	5,940	3,500	850
Cumulative Capacity Additions (MW)	1,350	7,140	11,920	17,860	21,360	21,850
Equipment Retirements (MW)	955	2,086	2,379	2,453	950	--
Net Added Capacity	395	5,054	9,541	15,407	20,410	21,850

Source: ERCOT 2014, 2018

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 producers and industrial generators. **Figure 3.9-5** illustrates Texas' electricity generation estimates by type in 2018.

Figure 3.9-5: Texas Electricity Generation Estimates in 2018



Source: EIA 2018

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 2017, crude oil production exceeded 3.4 million barrels per day. Texas also leads the nation in crude oil refining capacity, with 30 refineries that can process more than 5.7 million barrels of oil per day. Additionally, Texas leads the nation in total oil consumption and in 2015 was fifth in per capita consumption.[40]

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

[40] EIA, "Texas State Energy Profile," accessed February 10, 2020, https://www.eia.gov/state/print.cfm?sid=TX.

south Texas. In 2016, natural gas production reached more than eight trillion cubic feet. As discussed in **Section 3.9.4, Affected Environment**, 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.[41]

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, 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	-	-	-	-
Segment 3B	-	1	-	-
Segment 3C	5	-	-	-
Freestone County				
Segment 3A	-	-	-	-
Segment 3B	-	-	-	-
Segment 3C	3	5	1	775.5
Segment 4	1	-	-	-
Limestone County				
Segment 4	9	-	2	316.3
Leon County				
Segment 3C	3	1	-	851.9
Segment 4	7	-	4	307.9
Madison County				
Segment 3C	1	2	1	466.7
Segment 4	3	2	3	85.8
Grimes County				
Segment 3C	-	-	-	68.2
Segment 4	-	-	-	38.3
Segment 5	2	2	2	455.5
Harris County				
Segment 5	3	-	1	37.2
Segment 5 Northwest Transit Center	1	-	-	-
Total	**38**	**13**	**14**	**3,403.3**

Source: AECOM 2019

Note: No oil/gas wells are located in Dallas, Ellis or Waller Counties.

[41] Ibid.

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 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**.[42]

Table 3.9-9: Transportation Energy Consumption by Source for 2013

	Distillate Fuel (diesel)	Jet Fuel	Motor Gasoline[a]	Residential Fuel	Other[b]	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: USDOT 2015

Note: All data are in trillion British thermal units, except for per capita data, which is in million British thermal units.
[a] Includes ethanol blended into motor gasoline.
[b] "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 from the HSR system. 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 other planned projects, such as the IH-35 East roadway improvement project in Dallas County and the Waxahachie Line rail project in Dallas and Ellis Counties. The impacts of these projects are discussed in **Section 4.4, Indirect Effects and Cumulative Impacts, Cumulative Impacts**.

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 Project (see included as **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports,** and **Appendix G, TCRR Final Conceptual Engineering Plans and Details**). Due to the unknown locations of these modifications at the time the

[42] USDOT, Bureau of Transportation Statistics, *State Transportation Statistics – 2015*.

Draft EIS was published, a project-level environmental assessment of these areas was not included in the Draft EIS, and these potential impacts were only discussed at the cumulative-level in **Chapter 4.0, Indirect Effects and Cumulative Impacts.** Since publication of the Draft EIS, TCRR has identified the potential locations of these modifications. The LOD for the Project has been modified to include these potential modifications to existing utilities, and an assessment of the impacts associated with these modifications is now included in this section. The LOD for the Project has also been modified to include the new electrical utility connections as an indirect, encroachment-alteration effect of the Project, and an assessment of the impacts associated with these new connections is now included in **Section 4.3.2, Indirect Effects and Cumulative Impacts, New Electrical Transmission Lines**. However, the utility provider would have ultimate decision-making authority over the size and location of each modification. For example, the provider could choose to combine the needs of the HSR system with other planned or authorized projects.

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 **Table 3.9-10** and conduct coordination to identify opportunities to avoid conflicts. Agreements between TCRR and utility providers would be completed before construction of the Project could begin. The utility providers would be responsible for undertaking any potential relocations, pole adjustments and/or new connections. Potential locations of these modifications are included in the LOD for the Project. However, the final location of these modifications would ultimately 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 Effects and Cumulative Impacts**.

Table 3.9-10 shows the number and type of the anticipated electrical transmission line modifications, including realignments and new connections. The six electric transmission lines that are noted in the No Impact column of the table would be parallel to the segment but would not require realignment or modifications. The potential locations of the modifications within the LOD are shown in **Appendix D, Mineral and Utility Resources Mapbook**.

Table 3.9-10: Electric Transmission Line Impacts

County/Segment	Pole Realignment	No Impact	TPSS Connections
Dallas County			
Segment 1	15	--	2
Ellis County			
Segment 2A	10	--	1
Segment 2B	14	--	1
Segment 3A	--	--	-
Segment 3B	--	--	-
Navarro County			
Segment 3A	11	--	2
Segment 3B	11	--	1

Table 3.9-10: Electric Transmission Line Impacts

County/Segment	Pole Realignment	No Impact	TPSS Connections
Segment 3C	10	1	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	4	2	1
Grimes County			
Segment 3C	1	--	-
Segment 5	11	1	2
Waller County			
Segment 5	3	--	-
Harris County			
Segment 5	16	--	2
Houston Industrial Site Terminal Station Option	--	--	-
Houston Northwest Mall Terminal Station Option	--	--	--
Houston Northwest Transit Center Terminal Station Option	2	--	-
Total	**131**	**6**	**21**

Source: AECOM 2019

Table 3.9-11 summarizes the electric transmission line impacts by alternative. Build Alternatives A, C, D, and F would require 13 new electrical connections at the TPSSs and Build Alternatives B and E would require the least amount of new connections, with 12 each. Pole adjustments, or raising the transmission line, could be required under all Build Alternatives to accommodate vertical clearances for the HSR ROW. Estimates of pole adjustments range from 74 under Build Alternative C to 89 under Build Alternatives D and E.

Table 3.9-11: Electric Transmission Line Impacts by Build Alternative

	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F
New Electric TPSS Connections	13	12	13	13	12	13
Electric Utility Pole Adjustments	85	85	74	89	89	78
Total Electric Connections and Adjustment	98	97	87	102	101	91

Source: AECOM 2019

Non-Electric Utility Modifications

While overhead utility lines are visible and can be verified prior to construction activities, below ground utility exploration would need to be performed by 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 Project would cross underground utilities, realignment may be necessary to provide adequate protection and/or depth. Where the Project 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 Project 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.

Tables 3.9-12 through **3.9-14** summarize the potential utility crossings by type (e.g., water, wastewater and communication underground, respectively) and proposed rail configuration (e.g., below grade, on embankment or viaduct), as well as how they would be impacted by the Project (e.g., relocated, protected or not impacted). Underground utilities, such as water/wastewater infrastructure, could conflict with construction of the Project, 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 Project would be on viaduct and there is not sufficient vertical clearance for the HSR system infrastructure beneath the overhead utility.

Table 3.9-12: Impacts to Existing Water Utilities

Type	Relocate	Protect	No Impact
Dallas County – Segment 1			
Water	--	--	9
Stormwater	--	--	21
Ellis County – Segment 2A			
Water	--	2	--
Ellis County – Segment 2B			
Water	--	2	--
Harris County – Segment 5			
Water	5	3	6
Stormwater	--	1	3
Houston Industrial Site Terminal Station Option			
Water	--	3	--
Stormwater	--	3	--
Houston Northwest Mall Terminal Station Option			
Water	1	1	--
Houston Northwest Transit Center Terminal Station Option			
Water	--	4	1
Stormwater	--	4	1
Total	**6**	**23**	**41**

Source: AECOM 2019

Table 3.9-13: Impacts to Wastewater Utilities

Type	Relocate	Protect	No Impact
Dallas County – Segment 1			
Sanitary	1	1	20
Harris County – Segment 5			
Sanitary	--	4	--
Wastewater	--	1	--
Houston Industrial Site Terminal Station Option			
Sanitary	--	1	--
Wastewater	--	1	--
Houston Northwest Mall Terminal Station Option			
Sanitary	--	2	--
Houston Northwest Transit Center Terminal Station Option			
Sanitary	--	1	1
Wastewater	--	2	--
Total	**1**	**13**	**21**

Source: AECOM 2019

Table 3.9-14: 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	15	2	34
Houston Industrial Site Terminal Station Option			
Communication	4	--	--
Houston Northwest Mall Terminal Station Option			
Communication	--	--	1
Houston Northwest Transit Center Terminal Station Option			
Communication	13	--	--
Total	33	5	64

Source: AECOM 2019

As seen in **Tables 3.9-12** and **3.9-13**, potential impacts to water and wastewater utilities would primarily occur in Dallas and Harris Counties, which include common segments of all the Build Alternatives and Houston Terminal Station options. As seen in **Table 3.9-14**, potential impacts to communication lines would primarily occur in Harris County.

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.

Operation of the Project would primarily use water at the stations, TMFs and MOW facilities. Trainsets 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 3.9-15**. The total daily water demand for the Project would be approximately 349,652 gallons per day, or 127,622,980 gallons per year. The contracted water supply volume of the relevant providers listed in **Table 3.9-4** could meet the anticipated operational demand.

Table 3.9-15: Projected Project Water Demand

Facility	Demand (gallons per day)	Demand (acre-feet per day)	Demand (gallons per year)	Demand (acre-feet per year)
Dallas Terminal Station	95,100	0.29	34,711,500	106.5
Brazos Valley Intermediate Station	25,800	0.08	9,417,000	28.9
Houston Terminal Station	73,800	0.23	26,937,000	82.7
TMFs (two)	128,275	0.39	46,820,375	143.7
MOW Facilities (seven)	26,677	0.08	9,737,105	29.9
Total	**349,652**	**1.07**	**127,622,980**	391.7

Source: TCRR 2019

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 MOW facilities, water demand would be associated with trainset washing, associated maintenance activities, trainset water supply and routine employee usage for consumption and restrooms. As shown in **Table 3.9-15**, water would also be required at the MOW facilities (approximately 26,677 gallons per day). 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. TCRR would coordinate with the Prairielands Groundwater Conservation District, the regulating entity for groundwater wells in Ellis County, in order to meet water demand for MOW facilities.

The Dallas Terminal Station, TMF and MOW facility would be located in the City of Dallas and would generate an estimated water demand of 182.6 acre-feet per year. Water for these facilities would be provided by Dallas Water Utilities. The 182.6 acre-feet per year would be well within the service capabilities of Dallas Water Utilities and represents less than 0.04 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"[43] prior to construction to more accurately determine the needs of the Dallas area facilities.

The Brazos Valley Intermediate Station would generate an estimated water demand of 28.9 acre-feet per year. TCRR has not specifically identified how this water demand would be met. However, 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 Intermediate Station exceeds the annual water usage of Anderson Water Company. Capacity expansion would be required to accommodate the demand of the Project. TCRR would need to coordinate with Anderson Water Company to complete a development review prior to construction to more accurately determine the new infrastructure needs to support the Brazos Valley Intermediate Station. Additionally, 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 Special Utility District (SUD) is located less than one-half mile to the north, south or west of the Brazos Valley Intermediate Station site. A 6-inch water line exists along County Road 226, which crosses the LOD approximately 3,000 feet from the Brazos Valley Intermediate Station. The Wickson Creek SUD has 1,710 acre-feet per year under contract through 2020.[44] The estimated demand for water at the Brazos Valley Intermediate Station would represent approximately 1.9 percent of contracted capacity of the Wickson Creek SUD. TCRR would need to tie-in to the existing 6-inch water line in order to access the Wickson Creek SUD. Approximately 3,000 feet of water line connection would need to be built within the LOD for the Project to accommodate this tie-in.

The Houston Terminal Station Options and Houston TMF would generate an estimated water demand of 154.5 acre-feet per year. Water for these facilities would be provided by the City of Houston. The 154.5 acre-feet per year would be within the service capabilities of the City of Houston and would represent approximately 0.02 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 Intermediate Station would require new infrastructure from either Anderson Water Company or Wickson Creek SUD. Water for operation at the MOW facilities would come from local water wells.

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 disposed of in accordance with applicable state and local regulations. 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.

[43] City of Dallas, *Development Design Procedure and Policy Manual*, October 2015.
[44] TWDB, *2016 Brazos G Regional Water Plan for Texas Water Development Board. Volume I - Executive Summary and Regional Water Plan,* December 2015.

Operation of the Project would generate wastewater at the stations, TMFs and MOW facilities. Trainsets 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, TMF and MOW facility would be located within the City of Dallas and would generate an estimated wastewater demand of 163,049 gallons per day, or 0.16 mgd. Wastewater from the Dallas Terminal Station would be directed to the Central WWTP, operated by the City of Dallas, which currently has a capacity of 170 mgd. The wastewater generated by the Project would be well within the Central WWTP's capacity, representing 0.09 percent of its capacity.

The Brazos Valley Intermediate Station would generate an estimated wastewater demand of 25,800 gallons per day, or 0.03 mgd. Wastewater from the Brazos Valley Intermediate Station could be directed to Carter's Creek WWTP, operated by the City of College Station, which has a capacity of 9.5 mgd. However, Carter's Creek WWTP 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 within the LOD for the Brazos Valley Intermediate Station. This facility would be classified as a large capacity on-site sewage system and be regulated by TCEQ as a Class V Injection Well.[45] 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 137,938 gallons per day, or 0.14 mgd. Wastewater from the Houston Terminal Station options would be directed to the 69th Street WWTP, operated by the City of Houston, which has a capacity of 200 mgd. The wastewater generated by the Project would be well within the 69th Street WWTP's capacity, representing 0.07 percent of its capacity.

At the MOW facilities, wastewater demand would be generated by trainset washing, maintenance activities and routine employee usage for consumption and restrooms. The six additional MOW facility options (excluding the Dallas MOW previously discussed) would each generate an estimated 3,811 gallons of wastewater per day. All 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 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 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) within the LOD for the MOW facilities as part of the Project. TCEQ has granted authority to Texas counties to manage regulations regarding permits and enforcement of on-site sewage facilities.[46] Prior to the construction of an on-site septic system for each of the MOW

[45] Texas Administrative Code, Title 30 Environmental Quality, Chapter 331 Underground Injection Control.
[46] Texas Administrative Code, Title 30 Environmental Quality, Chapter 285 On-site Sewage Facilities.

facilities, TCRR would file on-site sewage facilities applications, which once approved, would be given to a licensed sceptic installer.

Wastewater generated during operation would be treated at existing WWTPs where accessible, and at on-site treatment facilities constructed as part of the Project. 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 within the LOD to serve the Brazos Valley Intermediate Station and the MOW facilities. These on-site facilities would be constructed in accordance with applicable state and local regulations.

3.9.5.2.2 Energy

Electricity

Electricity demand during construction of the Project would be limited to power requirements (primarily lighting and power tools) at laydown areas and facilities construction sites. Construction power usage would be negligible compared with overall system capacity, and electricity demand during construction is assumed to be the same for all Build Alternatives. Given the linear nature of the Project, 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, Affected Environment, Energy,** 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 Project.

Operational energy consumption would include the electricity needed to power the HSR trainsets, stations, TMFs and MOW facilities. The Project would obtain electricity from the major electrical service providers in the Study Area. Due to the size and expected electrical demand of the Project, it is likely that statewide electricity reserves and electrical transmission capacity would be affected. The Project 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 3.9.4.2, Affected Environment, Energy**. As shown in **Table 3.9-16,** the total energy (electrical) demand of the Project, at maximum, is estimated to be 531,867 MWh per year, or 1,814,804 (MMBtu per year, including power losses from transmission and transformers. Differences in power consumption estimates provided by TCRR would not vary among Build Alternatives A through F because of track length, but because of variations in stationing, 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 1 percent.

Table 3.9-16: Projected Power Demand for the Project

Facility	Power Consumption (MWh per day)	Power Consumption (MMBtu per day)	Power Consumption (MWh per year)	Power Consumption (MMBtu per year)
HSR trainsets (80 per day)	618.5	2,110	225,745	770,275
Trainset auxiliary power	108.0	369	39,420	134,507
Dallas Terminal Station	103.2	352	37,668	128,529
Brazos Valley Intermediate Station	30.4	104	11,096	37,861
Houston Terminal Stations	75.1	256	27,412	93,532

Table 3.9-16: Projected Power Demand for the Project				
Facility	**Power Consumption (MWh per day)**	**Power Consumption (MMBtu per day)**	**Power Consumption (MWh per year)**	**Power Consumption (MMBtu per year)**
TMFs (two) and accompanying MOW facilities	127.1	434	46,392	158,294
TMF traction	80.0	273	29,200	99,635
MOW facilities (five)	90.0	307	32,850	112,089
Switching and Substations	69.2	236	25,258	86,184
Signaling and communication houses (twenty)	86.3	294	31,500	107,481
Total	1,387.8	4,735	506,541	1,728,387
Power Losses at 5%	69.4	237	25,327	86,419
Total plus Losses	**1,457.2**	**4,972**	**531,868**	**1,814,806**

Source: AECOM 2019.

Note: MWh – megawatt hours
MMBtu – Millions of British Thermal Units

The TPSS would provide the electric power to the trainsets and would be composed of the following components: 138 kV electrical transmission line connections, TPSS substations, sectioning posts, sub-sectioning posts, auto transformer posts and a 25 kV 60 cycle OCS. Therefore, the energy (electricity) required for propulsion of the HSR trainsets between Dallas and Houston is estimated at 225,745 MWh per year, or 770,275 MMBtu per year. Auxiliary power to provide lights and climate control would require 39,420 MWh per year, or 134,507 MMBtu per year.

Terminal and intermediate 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 trainsets (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 (any one of the terminal station options) are estimated to use 37,668 MWh per year and 27,412 MWh per year, respectively, or collectively, 65,080 MWh per year, or 222,060 MMBtu per year. The Brazos Valley Intermediate Station would be smaller and estimated to use 11,096 MWh per year, or 37,861 MMBtu per year.

TMF and MOW facilities would require energy (electricity) to power the trainset storage areas, inspection and overhaul shops, trainset wash areas, stabling tracks, administrative offices and staff welfare areas (e.g., employee parking, lockers, offices, break rooms). Combined, the TMF facilities and their associated MOW facilities and traction power requirements are estimated to use 75,592 MWh per year, or 257,929 MMBTtu per year. Combined, the five other MOW facilities are estimated to use 32,850 MWh per year, or 112,089 MMBtu per year. Switching and substations, which regulate and switch power on and off to trainsets traveling long the high speed track, are estimated to use 25,258 MWh per year, or 86,184 MMBtu 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 the Project, and would require approximately 31,500 MWh per year, or 107,481 MMBtu per year.

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 1,457.2 MWh, as shown in **Table 3.9-16,** would represent 0.30 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.[47] Even if it were not accounted for in planned or forecasted demand, the daily demand of the Project would represent less than the reserve margin considering its percentage of the planned added capacity. Recent near-term reserve margin forecasts using more certain ("firm") load forecasts include a 2016 forecast for 2017 to 2026 ranging from 15.9 percent to 25.4 percent of reserve margin, and a more recent 2018 forecast for 2019 to 2023 ranging from 7.5 percent to 12.2 percent.[48, 49]

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 applicable electrical providers (e.g., CenterPoint Energy, Entergy, Mid-South Synergy, Oncor and San Bernard) to complete development reviews prior to construction to more accurately determine the electricity needs of the Project and available power supplies.

3.9.5.2.3 Fuel

Crude Oil and Natural Gas

Table 3.9-17 summarizes oil and gas utility crossings and how they would be impacted by the Project (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 Project would result in scheduled and/or accidental interruptions of oil and gas utility services. Final design and phasing of construction activities would minimize interruptions.

Table 3.9-17: Impacts to Oil and Gas Utilities

Type	Relocate	Protect	No Impact
Dallas County – Segment 1			
Natural Gas	--	2	--
Ellis County – Segment 2A			
Crude Oil	--	1	--
Natural Gas	--	7	--
Ellis County – Segment 2B			
Crude Oil	--	1	--
Natural Gas	--	7	--
Navarro County – Segment 3A			
Crude Oil	--	1	--
Empty	--	1	--
Gasoline/Jet Fuel/Diesel	--	1	--
Natural Gas	--	1	--

[47] ERCOT, "Resource Adequacy," accessed April 2019, http://www.ercot.com/gridinfo/resource.

[48] ERCOT, *Report on the Capacity, Demand and Reserves (CDR) in the ERCOT Region, 2017-2026,* Capacity, Demand and Reserves Report, May 3, 2016, accessed September 2016, http://www.ercot.com/content/wcm/lists/96607/CapacityDemandandReserveReport_May2016.xlsx.

[49] ERCOT, *Report on the Capacity, Demand and Reserves (CDR) in the ERCOT Region, 2019-2023,* December 4, 2018, accessed February 14, 2020, http://www.ercot.com/content/wcm/lists/167023/CapacityDemandandReservesReport-Dec2018.xlsx.

Table 3.9-17: Impacts to Oil and Gas Utilities			
Type	**Relocate**	**Protect**	**No Impact**
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	--
Natural Gas Liquids	--	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			
Crude Oil	1	2	--
Natural Gas	--	8	--
Madison County – Segment 3C			
Natural Gas	--	1	--
Madison County – Segment 4			
Crude Oil	4	10	--
Natural Gas	--	1	--
Grimes County – Segment 4			
Crude Oil	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	--

Table 3.9-17: Impacts to Oil and Gas Utilities

Type	Relocate	Protect	No Impact
Harris County –Segment 5			
Crude Oil	--	4	--
Natural Gas	5	18	--
Natural Gas Liquids	--	1	--
Total	**14**	**145**	**6**

Source: AECOM 2019

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. As detailed in **Section 3.4.5.2, Noise and Vibration, Environmental Consequences, Build Alternatives,** certain construction activities, such as pile driving, may cause perceptible ground-borne vibration. Where these activities occur very close to underground utilities, TCRR would coordinate with the utilities to identify where relocation and/or encasement of pipelines would be needed to avoid vibration damage from nearby construction.

Construction of the Project 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 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 1 year of operations ceasing. **Table 3.9-18** includes surface wells identified by Build Alternative.

Table 3.9-18: Surface Wells Within the LOD

	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F
Surface Well Count	37	37	22	37	37	22

Source: TCRR 2019

TCRR would communicate its intent to oil and gas owners, coordinate to identify opportunities to avoid conflicts and complete agreements before construction begins with concurrence from the Texas Railroad Commission. TCRR would follow federal and state[50] requirements for the abandonment of oil and gas wells prior to the construction of the Project. 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 3.13.5.2.5, Land Use, Structure Displacement and Land Acquisition**.

The LOD of the Project would impact current access roads to operating oil and gas wells. Therefore, TCRR would construct new access roads within the LOD as part of the Project 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 during construction or operation. This would not impact the operation of these oil and gas wells.

[50] 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.

Fuel and Energy Consumption

During the construction period, fuel would be consumed in order to produce and transport materials needed to construct the Project. Operating and maintaining construction equipment would also consume fuel. Per **Section 3.9.3.2**, **Methodology, Energy Consumption**, fuel consumption was calculated and is summarized in **Table 3.9-19**. 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 (Build Alternative E) is negligible at 1 percent. As discussed in **Section 3.2.3.2.1, Air Quality, Trainset Operation Emissions**, the energy consumption estimate during construction of the Project would be approximately 58,043 MMBtu.

Table 3.9-19: Construction Fuel Consumption Estimate

Facility	Total Working Hours	Total Fuel Used (gallons)	Total MMBtu of Energy Consumed
Rail Line	1,646,400	329,280	37,702.56
Dallas Terminal Station	118,800	23,760	2,720.52
Brazos Valley Intermediate Station	39,204	7,841	897.7716
Houston Terminal Station	118,800	23,760	2,720.52
Heavy Maintenance Facility	146,160	29,232	3,347.06
Light Maintenance Facility	146,160	29,232	3,347.06
MOW Facilities	319,125	63,825	7,307.96
Total Hours/Fuel Used	2,534,649	506,930	58,043.46
Total BTU of Energy	-	-	**58,043**

Source: AECOM 2019

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.
BTU – British Thermal Units

Since the Project would use electricity to power the trainsets, 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 in **Section 3.2.3.2, Air Quality, Operational Emissions Methodology**. **Table 3.9-20** provides the estimated fuel consumption savings**.**

Table 3.9-20: Annual Operation Energy Savings Estimate

Passenger Vehicle Travel Energy Saved							
Auto Trip	**One-Way Trip Distance (miles)**	**Total Cars/Year (000s)**	**VMT (million)**	**2016 CAFE Standard (miles per gallon)**	**Gallons of Gas Used in One-Way Trip**	**Total Fuel Saved (000s) [gallons]**	**Total Annual MMBTU of Energy Saved**
Dallas to Houston	239	5,340	1,276	34.1	7.0	37,427	4,285,420
HSR Operation Energy Consumption							
Total Annual Energy Consumed (MMBTU)							1,554,571
Net Energy Saved (MMBTU) [Energy Saved – Energy Consumed]							**2,730,849**

Source: National Highway Traffic Safety Administration 2009; AECOM 2018

Notes: BTU – British Thermal Units

The fuel consumption savings estimated for the Project by reducing passenger vehicle travel would be approximately 37.4 million gallons of gasoline, or 4,285,420 MMBtu, annually. These data do not include passengers traveling by air. By comparison, the annual operation of the HSR would consume approximately 1,554,571 MMBtu, resulting in a net savings in energy of 2,730,849 MMBtu. Because the Project would save more energy annually (2,730,849 MMBtu) than it would take to construct the HSR system (58,043 MMBtu 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, approximately 48 percent of the LOD, on average, would be located adjacent to existing road, rail or utility infrastructure. Adjacency to existing utility infrastructure may offer the potential for direct connections to the electric grid where transmission service voltage is compatible, which would minimize impacts resulting from new transmission line connections in those instances. Extension of transmission service greater than 1 mile in length is subject to Texas Public Utility Commission Substantive Rule 25.101 for siting and certification of new transmission lines, which will be considered by TCRR and electric utility providers when determining transmission points of service. 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 55 percent of the Project would be on viaduct. Pier locations would be adjusted to avoid direct impacts to utilities.

TCRR has incorporated a Low Impact Development (LID) design approach for the HSR system, as shown in **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports (Section 3.14)**. The Project design LID approach would incorporate sustainable and low-impact approaches into the design of station buildings. The stations would be designed to directly and indirectly reduce the need for electricity and potable water by:

- Reducing energy demand through use of elements such as motion sensitive lights in maintenance areas
- Increasing energy efficiency using energy efficient lighting and appliances
- Monitoring energy use
- Using renewable energy sources such as solar panels
- Painting the roofs and creating green spaces to reduce heat gain and retention and to save energy
- Reusing water in innovative ways such as using reclaimed wastewater, condensation or rainwater for irrigation or toilet flushing
- Installing efficient water fixtures and appliances in the station
- Planting native vegetation with less need for irrigation

3.9.6.1 Compliance Measures

TCRR would be required to comply with the following Compliance Measures (CM):

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 Dallas 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: Coordination with Prairielands Groundwater Conservation District for the Bardwell MOW Water Demand. TCRR or its contractor shall evaluate options to accommodate the daily water demand (3,811 gallons per day) of the Bardwell MOW facility. One option could include drilling local water wells in Ellis County, which would require coordination with the Prairielands Groundwater Conservation District. New utilities shall be installed in full accordance with applicable state, local and federal regulations.

EU-CM#3: Coordination with Anderson Water Company and Wickson Creek SUD for the Brazos Valley Intermediate Station Water Demand. Prior to construction, TCRR shall evaluate options to provide the estimated 28.9 annual acre/feet of water demand at the Brazos Valley Intermediate Station. Should TCRR acquire water from Anderson Water Company, TCRR shall coordinate with Anderson Water Company to complete a development review and determine infrastructure needs and any required permits/approvals. TCRR may also decide to partner with Wickson Creek SUD, which has capacity. New utilities shall be installed in full accordance with applicable state, local and federal regulations.

EU-CM#4: Coordination with the City of College Station for the Brazos Valley Intermediate 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. Should TCRR decide to connect to the Carter's Creek WWTP (approximately 20 miles east of the station), TCRR shall obtain any necessary permits or approvals from the City of College Station. Should TCRR decide to develop a large capacity on-site sewage system, TCRR shall obtain any necessary permits or approvals from the TCEQ for a Class V injection well. New utilities shall be installed in full accordance with applicable state, local and federal regulations.

EU-CM#5: TCEQ Permits. Contingent upon **EU-CM#4: Coordination with the City of College Station for the Brazos Valley Intermediate Station Wastewater Demand**, during final design, TCRR shall coordinate with TCEQ, as applicable, for state permits pertaining to the development of Class V injection wells at the Brazos Valley Intermediate 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 Houston TMF.

EU-CM#7: Abandonment and Relocation of Oil and Gas Wells. Prior to construction, TCRR shall identify and coordinate oil and gas well abandonments and relocations required for the Project with the well operator/owner and Railroad Commission of Texas, in accordance with Statewide Rule 14, Plugging, Revised and Statewide Rule 13.

See also **WQ-CM#2: TPDES General Construction Permit (TXR150000) and Multi-Sector General Permit (TXR050000),** and **WQ-CM#3: Stormwater Management/Stormwater Pollution Prevention Plan,** discussed in **Section 3.3.6.1, Water Quality, Compliance Measures**.

3.9.6.2 Mitigation Measures

TCRR would be required to implement the following Mitigation Measures (MM):

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 Final EIS, the Project collectively would impact more than 400 major utilities, which are owned by 35 different providers. Where utilities must be relocated, TCRR will coordinate with the utility providers to combine multiple relocations of the same type, where possible, and comply with other regulatory requirements applicable to utility relocations, including landowner consents, where applicable. Utility relocations will be completed at TCRR's expense. Because of utility relocations, construction of the Project 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. Relocation of electric transmission lines will be in accordance with the Texas Public Utility Commission Substantive Rule 25.101, as applicable to electric utilities.

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, etc.). As of the publication of the Final EIS, the Project collectively would impact more than 400 major utilities, which are owned by 35 different providers. Where utilities must be protected or encased, TCRR will coordinate with the utility providers to protect or encase utilities in place rather than relocate, as often as practicable. Protection and encasement of utilities will be completed at TCRR's expense. Protective actions include activities during construction (e.g., shoring) and/or operations (e.g., encasement). Due to utility protection and encasement, construction of the Project 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 and comply with other regulatory requirements applicable to utility interruptions, such as electric transmission line outage clearances.

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 Energy to provide connections to the electric grid. The modifications required to make these connections include relocating existing lines at TCRR's expense, connecting new lines and vertically adjusting existing structures. The location of these modifications would be determined by the utility provider and would be subject to other applicable regulatory requirements, which may include landowner consent where applicable. The utility provider may choose to include these modifications into existing plans to support the operation of their system. Water and wastewater lines or other non-electric utilities required by TCRR shall not interfere with the electric utility lines and structure foundations within the designated electric utility easements and ROWs as determined by the electric utility.

EU-MM#6: Discovery of Unidentified Utility. During construction, TCRR shall cease construction in the area should a utility line be discovered that was not previously identified and conflicts with construction activities. TCRR shall coordinate with the utility owner regarding utility protection or relocation, as needed.

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 as discussed in **Appendix F: TCRR Final Conceptual Engineering Design and Constructability Reports (Section 3.14.2.4)**.

EU-MM#8: Vegetation to Minimize Water Use and Avoid Interference with Electric Utility Lines. During final design, TCRR shall develop a landscape plan as referenced in **AS-MM#5: Landscaping Plan.** The plan shall specify drought resistant or native vegetation that would minimize the use of water. TCRR shall not plant trees or vegetation that at maturity will exceed 10 feet in height and interfere with the operation and maintenance of electric utility lines.

3.9.7 Build Alternatives Comparison

The summary of utilities and energy impacts is shown in **Table 3.9-21**. All 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 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 among Build Alternatives A through F, or the Houston Terminal Station options, for water use and wastewater generation. Additionally, there would be no discernable difference among Build Alternatives A through F, or the Houston Terminal Station options, for the energy required to operate the HSR system, as well as the anticipated energy saved as a result of the Project.

Table 3.9-21: Comparison of Utility Impacts by Build Alternative

	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F
New Electric TPSS Connections	13	12	13	13	12	13
Electric Utility Pole Adjustments	85	85	74	89	89	78
Total Electric Connections and Adjustment	98	97	87	102	101	91
Abandoned Oil and Gas Wells	37	37	22	37	37	22

Source: AECOM 2019

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3.10 Aesthetics and Scenic Resources[1]

3.10.1 Introduction

> **Viewer:** Neighbors and travelers with views of the Project or from the Project.
>
> **Neighbor**: Viewers who occupy or will occupy the land adjacent or visible to the proposed project.
>
> **Traveler**: Viewers who use the existing roadway system (urban and rural highway travelers) and transit system (transit travelers) in the vicinity of the project or would use the proposed transportation project.

This section describes how the Project is expected to change the visual character of aesthetic and scenic resources within the Study Area and how those changes are expected to be perceived by viewers. For the purposes of this analysis, the terms aesthetic and scenic resources are interchangeable with visual resources. Two categories of **viewers** are considered in the impact analysis; **neighbors** and **travelers**.

Visual impacts, or changes to visual quality coupled with the response from viewers of those changes, associated with the Project are described in this section. The applicable laws and regulations are explained first, followed by a discussion of the methods used to assess the existing visual quality, define the viewers affected, determine the anticipated visual changes, and evaluate the overall visual impacts, as well as recommended mitigation for visual impacts.

3.10.2 Regulatory Context

Federal

NEPA identifies aesthetics as one of the factors in the human environment that must be considered in determining the effects of a project. FRA's *Procedures for Considering Environmental Impacts* state that an EIS should identify any significant changes likely to occur in the natural landscape and in the developed environment.[2] As FRA does not provide specific guidance on assessing visual impacts, this document uses FHWA's *Guidelines for the Visual Impact Assessment of Highway Projects*[3] for conducting analyses related to visual and aesthetic conditions and impacts of the Project. Federal regulations require that visual impacts be addressed for compliance with Section 106 of the Historic Preservation Act and with Section 4(f) of the Department of Transportation Act for the protection of publicly owned parks, recreational areas, wildlife and waterfowl refuges, or public and private historical sites. Visual impacts should also be considered in the evaluation of other topic areas.

State

While a number of state regulations and policies establish TxDOT responsibilities in the area of landscape and aesthetics design, no state regulations would apply specifically to an intercity HSR system.

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[1] This section has been reorganized and expanded since the publication of the Draft EIS. Therefore, text changes since the Draft EIS are not shaded in grey in **Section 3.10, Aesthetics and Scenic Resources**.

[2] FRA, *Procedures for Considering Environmental Impacts*, 64 Federal Register 28545, May 26, 1999, as updated in 78 Federal Register 2713 (January 14, 2013).

[3] FHWA, *Guidelines for the Visual Impact Assessment of Highway Projects*, 2015, accessed February 2020, https://www.environment.fhwa.dot.gov/guidebook/documents/VIA_Guidelines_for_Highway_Projects.asp.

Local Framework

Table 3.10-1 summarizes the local plans and regulations that provide guidance for the visual character of the communities. While these plans do not specifically address HSR infrastructure, many of the provisions noted in the table could apply. Many of these plans and regulations are in place to control visual quality, such as signage and fence regulations. No plans or regulations related to visual and scenic resources were identified for Navarro, Limestone, Leon, Madison, Grimes and Waller Counties.

Table 3.10-1: Local Plans and Regulations

County	City/ Town	Plan/ Regulation	Policy	Guidance
Dallas	Dallas	Complete Streets Design Manual	Pedestrian Zone Design Elements	Suggests streetscape amenities, transit stop guidelines, signage/wayfinding and utilities guidelines
		ForwardDallas! Comprehensive Plan	Urban Design Element, 5.1.2	Seeks to define how the city's identity and values can be captured in the visual and physical qualities of its urban landscape
			Environmental Element 6.2	Preserve and increase tree canopy
			Development Code Amendments, 4	Use of appropriate scale and materials for barriers and facades
Dallas	Dallas	Zoning Code	Chapter 39 Railroads, Article III, Section 39-13	ROW fencing may not contain barbed wire within City of Dallas limits, and may not obstruct extending to or across the ROW.
			Article X Section 51a-10.100	Landscape and tree preservation regulations
			Chapter 51A	Outlines City of Dallas sign regulations
			Article VII, Section 51A-7.100	
	Hutchins	Zoning Ordinance	Article 3.11	Outlines sign regulations
			Article 3.13	Determines fence regulations, height requirements
	Lancaster	Comprehensive Plan (2002)	Chapter 10-2	Urban Design Challenges and Solutions - buffers, landscaping, signage, tree and open space preservation
		Zoning Ordinance	Section 14.1200	Determines sign standards
			Section 14.500	District development regulations and standards; outlines fence regulations
			Section 14.900	Promotes preservation and protection of trees
	Wilmer	Community Plan 2030	Chapters 1-5	Provides goals for community character, parks and open space conservation
		Sign Ordinance	Section 13-1	Outlines sign regulations
		Tree Ordinance	Section 10-0401	Outlines conservation and development requirements for trees
Ellis	Ferris	Zoning Ordinance	Section 154.080	Outlines sign regulations
	Ennis	Comprehensive Plan 2015	Chapters 4, 5, 6	Outlines goals, strategies, and community character for Ennis. Emphasizes rural and relaxing nature of recreation areas and proposes further studies.
		Planned Development Standards	Section 10-409	Landscaping for non-residential developments, permits, procedure, sight distance and visibility. Buffers and screening, signage
		Zoning Ordinance	Sec 10-400	Outlines regulations for Planned Developments including landscaping and buffering requirements

Table 3.10-1: Local Plans and Regulations				
County	**City/ Town**	**Plan/ Regulation**	**Policy**	**Guidance**
			Sec 10-49	Determines landscape and screening requirements
Freestone	Fairfield	Zoning Ordinance	Sec 3.11	Outlines sign regulations
Harris	Jersey Village	Comprehensive Plan 2015 (Draft)	Chapter 7	Defines elements of community character - wayfinding/signage, corridor and community landscaping
	Houston	Complete Streets Design Standards (Draft)	Pages 5-16,19-24	Recommendations for street design, signage, transit considerations, ADA crossings, planning process, and public engagement.
		Code of Ordinances	Chapter 26 Sec 26-471	Defines parking and loading regulations. Outlines site plan/permit requirements, and deed restriction compliance.
Harris	Houston	Code of Ordinances	Chapter 30	Determines noise and sound level regulations, and addresses how sound buffers could impact visual quality
			Chapter 33, Article V	Determines trees, shrubs and screening regulations, and also addresses regulations regarding landscaping plans for new building sites.
			Sec 33-101	Provides requirements for trees, shrubs and screening fences
			Sec 38	Railroads, Lighting requirements for crossing, noise and whistleblowing requirements; sound buffers could impact visual quality

Source: AECOM 2019; City of Dallas 2013; City of Dallas 2006; City of Dallas 2016; City of Hutchins 2016; City of Lancaster 2002; City of Lancaster 2015; City of Wilmer 2009; City of Wilmer 2016; City of Ferris 2016; City of Ennis 2016; City of Ennis 2016; City of Fairfield 2012; City of Jersey Village 2015; City of Houston, 2015; City of Houston 2016.

3.10.3 Methodology

This visual impact assessment generally follows the FHWA *Guidelines for the Visual Impact Assessment of Highway Projects* methodology as the FRA has not issued specific guidance on the visual quality and assessment methodology. The methodology for identifying and assessing visual impacts generally includes the following steps and is illustrated on **Figure 3.10-1.**

Determine the Affected Environment:

- **Data Collection:** Identify data resources to develop an inventory of visual and aesthetic resources within the Study Area.
- **Establish Viewshed:** Establish and describe the viewshed (Study Area)
- **Define Landscape Units and Key Viewpoints:** Define landscape units and key viewpoints (KVPs)
- **Document Visual Resources**: As there are no federal, state, or locally designated visual resources within the viewshed of the Project, highlight community and cultural resources that may have a visual quality component
- **Assess Existing Visual Quality:** Establish the existing visual quality based on vividness, natural harmony and cultural order

Determine Environmental Consequences:

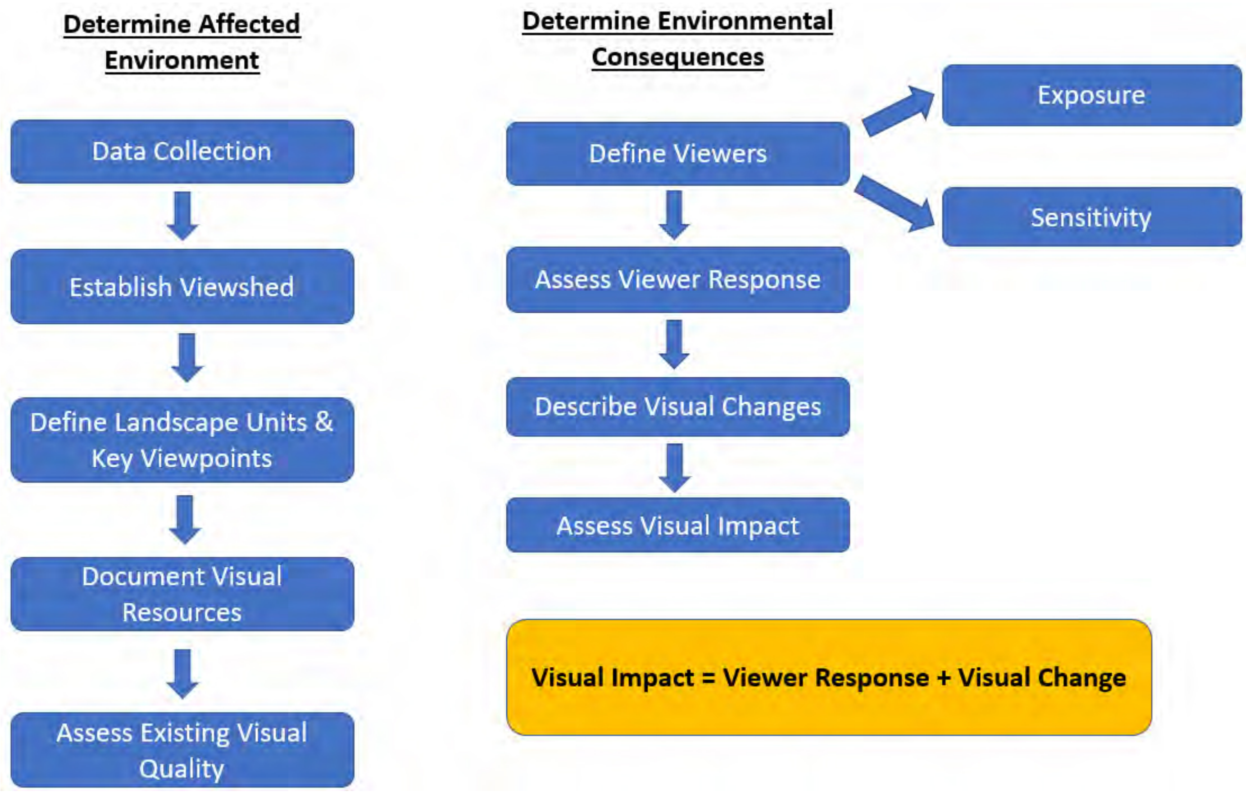
- **Define Viewers.** Identify viewers and define viewer exposure and sensitivity

- **Assess Viewer Response:** Assess the viewer response in areas where the Project would be visible
- **Describe Visual Changes:** Describe the visual changes that would likely occur as a result of the Project
- **Assess Visual Impact:** Determine the visual impact by assessing the visual changes and the viewer response

Develop mitigation measures:

- Develop mitigation measures for adverse impacts

Figure 3.10-1: Visual Assessment Methodology Flow Chart



Source: AECOM 2019

The following subsections describe the methods used for each of these steps.

3.10.3.1 Data Collection

The following data were used to identify and document visual and aesthetic resources within the Study Area:

- Project plans including conceptual drawings and elevated alignments in Appendix F, **TCRR Final Conceptual Engineering Design and Constructability Reports**, and **Appendix G, TCRR Final Conceptual Engineering Plans and Details.**
- Observations and photographs collected during field visits.
- Aerial photographs of the Study Area.

- Google Earth Street View and Bing Maps Bird's Eye View to supplement field visits,
- GIS data of cultural resources, cemeteries, community facilities, parks and trails.
- Digital Elevation Model (DEM) with a 5-mile buffer from the centerline. The DEM illustrates changes in elevation and considers the construction type.
- Desktop research to identify Texas Scenic and Historic Byways, scenic vistas, historical sites and other specific views along the Project.
- Documentation of potential visual resources within the Study Area based on topographic maps and findings documented within this Final EIS (**Section 3.6, Natural Ecological Systems and Protected Species**; **Section 3.7, Waters of the U.S.**; **Section 3.11, Transportation**; **Section 3.13, Land Use**; **Section 3.14, Socioeconomics and Community Facilities**; **Section 3.17, Recreational Facilities**; **Section 3.19, Cultural Resources**; and **Section 3.20, Soils and Geology**).
- Local plans and policies that encourage the protection of visual and aesthetic resources as discussed in Table 3-10.1.

3.10.3.2 Establish the Viewshed (Study Area)

Viewshed: the aggregate landscape visible from a particular location (e.g., an overlook) or a sequence of locations (e.g. a roadway or trail). This is the Study Area for visual impacts.

Landscape unit: subareas of the viewshed that have distinctive visual character based on their visual attributes. The landscape unit is used for assessing visual impacts.

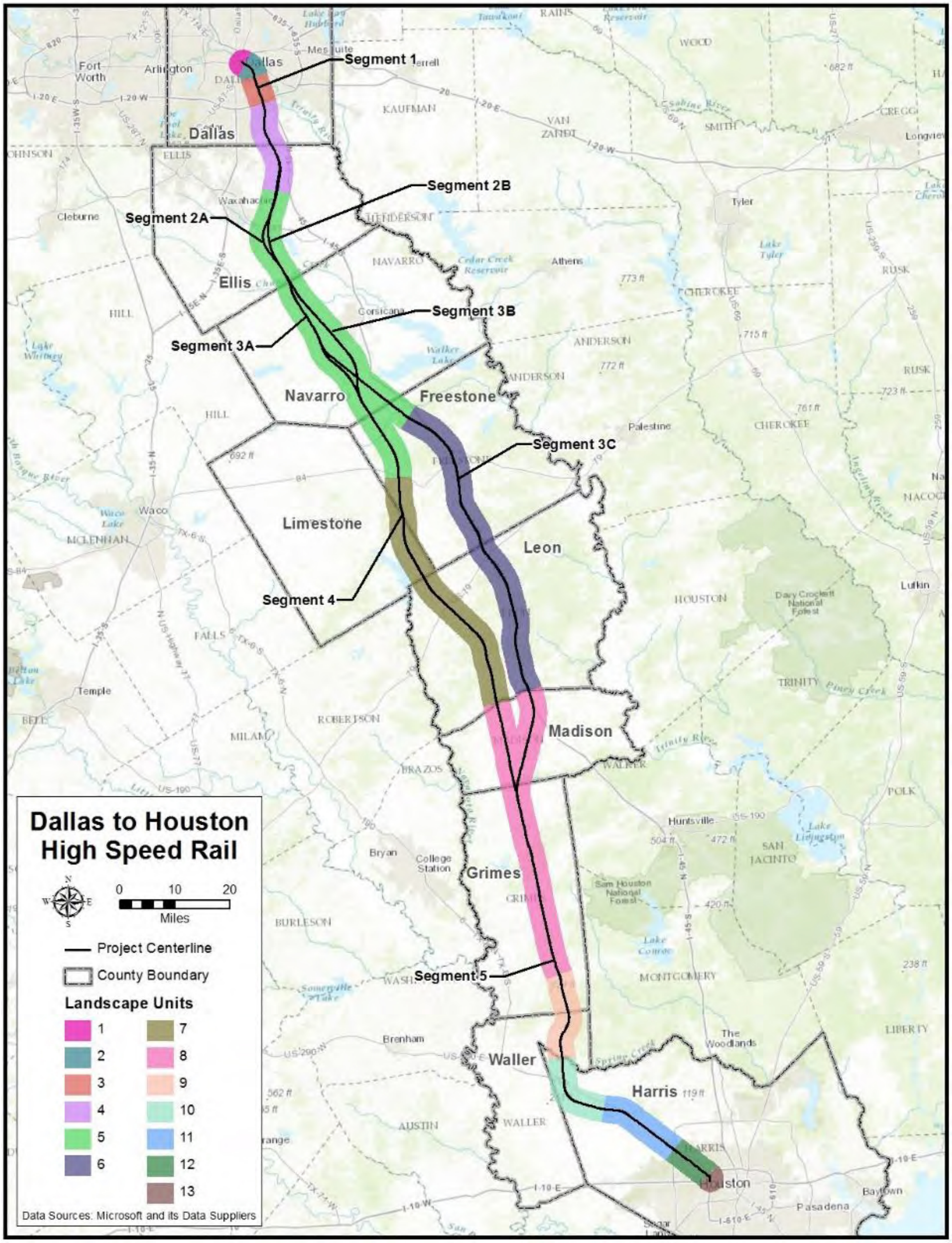
Key viewpoint (KVP): a location from which a viewer can see either iconic or representative landscapes.

The Project **viewshed (or Study Area)** generally includes the land on either side of the proposed alignment. The Project is generally located on flat terrain and primarily passes through rural agricultural and pasture lands, except for some forested areas. Viewshed distances vary along the corridor. The counties at the northern and southern ends of the Project (Dallas and Harris Counties) are urbanized with restricted views due to high density buildings and other tall structures. Due to the mix of suburban and rural character of parts of the adjacent counties (Ellis and Waller Counties), the viewshed can be a mix of restricted and unrestricted views. The flat terrain and presence of existing mature groups of trees can limit expansive viewsheds in both suburban and rural areas. The rural counties in between (Navarro, Freestone, Limestone, Leon, Madison, and Grimes) are mostly large parcels of land for agricultural and ranching activities. Viewsheds are typically larger but have variations in size along the Project. The size of the viewshed in these areas depends on the changes in terrain elevation, existing understory vegetation and trees and function of adjacent properties. Seasonal variation in some crops' height may limit views. To account for this variance, the viewshed was defined as the LOD with a quarter-mile buffer around the alignment and stations in Dallas and Harris Counties and a half-mile buffer around the alignment and station for all other counties.

3.10.3.3 Define Landscape Units and Key Viewpoints

The viewshed was broken into 13 **landscape units** with similar visual characteristics. Given the size and diversity of the region, there are some landscape units with predominant characteristics that may contain small areas that differ from the overall character of the landscape unit. For example, the predominant characteristics of a unit may be that it is flat and rural with limited trees, but it may contain small areas of dense forest or ponds. Rural areas typically share similar visual characteristics across larger areas because parcels are larger and, therefore, result in larger landscape units than urban and suburban areas. The landscape units are shown on **Figure 3.10-2**.

Figure 3.10-2: Landscape Units



Source: AECOM 2019

Each landscape unit is made up of KVPs. KVPs are designated within each landscape unit to provide examples of the existing views within the landscape unit and to provide a location for evaluating visual changes resulting from the Project. KVPs do not reflect every view within the entire landscape unit. KVPs were selected for typical views and specific views. Typical KVPs offer a common viewpoint of the Project, such as from a highway, utility corridor, residential community or agricultural area. Specific KVPs come from local visual resources accessible by the public where the community may gather and share a common viewshed such as parks, trails, community facilities, historic districts and designated viewpoints, such as a viewing platform or locally marked viewing area. Photographs from each KVP were taken to represent the visual characteristics of the landscape unit, and are depicted in **Section 3.10.5.2, Build Alternative**.

3.10.3.4 Document Visual Resources

Visual resources: sites, objects or landscape features that contribute to the composition of the landscape unit or KVP.

Visual resources include sites, objects or landscape features that contribute to the composition of the landscape unit or KVP. The visual resources for this analysis include historical and cultural designated places, natural resources, community facilities (including schools, religious facilities, and community centers), and recreational facilities that are accessible by the public. Visual resources were also identified based on public input.

3.10.3.5 Assess Existing Visual Quality

Visual attributes: features that make up the viewshed.

Visual character: a description of the visual attributes of a scene or object. The description is an impartial narrative of the components of the landscape and is defined by the relationship between the natural and built environment.

Visual quality: describes the excellence of the visual character and the viewer's experience

After establishing the viewshed, landscape units, KVPs and visual resources, a visual quality assessment was performed on the existing environment. The **visual attributes** of the viewshed and landscape units can be described by the **visual character** and assigned a **visual quality**. Visual quality is subjective but is generally described in terms of three criteria:

- **Vividness:** The degree of memorable, dramatic or distinctive components of the landscape
- **Natural harmon**y: The visual coherence and compositional harmony of the landscape considered
- **Cultural order:** How viewers perceive the organization of the cultural visual environment, or the man-made built environment, labeling the built environment as orderly or disorderly

FRA applied three scores to each KVP–one for vividness, natural harmony and cultural order–according to the following scale:

- **Low (1)** refers to areas lacking value or having degraded visual resources with no aesthetically pleasing composition. An example would be a disjointed, abandoned industrial area adjacent to a heavily trafficked highway.
- **Moderately low (2)** refers to areas containing some visual resources but lacking a coherent and aesthetically pleasing composition. An example would be a poorly maintained commercial area adjacent to a new community center.
- **Moderate (3)** refers to areas primarily of visual resources combined in an aesthetically pleasing composition with low levels of disruptive visual detractors. An example would be a cohesive, well-maintained development. This could be urban, suburban or rural.

- **Moderately high (4)** refers to areas of visual resources combined in an aesthetically pleasing composition, expressing a sense of place and lacking prominent disruptive visual detractors. An example would be a planned development that includes open space and trails, or well-maintained agricultural lands with open vistas.
- **High (5)** refers to areas comprising visual resources free of disruptive visual detractors and with a strong sense of place. An example would be federally protected, undeveloped land with unique, scenic vistas.

FRA averaged the three scores (vividness, natural harmony and cultural order) to give an overall visual quality score for each KVP. The scores for all the KVPs in a landscape unit were then averaged to produce the overall visual quality score for each landscape unit. Averages result in non-whole numbers; therefore, FRA applied the following thresholds for overall scores:

- **Low**: Less than 1.5
- **Moderately low**: Greater than or equal to 1.5 and less than 2.5
- **Moderate**: Greater than or equal to 2.5 and less than 3.5
- **Moderately high**: Greater than or equal to 3.5 and less than 4.5
- **High**: Greater than or equal to 4.5

3.10.3.6 Define the Viewers and Assess the Viewer Response

Viewers and their preferences and sensitivity to changes in the viewshed need to be identified and understood in order to assess visual impacts of the Project. Viewers or viewer groups of each landscape unit were identified through field observations and public involvement.

As projects have a range of visual attributes and project elements, a typical rating is developed. The scale used to guide the evaluation of the exposure and sensitivity of viewers is provided in **Table 3.10-2**. The typical rating of exposure and sensitivity by viewer or viewer group is provided in **Table 3.10-3**.

The viewer **exposure** and **sensitivity** of the primary viewers or viewer groups within each landscape unit determine the **viewers' response** to the proposed changes. Careful consideration of any changes to the view is especially important where there are viewers with high exposure and high sensitivity.

Viewers: Neighbors and travelers with views of the Project or from the Project.

Exposure: A measure of the proximity (distance), extent (number of people viewing) and duration (length of viewing time) of a viewer to a visual attribute or resource.

Sensitivity: The viewers' variable receptivity to the visible environment, affected by their attention (level of observation based on routine and familiarity), focus (level of concentration) and protection (legal and social constraints on the use of visual resources).

Viewer Response: The combination of the viewer's exposure and sensitivity to proposed changes in the surrounding environment.

Table 3.10-2: Scale for Viewer Exposure and Sensitivity

Exposure	Sensitivity
High: Many viewers, consistent exposure for long periods of time, close proximity, unobstructed line of sight.	**High:** Occurs when a project is highly prominent, open to view, and the view is important to the values and goals of the viewer.
Moderate: Some viewers, regular exposure for a short period of time, moderate proximity to the view, some obstructions to the view.	**Moderate:** Viewers' activity may cause some distraction from the view or expectations are moderate.
Low: Few viewers, short duration, far from the view, obstructed view.	**Low:** Viewers' activity distracts them from the view. Views are not supported by the values and goals of the viewer.

Source: AECOM 2019

Table 3.10-3: Viewers, Exposure, and Sensitivity

Viewer Type	Exposure				Sensitivity		
	Proximity	Extent	Duration	Overall	Attention	Focus	Overall
Residential neighbors in urban areas	High	High	High	High	Moderate	Moderate	Moderate
Residential neighbors in rural areas	High	Moderate	High	High	High	High	High
Recreational neighbors in urban parks	High	Moderate	Low	Moderate	Moderate	Moderate	Moderate
Recreational neighbors in rural areas	High	Moderate	Low	Moderate	High	High	High
Institutional neighbors – office workers	High	High	Moderate	High	Low	Low	Low
Institutional neighbors – schools, community centers, churches	High	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Industrial/commercial neighbors	High	Moderate	Moderate	Moderate	Low	Low	Low
Agricultural neighbors	High	Moderate	Moderate	Moderate	Low	Low	Low
Travelers on urban highways	High	High	Moderate	High	Low	Low	Low
Travelers on rural routes	High	Moderate	Moderate	Moderate	Moderate	Low	Moderate
Transit travelers	High	Moderate	Low	Moderate	Low	Low	Low

Source: AECOM 2019

3.10.3.7 Describe the Visual Changes

Project changes may be perceived as detracting from or enhancing visual quality. There are two general ways the Project can change visual quality in each landscape unit: (1) remove or alter existing visual attributes and (2) alter the visual character in the viewshed by introducing new elements.

Visual Change: visual disruption based on the compatibility of the Project

The potential new visual elements that could result in a change in the visual quality were identified. These include temporary visual changes during construction, such as fencing, lighting, tree clearing, grading, stockpiling materials and construction equipment. Permanent visual changes would include structural components of the HSR system, such as the trainsets, track construction type, bridges, and retaining walls; the OCS; lighting; fencing; stations and other operational facilities. Visual simulations were used to depict the appearance of the Project and visual change at KVPs, and are depicted in **Section 3.10.5.2, Build Alternative**.

Visual changes summarized in tables in **Section 3.10.5, Environmental Consequences,** represent overall determinations for the KVP and landscape unit based on the factors above rather than a calculated result from the other columns in the tables: Visual Quality – Existing and Visual Quality – Build Alternatives. In addition, KVPs do not reflect every view in the entire landscape unit; therefore, an adverse or beneficial impact to a KVP does always not equate to the adverse or beneficial impact to the entire landscape unit.

3.10.3.8 Assess the Visual Impact

Visual Impact = Viewer Response + Visual Change

Visual impacts are the combination of changes to existing visual attributes associated with construction and operation of the Project and viewers' responses to those changes. Visual impacts are assessed for visual resources and KVPs and an overall visual impact is determined for each landscape unit. For each landscape unit, visual impacts are first assigned a degree of impact from low, moderate, or high. A summary of the different degrees of impact based on various potential visual changes is presented in **Table 3.10-4**.

Table 3.10-4: Potential Degree of Impact for New Visual Elements

High Impact	Moderate Impact	Low Impact
Definitions		
A substantial change would be made to the visual quality and existing character of the viewshed	Notable changes would take place and affect the visual quality and existing character of the viewshed	Few or very specific instances can be noted that would have an effect on the visual quality and character of the viewshed
Associated Elements and Changes		
Introduction of transit infrastructure	Expanding existing scale of transit infrastructure	Adjacent to similarly scaled transit infrastructure
Prominent new elevated structure(s)	Moderate new grade separation	At grade / below grade
Substantial displacement of structures	Moderate displacement of structures	Low displacement of structures
Substantial new parking areas	Moderate new parking areas	Few new parking areas
View disruption	Moderate view disruption	Low view disruption
Removal of existing screens to residential uses	Partial removal of existing screens to residential uses	Limited removal of existing screens to residential uses
Substantial visual change to public parks or open space	Moderate visual change to public parks and open space	Limited visual change to public parks and open space
Blocks scenic features	Disrupts scenic features	Minimal disruption of scenic features
Substantial changes to streetscape	Moderate change to streetscape	Limited change to streetscape
Substantial removal of vegetation	Moderate removal of vegetation	Limited removal of vegetation
Substantial changes to National Register of Historic Places (NRHP) historic districts	Moderate changes to NRHP historic districts	Limited changes to NRHP historic districts
Substantial new night lighting	Moderate new night lighting	Low new night lighting

Source: AECOM 2019

Project impacts can be beneficial, neutral or adverse. Beneficial impacts improve the experience for the viewer and may enhance visual resources or create improved views of those resources. Neutral impacts occur when the existing visual quality is not perceived to be enhanced or degraded. These impacts could result in a change to the existing visual quality; however, viewer responses are low to moderate, and the Project would be compatible with the existing environment. Therefore, neutral impacts occur in an environment where viewer responses are moderate or lower, which result in most viewers not perceiving visual enhancements or degradation. Impacts that adversely impact visual quality degrade the quality of the visual resources, obstruct sensitive views or change desired views. Mitigation measures have been developed for adverse impacts.

3.10.4 Affected Environment

This section presents a description of the various landscape units in the viewshed, including a summary of existing land uses, transportation network, community character, key cultural resources and natural environment. Thirteen landscape units were identified within the viewshed (**Figure 3.10-2**). This section also identifies the location of the KVPs within each landscape unit and provides an assessment of the existing visual quality of the landscape units and KVPs.

The visual resources for this analysis include historical and cultural designated places, natural resources, community facilities (including schools, religious facilities, and community centers) and recreational facilities. These visual resources are listed in tables within each landscape unit. To find more detail on these visual resources, refer to **Section 3.6, Natural Ecological Systems and Protected Species**; **Section 3.13, Land Use**; **Section 3.14, Socioeconomics and Community Facilities**; **Section 3.17, Recreational Facilities**; and **Section 3.19, Cultural Resources**. For some historic and cultural resources, only an address is provided in the Resource Name column of the visual resources tables. Generally, these are historic properties; however, more detail is provided in **Section 3.19.4.2, Cultural Resources by County**.

3.10.4.1 Landscape Unit #1 Downtown/Cedars/Riverfront District (Dallas County)

Landscape Unit #1 is within Segment 1 of the Project within the downtown Dallas area and Dallas County. The landscape unit is comprised of existing commercial and residential land uses south of downtown Dallas and intersects five downtown districts (Reunion/Union Station, Dallas Civic Center, South Side, Cedars, and Riverfront). The area is a moderately dense environment to the north of the proposed station area, with many large apartment complexes under construction or newly opened that would increase the density in this urban environment. South of the proposed station along the Trinity River the area is mostly undeveloped or low-density industrial land uses.

Three KVPs were selected for this landscape unit:

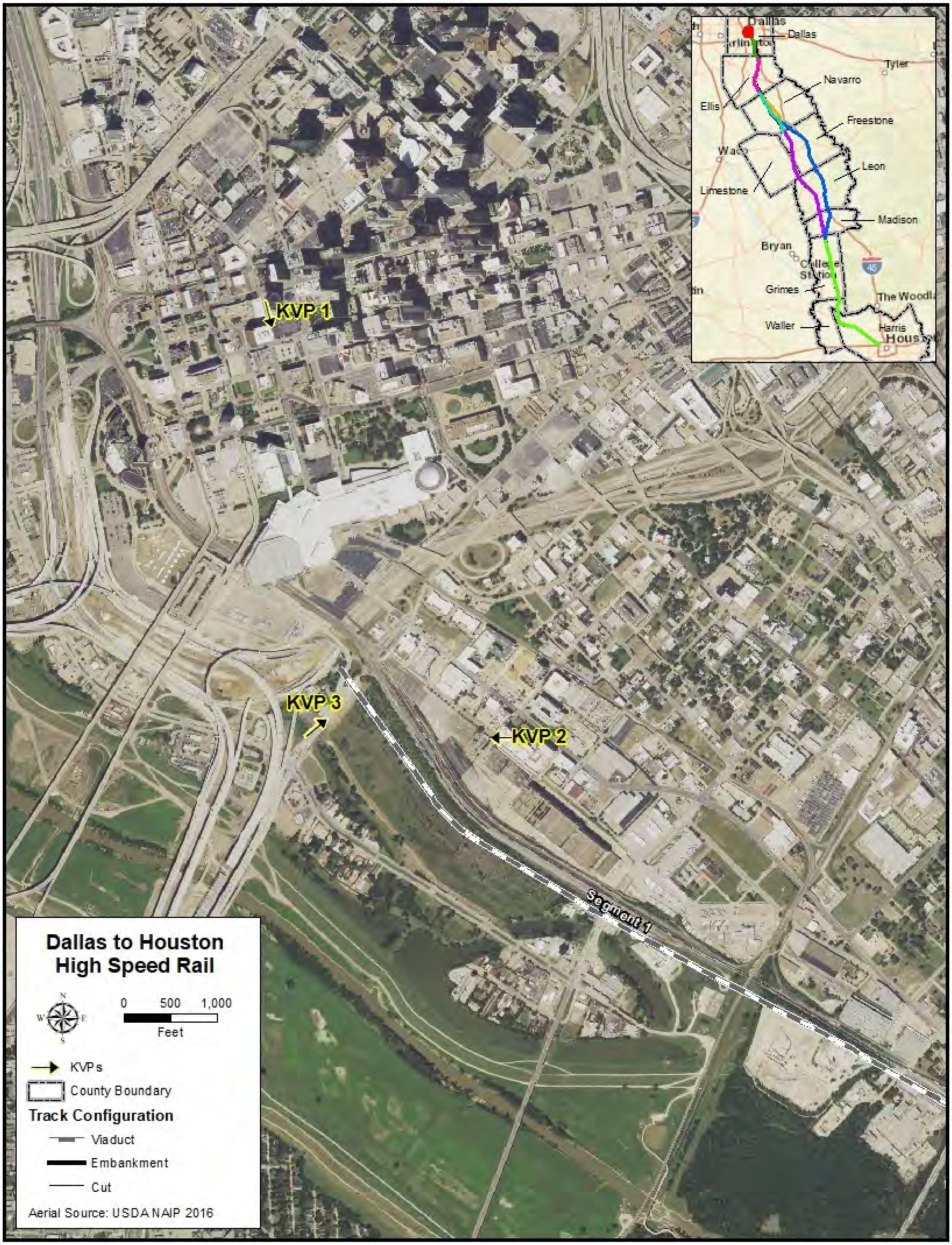
- KVP #1 is a typical view from a high-rise building in downtown Dallas.
- KVP #2 is a typical view from a mid-rise building adjacent to the proposed station area in the Cedars neighborhood.
- KVP #3 is a typical view from the sidewalk along Cadiz Street adjacent to the station area.

Landscape Unit #1 and the three KVPs are shown on **Figure 3.10-3**.

3.10.4.1.1 <u>Landscape Unit #1 Visual Quality</u>

At KVP #1, the downtown area is composed of tall and dense buildings and transportation infrastructure, which has a moderately high rating for vividness resulting from the unique downtown skyline and the view provided from an elevated perspective within multi-story buildings. This area has moderate natural harmony and cultural order, as the composition and organization of the urban core environment is generally aesthetically pleasing.

Figure 3.10-3: Landscape Unit #1 (KVP #1, #2 and #3)



Source: AECOM 2019

The Southside (KVP #2) area has an urban character with a mix of older buildings, vacant lots and new construction, as well as views of major transportation infrastructure (IH-30, UPRR and Dallas Area Rapid Transit [DART] light-rail) and adjacent industrial development. The Cedars/Riverfront District (KVP #3) borders the Trinity River and Trinity River Greenbelt, with mostly undeveloped areas/urban parks and a few older, low-density commercial and industrial buildings. Some areas at KVP #2 and #3 are not memorable or have degraded visual resources, which result in a moderately low vividness. The natural harmony of the area is moderate because some views are aesthetically pleasing, primarily provided by the Trinity River and the urban parks preserved in the area. The cultural order is moderate because these parts of the landscape unit are undeveloped or contain industrial infrastructure or businesses adjacent to a developing moderately dense downtown neighborhood, the Cedars; however, in general, these views have a pleasing composition.

The overall visual quality of each KVP and Landscape Unit #1 is moderate. **Table 3.10-5** summarizes the KVP and landscape unit ratings.

Table 3.10-5: Visual Quality Assessment – Landscape Unit #1

KVP	KVP Location	Vividness	Natural Harmony	Cultural Order	Visual Quality
1	Downtown Dallas	Moderately high (4)	Moderate (3)	Moderate (3)	**Moderate (3.3)**
2	Southside on Lamar	Moderately low (2)	Moderate (3)	Moderate (3)	**Moderate (2.7)**
3	Cadiz Street	Moderately low (2)	Moderate (3)	Moderate (3)	**Moderate (2.7)**
LU 1	**Landscape Unit #1**	**Moderate (3)**	**Moderate (3)**	**Moderate (3)**	**Moderate (3)**

Source: AECOM 2019

3.10.4.1.2 Visual Resources in Landscape Unit #1

Visual resources in the downtown district include several key buildings in downtown Dallas, such as the Dallas Morning News, Dallas County Courthouse, Reunion Park and Reunion Tower, and Kay Bailey Hutchinson Convention Center. Other resources include the Old City Park and the Trinity River and Greenbelt. Visual resources in the Southside and Cadiz Street areas include Cadiz Street overpass and underpass, the Cadiz Pump Station complex, and the Sears Complex Historic District, which includes Sears Dining Hall, Sears Distribution Center, and Dallas Coffin Company. There are also two eligible National Register of Historic Places (NRHP) single-family residential structures located on Powhattan Street, as well as Wayside Missionary Baptist Church.

Table 3.10-6 identifies the visual resources noted within landscape unit #1.

Table 3.10-6: Visual Resources – Landscape Unit #1

Segment	Resource Name	Resource Type	Special Designation	Distance from LOD (feet)	Mapbook Page #[a]
1	Downtown Dallas	Cultural	No	0	1
1	Kay Bailey Hutchinson Convention Center	Cultural	No	120	1
1	Reunion Park and Reunion Tower	Recreation/Cultural	No	1,620[b]	1
1	1214 Powhattan Street	Building	NRHP Eligible	336	1
1	1300 Powhattan Street	Building	NRHP Eligible	311	1
1	Cadiz Street Overpass and Underpass	Building	NRHP Eligible	0	1
1	Cadiz Pump Station	Complex	NRHP Eligible	135	1

Table 3.10-6: Visual Resources – Landscape Unit #1					
Segment	**Resource Name**	**Resource Type**	**Special Designation**	**Distance from LOD (feet)**	**Mapbook Page #[a]**
1	Cadiz Street Viaduct	Bridge	NRHP Eligible	0	1
1	Dallas Coffin Company	Building	NRHP Listed; Local Designation (Contributing resource to City of Dallas: Sears Complex Historic District)	186	1
1	Sears Dining Hall	Building	Local Designation (Contributing resource to City of Dallas: Sears Complex Historic District)	245	1
1	Sears Complex Historic District	Historic District	NRHP Eligible	22	1
1	Sears Roebuck and Company Catalog Merchandise Distribution Center	Building	Local Designation (Contributing resource to City of Dallas: Sears Complex Historic District)	351	1
1	Oak Cliff Box Company (1212 Riverfront Boulevard)	Building	NRHP Eligible	208	1
1	Trinity River	Natural Resource	No	0	1
1	Trinity River Greenbelt	Recreation/ Natural Resource	No, some preserve areas	0	1
1	The Dallas Floodway	Infrastructure/Recreat ional	No	0	1
1	Dallas Community College District	School	No	707	1
	Wayside Missionary Baptist Church	Religious Facility	No	1,235	1
1	Old City Park	Recreation / Cultural	NRHP Listed	1,044	1

Source: AECOM 2019

NRHP - National Register of Historic Places

[a] Refer to **Appendix D, Community and Cultural Resources Mapbook**

[b] This visual resource is outside of the ¼-mile viewshed for this resource area; however, it is included in this list due to the high significance of this building to offer unique views from an elevated platform. Views of the Dallas Terminal Station would be prominent.

3.10.4.2 Landscape Unit #2 Trinity River Crossing (Dallas County)

Landscape Unit #2 is within Segment 1 of the Project and is south of downtown Dallas within Dallas County, approximately from Corinth Street to the utility transmission line located just north of Overton Road. The area contains light to heavy industrial land uses, including a large municipal wastewater treatment plant, and park lands along the Trinity River.

Three KVPs were identified for this landscape unit:

- KVP #4 is a typical viewpoint that represents the residential and commercial area in the northern portion of the landscape unit east of the Project.
- KVP #5 is a specific view located in the vicinity of the Santa Fe Trestle Trail near the Trinity River.

- KVP #6 is a typical view located in the middle of the landscape unit, and the viewshed includes portions of IH-45 on structure in the vicinity of the Trinity River crossing.

Landscape Unit #2 and the three KVPs are shown on **Figure 3.10-4**.

3.10.4.2.1 Landscape Unit #2 Visual Quality

KVP #4 is located in a residential and commercial area east of the Project where there are single-family and multi-family residences mixed with commercial buildings and vacant parcels located near Martin Luther King, Jr. Boulevard and South Lamar Street. The area has numerous degraded buildings and lacks memorable and distinctive features, resulting in low vividness. The area generally lacks coherent composition and order, with moderately low natural order and cultural harmony. KVP #4 has an overall visual quality of moderately low.

KVP #5 is located along the Santa Fe Trestle Trail with a mix of views of adjacent transportation structures, including highway and rail bridges, overhead utility lines, and green space comprising the park. Views of the downtown Dallas skyline can be seen in the distance. Vividness is moderate with aesthetically pleasing views of downtown but some disruption in the form of the utility lines. The natural harmony and cultural order are moderate, lacking cohesion and order, but generally pleasing.

KVP #6 is the view from the IH-45 structure over the Trinity River. To the east, views include the River and Trinity Forest. To the west is a municipal water treatment facility, with views of the downtown skyline in the distance. The views here have moderately high vividness with distinctive views of the river and forest, as well as downtown skyline. The natural order and cultural harmony of the river and forest are high, but the municipal utility plant disrupts these elements, resulting in moderately low ratings.

The vividness rating in this landscape unit ranges from low in the areas with degraded buildings and infrastructure, to moderately high when views of downtown are unobstructed and include aesthetically please natural environments along the Trinity River. Natural harmony and cultural order range from moderately low to moderate. Some areas lack a coherent composition, such as the heavy industrial land uses along the Trinity River, while other areas may have dense natural forest. Therefore, the landscape unit has an overall moderate visual quality. **Table 3.10-7** summarizes the KVP and landscape unit ratings.

Table 3.10-7: Visual Quality Assessment – Landscape Unit #2

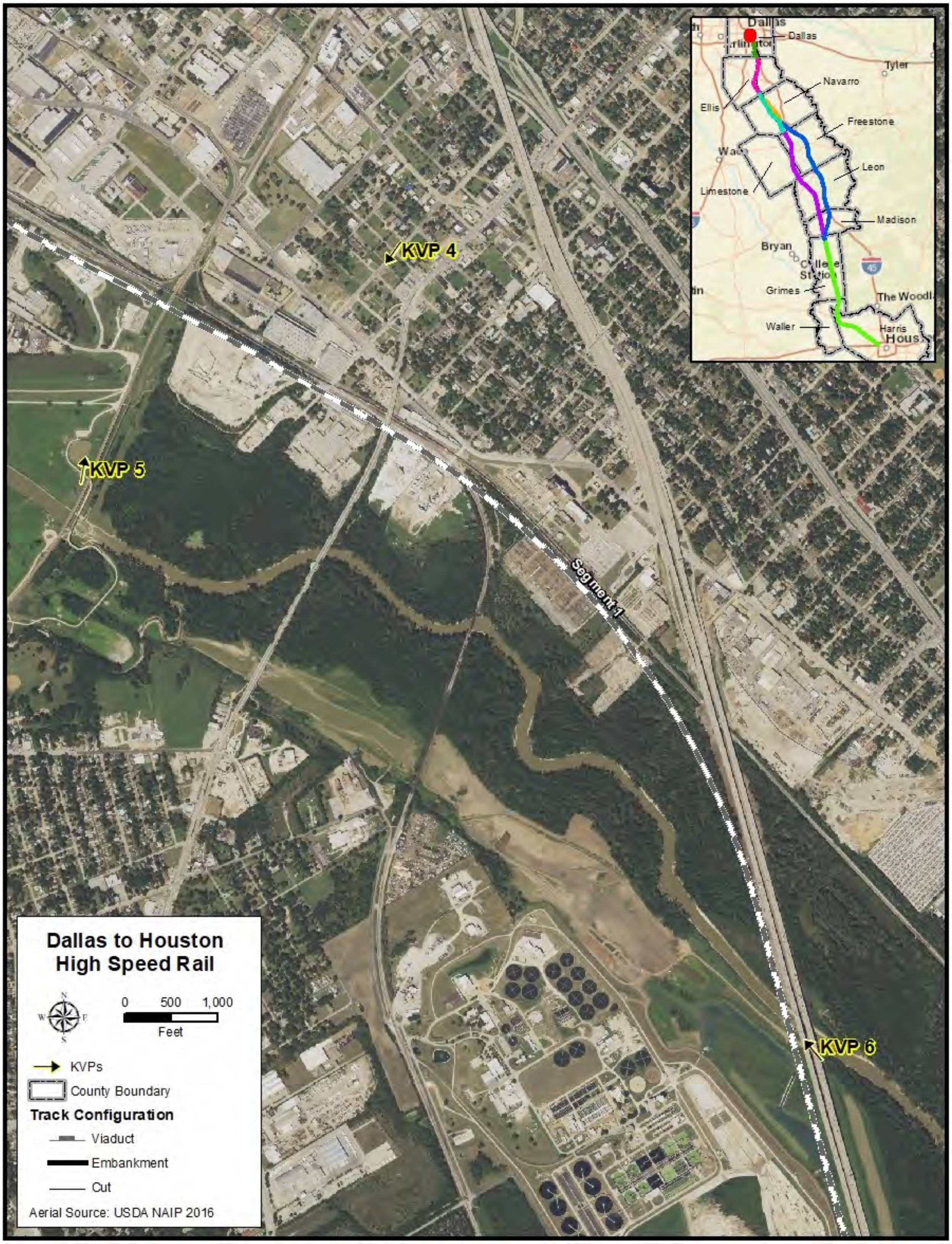
KVP	KVP Location	Vividness	Natural Harmony	Cultural Order	Visual Quality
4	Lamar St & MLK Blvd	Low (1)	Moderate (3)	Moderately low (2)	**Moderately low (2)**
5	Santa Fe Trestle Trail	Moderate (3)	Moderate (3)	Moderate (3)	**Moderate (3)**
6	IH-45/Trinity River	Moderately high (4)	Moderately low (2)	Moderately low (2)	**Moderate (2.7)**
LU 2	**Landscape Unit #2**	**Moderate (3)**	**Moderate (3)**	**Moderately low (2)**	**Moderate (2.7)**

Source: AECOM 2019

3.10.4.2.2 Visual Resources in Landscape Unit #2

Visual resources in Landscape Unit #2 include Guiberson Corporation Machine Shop and Residence, Forest Park, Martin Luther King Median, Damascus Missionary Baptist Church, the Proctor and Gamble Complex, Corinth Street underpass and overpass, Santa Fe Trestle Trail, Trinity River and Greenbelt and Trinity River Forest. The downtown Dallas skyline is also visible from several points in this landscape unit.

Figure 3.10-4: Landscape Unit #2 (KVP #4, #5 and #6)



Source: AECOM 2019

Table 3.10-8 identifies the visual resources noted within Landscape Unit #2.

Table 3.10-8: Visual Resources – Landscape Unit #2

Segment	Resource Name	Resource Type	Special Designation	Distance from LOD (feet)	Mapbook Page #[a]
1	Trinity River	Natural Resource	No	0	1, 2
1	Trinity River Forest	Recreation/Natural Resource	No, some preserve areas	0	2, 3
1	Corinth Street Underpass and Overpass	Bridge	NRHP Eligible	49	1, 2
1	Santa Fe Trestle Trail	Recreation	No	1,025[a]	1, 2
1	Forest Park	Recreation	No	948	2, 3
1	Martin Luther King Median	Recreation	No	955	1
1	Dallas Floodway Historic District	Historic District	NRHP Eligible	0	1
1	Guiberson Corp. Machine Shop	Buildings	NRHP Eligible	0	1, 2
1	Guiberson Corp. Residence	Buildings	NRHP Eligible	52	1, 2
1	Proctor and Gamble Complex	Buildings	NRHP Eligible	413	2
1	Damascus Missionary Baptist Church	Religious Facility	No	1,122	2

Source: AECOM 2019

NRHP - National Register of Historic Places

[a] Refer to **Appendix D, Community and Cultural Resources Mapbook.**

[b] This distance is from the KVP location. At its closet point Santa Fe Trestle Trail is approximately 750 feet from the LOD.

3.10.4.3 Landscape Unit #3 South Dallas Residential (Dallas County)

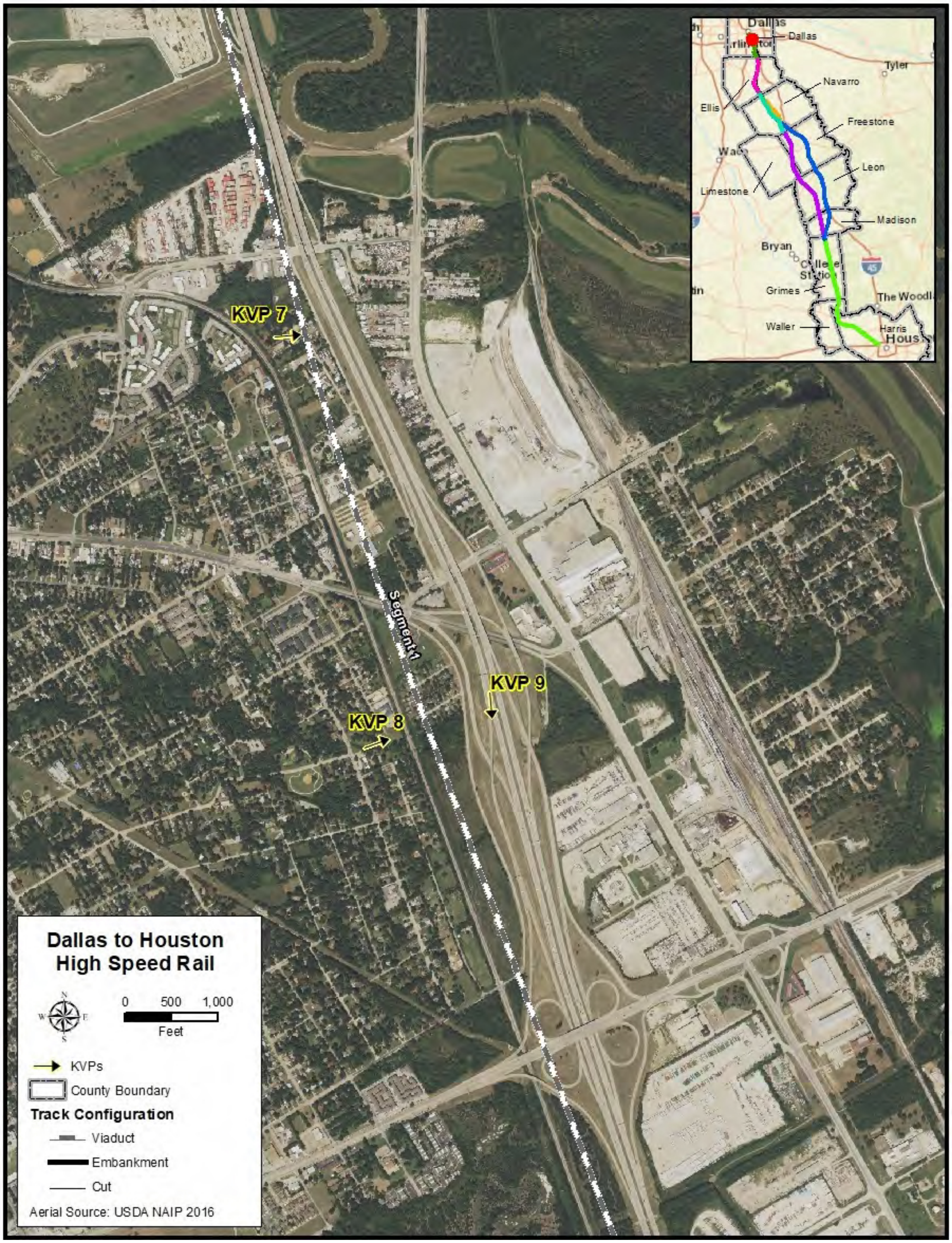
Landscape Unit #3 is located within Segment 1 of the Project and extends from approximately Overton Road to IH-20 in Dallas County. IH-45 is the predominate visual element within Landscape Unit #3. This landscape unit is composed of established, low-to-medium density residential neighborhoods with small forested areas and neighborhood parks along Five Mile Creek west of the Project. The neighborhood has several mature trees that disrupt residents' view towards the existing UPRR line and the overhead utility lines. The area east of the Project is mostly commercial and light to heavy industrial uses between IH-45 and the Trinity River. In addition, freight trains frequently travel through the area on the existing UPRR line.

Three KVPs were identified in this landscape unit:

- KVP #7 is a specific view from Honey Springs (Bulova Homecoming Cemetery), a special use park.
- KVP #8 is a specific view located at Fruitdale Park and Recreation Center.
- KVP #9 is a typical view shown from the traveler's perspective along IH-45 heading south and is composed of a variety of residential streets, arterials, and collectors distributing neighborhood traffic.

Landscape Unit #3 and the three KVPs are shown on **Figure 3.10-5**.

Figure 3.10-5: Landscape Unit #3 (KVP #7, #8 and #9)



Source: AECOM 2019

3.10.4.3.1 Landscape Unit #3 Visual Quality

Views from KVP #7 are dominated by IH-45 to the west and mixed residential and industrial uses to the east. The residential and industrial uses are somewhat degraded in appearance, with moderately low vividness. The natural harmony and cultural order are generally moderate, lacking coherent composition and order.

KVP #8 is located in a residential area west of IH-45 with single-family residential homes and heavy vegetation. The area is not particularly distinctive or memorable, with moderately low vividness. There is a moderate level of natural harmony and cultural order with the vegetation, consistent lot sizes and cohesive land use.

KVP #9 is a typical view from IH-45. The topography in this area is flat and the highway is wide, with numerous travel lanes along the mainline, as well as adjacent auxiliary lanes. Views from the highway include industrial development with residential areas screened from direct view by vegetated areas. The vividness is moderately low without memorable or distinctive features. The natural harmony and cultural order are moderate with composition and order typical of highway development.

The vividness rating in this landscape unit ranges from moderately low to moderate. Generally, residential areas are aesthetically pleasing; however, some industrial areas and degraded residential areas located near the Project lack a coherent composition or are not aesthetically pleasing. Natural harmony and cultural order are generally moderate. Neighborhoods and community areas are well maintained and have a moderate level of trees to provide a pleasing natural environment; however, there are some less aesthetically pleasing industrial land uses primarily near KVP #7 and the Project's alignment, and the areas located east of IH-45. The overall visual quality of Landscape Unit #3 is moderate. **Table 3.10-9** summarizes the KVP and landscape unit ratings.

Table 3.10-9: Visual Quality Assessment – Landscape Unit #3

KVP	KVP Location	Vividness	Natural Harmony	Cultural Order	Visual Quality
7	Bulova/Homecoming (Honey Springs Cemetery)	Moderately low (2)	Moderate (3)	Moderate (3)	**Moderate (2.7)**
8	Fruitdale Park	Moderately low (2)	Moderate (3)	Moderate (3)	**Moderate (2.7)**
9	IH-45	Moderately low (2)	Moderate (3)	Moderate (3)	**Moderate (2.7)**
LU 3	**Landscape Unit #3**	**Moderately low (2)**	**Moderate (3)**	**Moderate (3)**	**Moderate (2.7)**

Source: AECOM 2019

3.10.4.3.2 Visual Resources in Landscape Unit #3

Several neighborhood parks and community centers were noted as visual resources in Landscape Unit #3, including Fruitdale Park and Recreation Center, Seaton Park, JJ Lemon Park, and Turnkey Community Center. In addition, several places of worship are located in the landscape unit. **Table 3.10-10** lists visual resources in Landscape Unit #3.

Table 3.10-10: Visual Resources – Landscape Unit #3

Segment	Resource Name	Resource Type	Special Designation	Distance from LOD (feet)	Mapbook Page #[a]
1	Honey Springs (Bulova Homecoming Cemetery)	Cemetery/Special Use Park	No	3	3
1	Railroad Bridge at E. Illinois Ave.	Bridge	NRHP Eligible	47	4
1	Smith Family Cemetery	Cemetery	HTC	5	4

Table 3.10-10: Visual Resources – Landscape Unit #3					
Segment	**Resource Name**	**Resource Type**	**Special Designation**	**Distance from LOD (feet)**	**Mapbook Page #[a]**
1	Fruitdale Park/Recreation Center	Recreation	No	213	4
1	Seaton Park	Recreation	No	943	4
1	J.J. Lemon Park	Recreation	No	995	5
1	Paul Quinn College	Community Facility	No	1,526[b]	5
1	Wiley Chapel Baptist Church	Religious Facility	No	458	4
1	Rejoicing Tabernacle Church of God in Christ	Religious Facility	No	453	3
1	Church of Revelation	Religious Facility	No	163	4
1	Friendship Missionary Baptist Church	Religious Facility	No	641	4
1	Kingdom United Baptist Church	Religious Facility	No	1,605[b]	4
1	Galilee Missionary Baptist Church	Religious Facility	No	732	4
1	College Park Baptist Church	Religious Facility	No	576	6
1	Full Faith Deliverance Church	Religious Facility	No	405	6

Source: AECOM 2019

NRHP - National Register of Historic Places; HTC – Historic Texas Cemeteries

[a] Refer to **Appendix D, Community and Cultural Resources Mapbook.**

[b] This resource is outside of the ¼-mile study for this resource; however, it is included in this section because it is evaluated in **Section 3.14, Socioeconomics and Community Facilities**, and would have a limited view of the Project.

3.10.4.4 Landscape Unit #4 Suburban to Rural Transition, IH 20 to Palmer (Dallas and Ellis Counties)

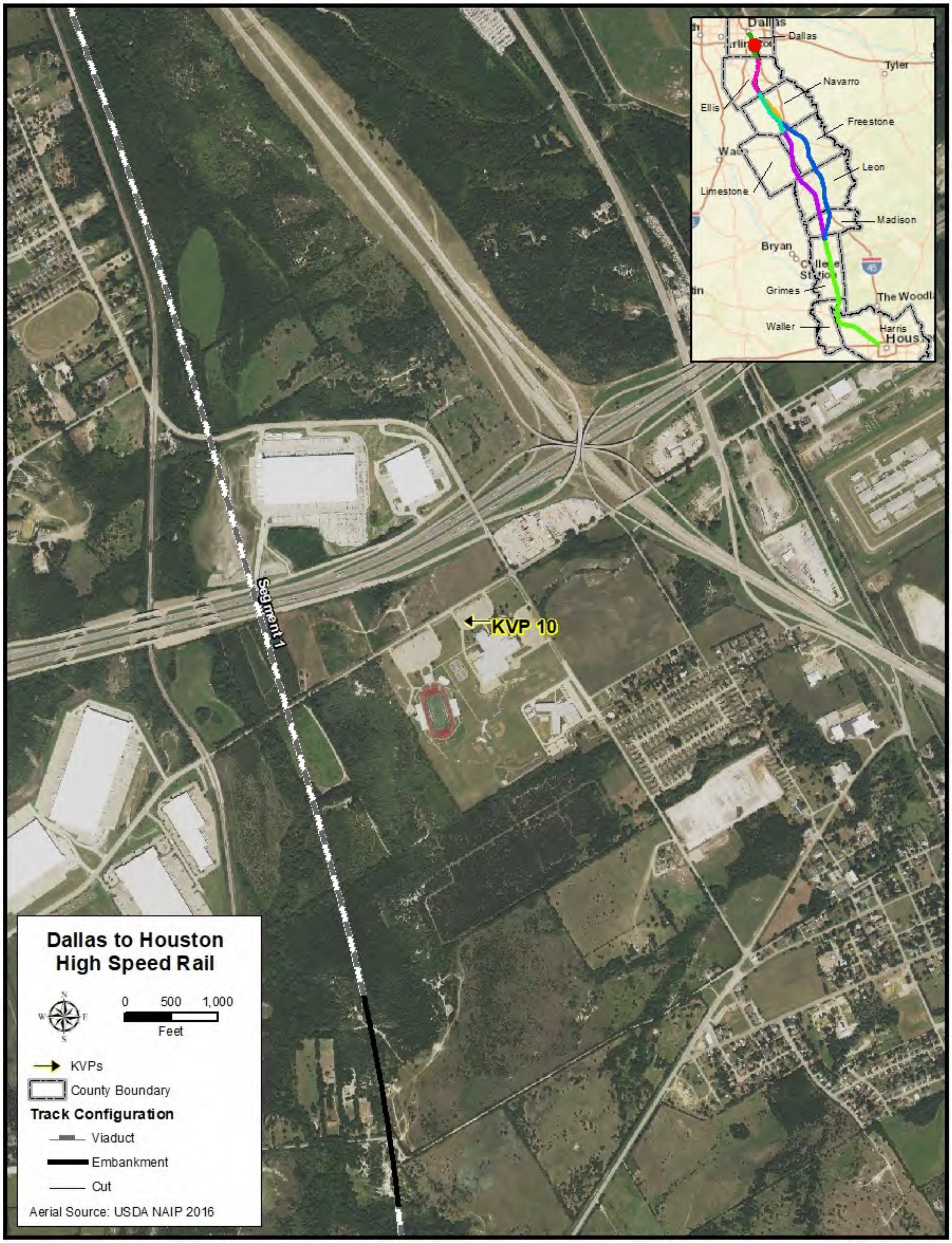
Landscape Unit #4 includes the southern end of Segment 1, as well as portions of Segments 2A and 2B, of the Project and extends from approximately IH-20 in Dallas County to FM 878 near the City of Palmer in Ellis County. This landscape unit transitions from an urban environment in Dallas County to a mix of suburban and rural settings within Ellis County. Land uses are a mix of agricultural, commercial and residential uses. The natural environment is mostly prairie with few trees, so views extend much farther than the previous urban landscape units. The few trees are usually located around creeks. There are several large open pastures clear of vegetation in this area.

Two KVPs were selected for this landscape unit:

- KVP #10 represents a specific view from Wilmer-Hutchins High School, located near the intersection of IH-45 and IH-20.
- KVP #11 is a typical view of the landscape unit, composed of large lots with scattered residential, which has mostly been cleared of trees as seen on Almand Road in the Town of Palmer.

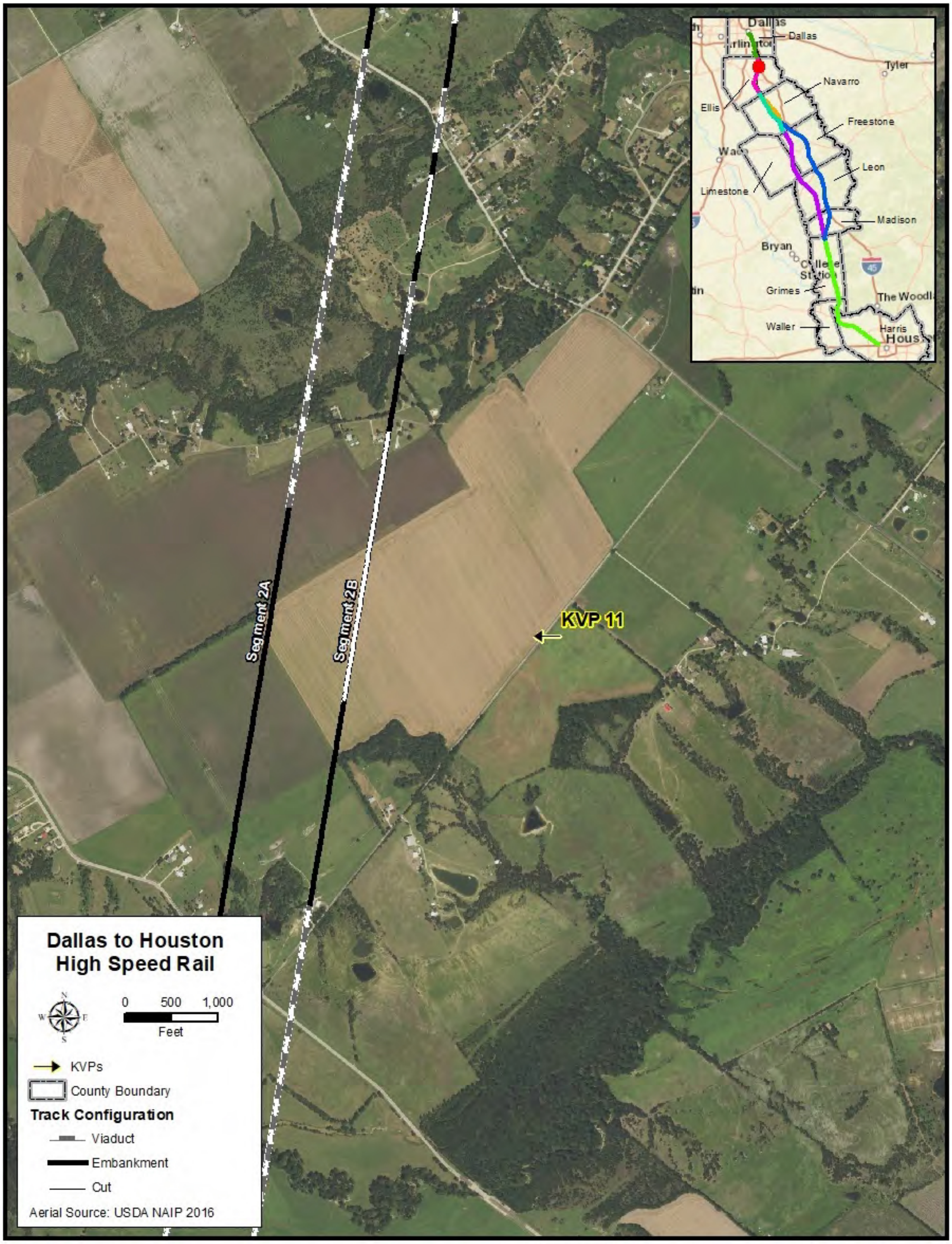
Landscape Units #4 and #5 are shown on **Figure 3.10-6** and **Figure 3.10-7**, respectively.

Figure 3.10-6: Landscape Unit #4 (KVP #10)



Source: AECOM, 2019

Figure 3.10-7: Landscape Unit #4 (KVP #11)



Source: AECOM, 2019

3.10.4.4.1 Landscape Unit #4 Visual Quality

KVP #10 is a specific view from Wilmer-Hutchins High School, located southwest of the IH-45 and IH-20 interchange. Two large interstates exist in the area, although the view of the infrastructure is disrupted by the natural landscape, including mature trees and vegetation combined with changes in elevation from rolling hills. Vividness is moderately low, as there are no distinct or memorable scenic features. There is some cohesion and order in the natural harmony and cultural order, but it is interrupted by the interstate facilities and large interchange. Natural harmony and cultural order are moderate. The overall visual quality is moderate at this KVP.

KVP #11 represents a typical view within this landscape unit in an area of large agricultural fields and scattered residential uses. Vividness is moderately low, as there are no memorable scenic views; however, there is a distinct order to the natural and cultural composition of the landscape because the area is primarily used for agriculture, resulting in moderately high natural harmony and cultural order.

The vividness in this landscape unit is generally moderately low, due to the lack of any unique or memorable views, and contains several large utility transmission corridors. There are some areas of aesthetically pleasing environments containing maintained farms and suburban neighborhoods. The overall visual quality in this landscape unit is moderate. **Table 3.10-11** summarizes the KVP and landscape unit ratings.

Table 3.10-11: Visual Quality Assessment – Landscape Unit #4

KVP	KVP Location	Vividness	Natural Harmony	Cultural Order	Visual Quality
10	Wilmer-Hutchins High School	Moderately low (2)	Moderate (3)	Moderate (3)	**Moderate (2.7)**
11	Almand Rd (Palmer)	Moderately low (2)	Moderately high (4)	Moderately high (4)	**Moderate (3.3)**
LU 4	**Landscape Unit #4**	**Moderately low (2)**	**Moderately high (4)**	**Moderately high (4)**	**Moderate (3.3)**

Source: AECOM 2019

3.10.4.4.2 Visual Resources in Landscape Unit #4

Table 3.10-12 identifies the visual resources noted within Landscape Unit #4.

Table 3.10-12: Visual Resources– Landscape Unit #4

Segment	Resource Name	Resource Type	Special Designation	Distance from LOD (feet)	Mapbook Page #[a]
1	Wilmer-Hutchins High School	School	No	2,018[2]	6
1	AIA Lancaster Elementary School	School	No	764	9
1	W. A. Strain House	Historic	NRHP Listed; SAL	2,722[b]	9, 10
2A & 2B	Geaslin	Cemetery	No Designation	0	15, 31
2A & 2B	Geaslin Homestead	Building	Local Designation (Palmer Preservation Society); ineligible for NRHP	0	15, 31

Source: AECOM, 2019

NRHP - National Register of Historic Places; SAL – State Antiquities Landmark

[a] Refer to **Appendix D, Community and Cultural Resources Mapbook**.

[b] These resources are outside of the ¼-mile study for this resource; however, they are included in this section because they are evaluated in **Section 3.14, Socioeconomics and Community Facilities**, and **Section 3.19, Cultural Resources**. Both resources and would have a view of the Project.

3.10.4.5 Landscape Unit #5 Northern Rural, Palmer to Fairfield/Teague (Ellis, Navarro and Freestone Counties)

Landscape Unit #5 occurs within Segments 2A, 2B, 3A, 3B, 3C and 4 of the Build Alternatives. This landscape unit is located in Ellis County, Navarro County, Freestone County, and Limestone County, approximately between FM 878 and SH-84 along Segments 3A and 3B, and between FM 878 and FM 80 along Segment 3C. The area is mostly rural with low densities and large lots. This landscape unit's ecosystem, Blackland Prairie, is a continuation from Landscape Unit #4 and runs through this area. Forests and dense vegetation are located around the various creeks throughout the area. The terrain is mostly flat but has some small gradual changes in elevation.

Three KVPs were identified in this landscape unit:

- KVP #12 represents typical views of the landscape unit in Segments 2A and 2B from a rural neighborhood located adjacent to the Project.
- KVP #13 is another typical view of a rural community.
- KVP #14 is a typical view from a farm where the land is cleared of crops for the winter.

3.10.4.5.1 Landscape Unit #5 Visual Quality

At KVP #12, large agricultural parcels dominate the landscape, with small pockets of residential homes located on large parcels scattered around the community (**Figure 3.10-8**). The natural environment is mostly prairie, with few trees that are usually located around creeks. A transmission line ROW is apparent for the majority of the viewshed.

There are slight differences in visual quality between the different segments in this landscape area. Segments 2A and 2B have generally the same viewshed as described in the previous paragraph with one exception, where Segment 2B enters Lake Bardwell property. The property includes a large lake and five parks. The portion of Lake Bardwell that would be crossed by Segment 2B is a limited use area with several multi-purpose trails. The area is mostly forested, allows seasonal hunting and is sporadically maintained by volunteers, which has resulted in overgrown and unkempt trails.[4] Segment 2A passes west of Lake Bardwell and maintains a viewshed common to the remainder of the landscape unit.

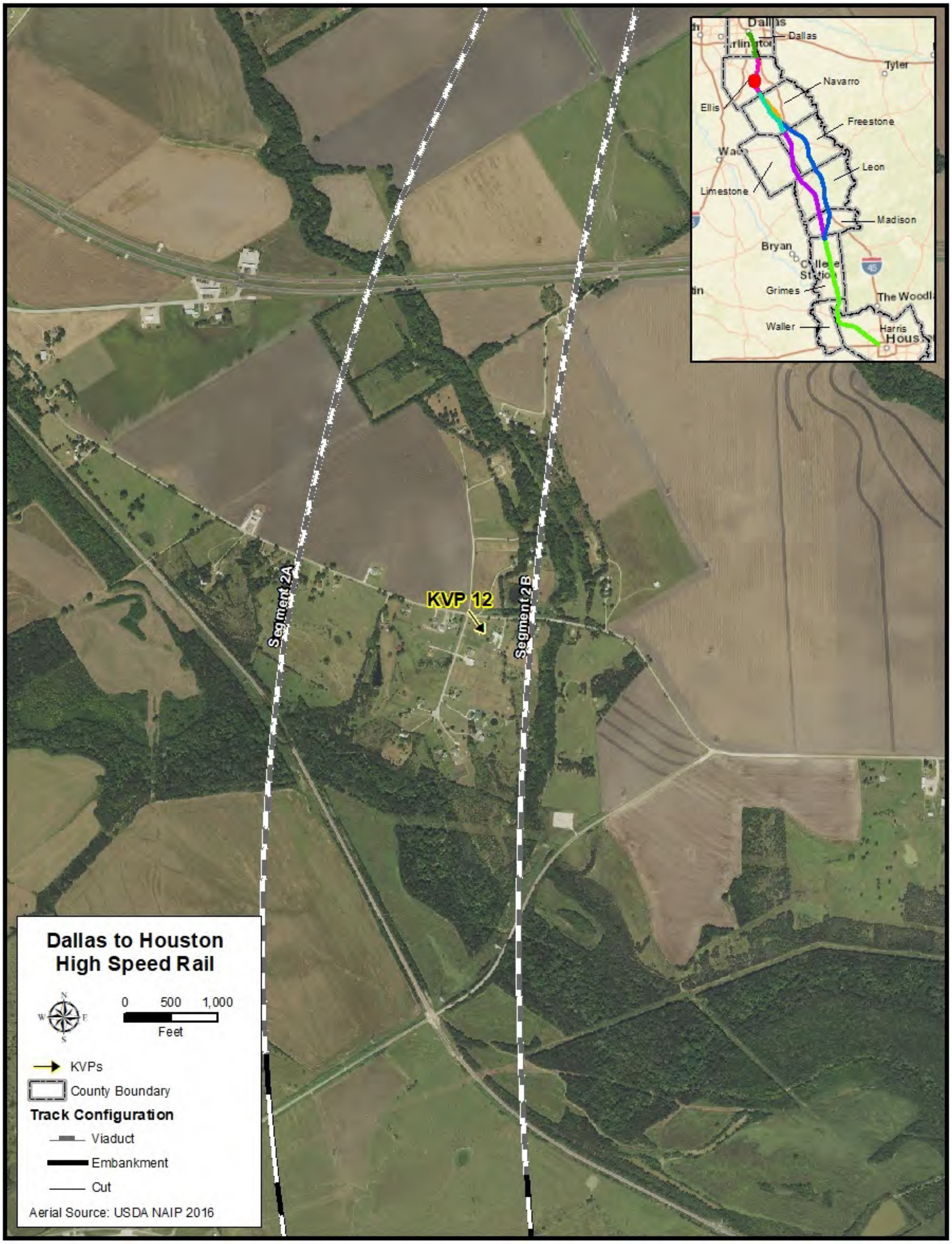
The vividness is moderately low as transmission lines cut wide corridors across the landscape. The Lake Bardwell property, forested areas and large agricultural properties have moderately high natural harmony, and the cultural order is moderate.

KVP #13 represents the common viewshed of Segments 3A, 3C and 4 (**Figure 3.10-9**). Although the segments follow different paths south of SH 31, their viewsheds remain similar and continue to follow an existing transmission line ROW through Navarro County and into the northern part of Freestone County. Segment 3C continues to follow a transmission corridor as it travels towards IH-45 into Freestone County and eventually merges with IH-45 north of Fairfield. The vividness is moderately low, with the utility corridors detracting from the views. Natural harmony and cultural order are moderate, consistent with the overall agricultural setting.

The viewshed for Segment 3B, represented by KVP #14 (**Figure 3.10-10**), is similar to Segments 3A and 3C, with primarily agricultural landscape. The vividness is moderate, as there is less disruption from utility corridors but still a lack of memorable or distinctive features. Natural harmony and cultural order are moderate, consistent with the overall agricultural setting.

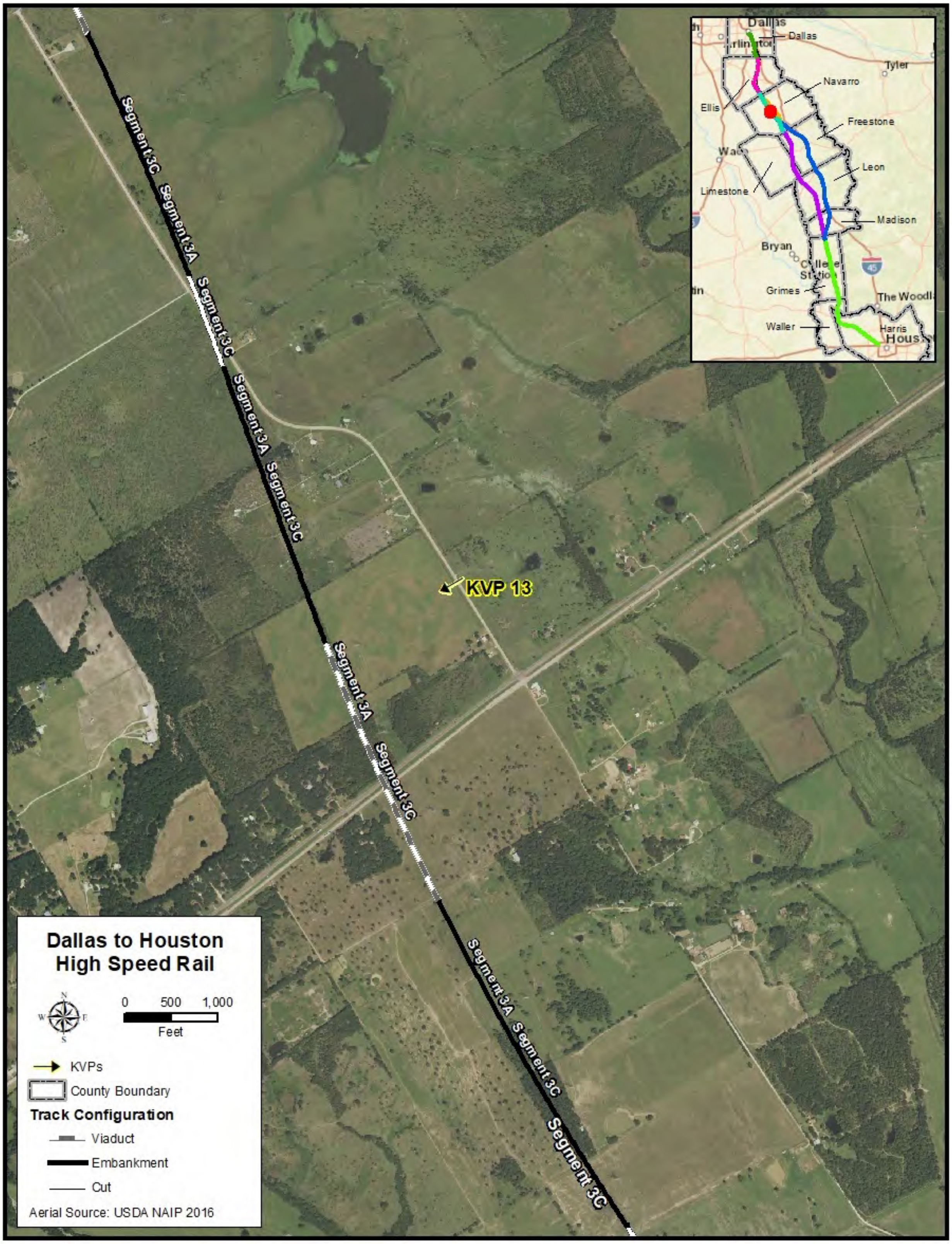
[4] USACE, "Bardwell Lake," accessed October 2019, http://www.swf-wc.usace.army.mil/bardwell/Recreation/Trails/Horse.asp.

Figure 3.10-8: Landscape Unit #5 (KVP #12)



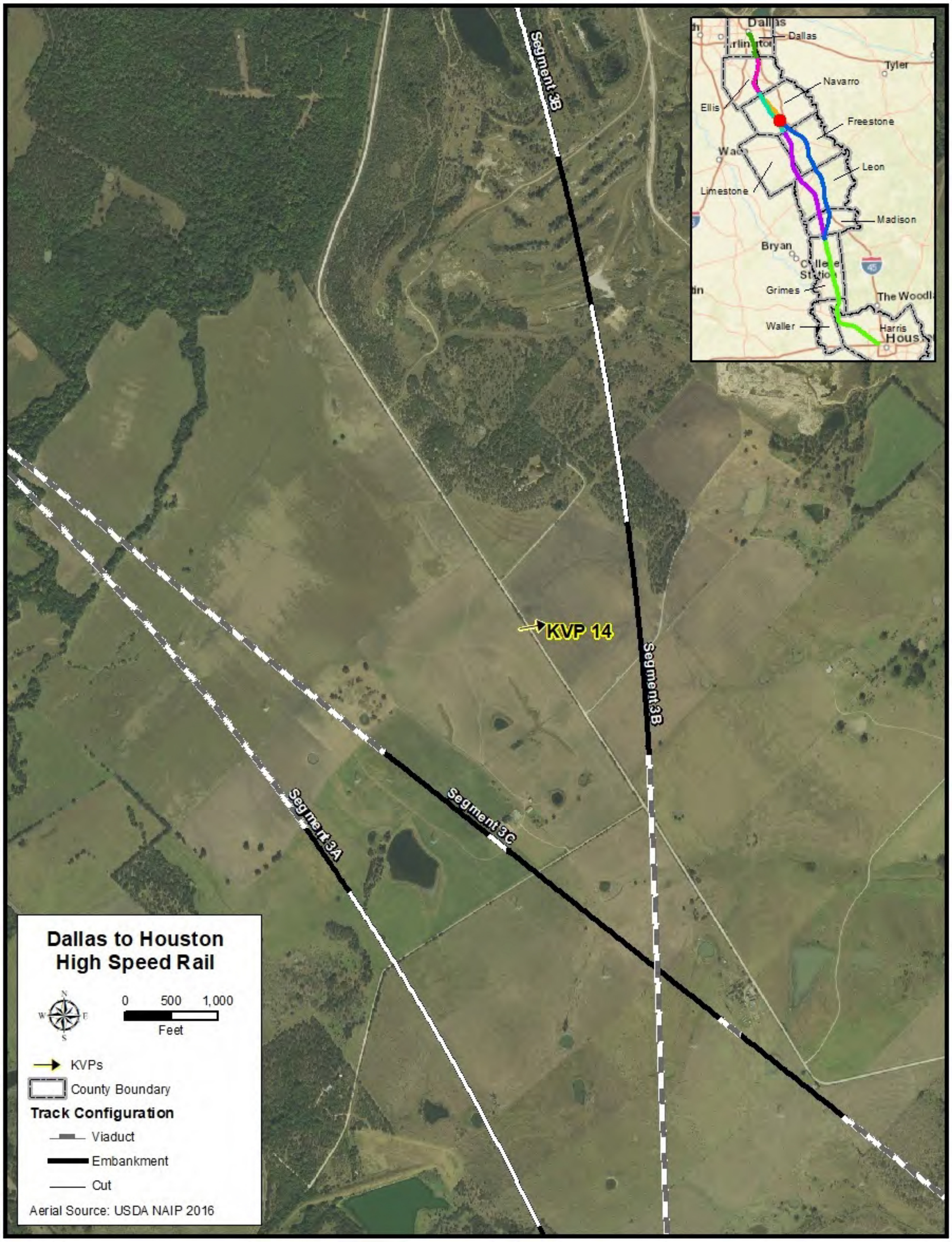
Source: AECOM 2019

Figure 3.10-9: Landscape Unit #5 (KVP #13)



Source: AECOM 2019

Figure 3.10-10: Landscape Unit #5 (KVP #14)



Source: AECOM 2019

The overall visual quality for this landscape unit is moderate, as shown in **Table 3.10-13**.

Table 3.10-13: Visual Quality Assessment – Landscape Unit #5					
KVP	**KVP Location**	**Vividness**	**Natural Harmony**	**Cultural Order**	**Visual Quality**
12	Old Waxahachie Road (Ennis)	Moderately low (2)	Moderately high (4)	Moderate (3)	**Moderate (3)**
13	TX 31 Segment 3A/3B	Moderately low (2)	Moderate (3)	Moderate (3)	**Moderate (2.7)**
14	Spikes Rd/Love Bridge Road	Moderate (3)	Moderate (3)	Moderate (3)	**Moderate (3)**
LU 5	**Landscape Unit #5**	**Moderately low (2)**	**Moderate (3)**	**Moderate (3)**	**Moderate (2.7)**

Source: AECOM 2019

3.10.4.5.2 Visual Resources in Landscape Unit #5

Table 3.10-14 identifies the visual resources noted within Landscape Unit #5. Visual resources in this area include the Boren Cemetery and Lake Bardwell Wildlife Management Area in Segments 2A and 2B and Anderson Family Cemetery, Shelton Family Cemetery, and Red Cemetery in Segments 3A and 3B**.**

Table 3.10-14: Visual Resources – Landscape Unit #5					
Segment	**Resource Name**	**Resource Type**	**Special Designation**	**Distance from LOD (feet)**	**Mapbook Page #[a]**
2A	Boren	Cemetery	HTC	301	22, 38
2B	Lake Bardwell Wildlife Management Area (WMA)	Recreation	USACE/WMA	0	22, 23
3A	Anderson Family	Cemetery	HTC	216	56, 75, 94
3B	Shelton Family	Cemetery	HTC	554	60, 79
3B	Red	Cemetery	No	336	154

Source: AECOM, 2019

NRHP - National Register of Historic Places; HTC – Historic Texas Cemeteries; USACE – United States Army Corps of Engineers; WMA – Wildlife Management Area

[a] Refer to **Appendix D, Community and Cultural Resources Mapbook**.

3.10.4.6 Landscape Unit #6 Central Eastern Rural, Fairfield to Old San Antonio Road (Freestone, Limestone and Leon Counties)

Landscape Unit #6 is within Freestone County and Leon County and follows the IH-45 corridor, along the west side of the interstate. The ecosystem within this landscape unit is Post Oak Savannah. This area contains more dense forests than Landscape Unit #5, but similar flat to gently rolling terrain. Pine trees, which can reach heights of 125 feet, become more prevalent in this landscape unit, especially near the southern end of the area. Oil and gas pump sites appear and are densely located in the northern half of the landscape unit.

Three KVPs were identified for this landscape unit:

- KVP #15 is a typical view along IH-45 in a southbound direction in Segment 3C.
- KVP #16 is a specific view from the parking lot of the Buffalo Public Library. Shelley Pate Memorial Park is located north of the library.
- KVP #17 is a specific view from the southbound rest stop along IH-45 adjacent to Fort Boggy State Park.

3.10.4.6.1 Landscape Unit #6 Visual Quality

KVP #15 is a typical view in Segment 3C along IH-45 (**Figure 3.10-11**). This corridor includes frontage roads and a wide clearing of land to accommodate multiple lanes of bi-directional traffic on an interstate. The two directions of traffic are generally only divided by a wide grassy median. The majority of the IH-45 corridor has a smaller viewshed than the previous landscape units, because trees and vegetation restrict sight distances. There are some sections of the interstate where only the southbound traffic is visible because of a forested median. The view lacks any memorable features; therefore, vividness is moderately low. Natural harmony and cultural order are moderate.

KVP #16 is a specific view along Segment 3C from a cluster of community resources located on the frontage road east of IH-45 near the town of Buffalo. The resources include Buffalo Public Library, Miracle Christian Center, and Shelley Pate Memorial Park near the Town of Buffalo (**Figure 3.10-12**). The view is dominated by IH-45 and the frontage road. Views across the highway are generally limited by trees. Vividness, natural harmony, and cultural order are moderate.

KVP #17 is a specific view along Segment 3C within Fort Boggy State Park. The park is located on both sides of IH-45 and is densely forested limiting views into and from within the park (**Figure 3.10-13**). The view lacks any memorable or distinct features; therefore, vividness is moderate. Natural harmony is moderately high due to views of the wooded park. Cultural order is moderate.

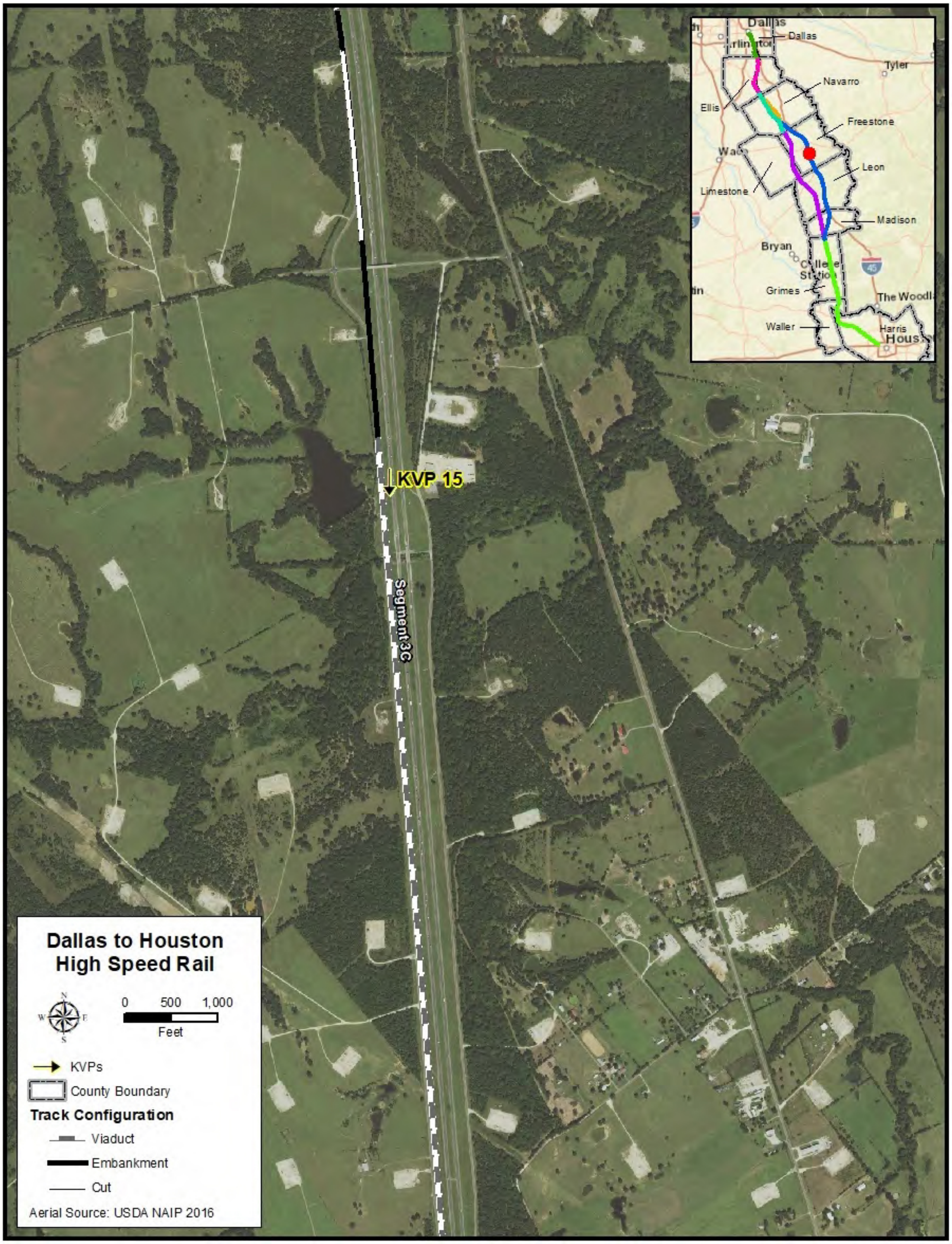
The vividness in this landscape unit ranges from moderately low to moderate. The natural harmony ranges from moderate to moderately high. Several areas of dense forest have not been disturbed and provide pleasing views, particularly at Fort Boggy State Park. The cultural order in the landscape unit is moderate because some areas in the northern part of the area contain oil and gas infrastructure, which may detract from views. Therefore, the visual quality in this landscape unit is generally moderate. **Table 3.10-15** summarizes the visual quality for the KVPs and landscape unit.

Table 3.10-15: Visual Quality Assessment – Landscape Unit #6

KVP	KVP Location	Vividness	Natural Harmony	Cultural Order	Visual Quality
15	IH-45 Southbound	Moderately low (2)	Moderate (3)	Moderate (3)	**Moderate (2.7)**
16	Buffalo Public Library	Moderate (3)	Moderate (3)	Moderate (3)	**Moderate (3)**
17	Fort Boggy State Park IH-45 Rest Stop	Moderate (3)	Moderately high (4)	Moderate (3)	**Moderate (3.3)**
LU 6	**Landscape Unit #6**	**Moderately low (2)**	**Moderate (3)**	**Moderate (3)**	**Moderate (2.7)**

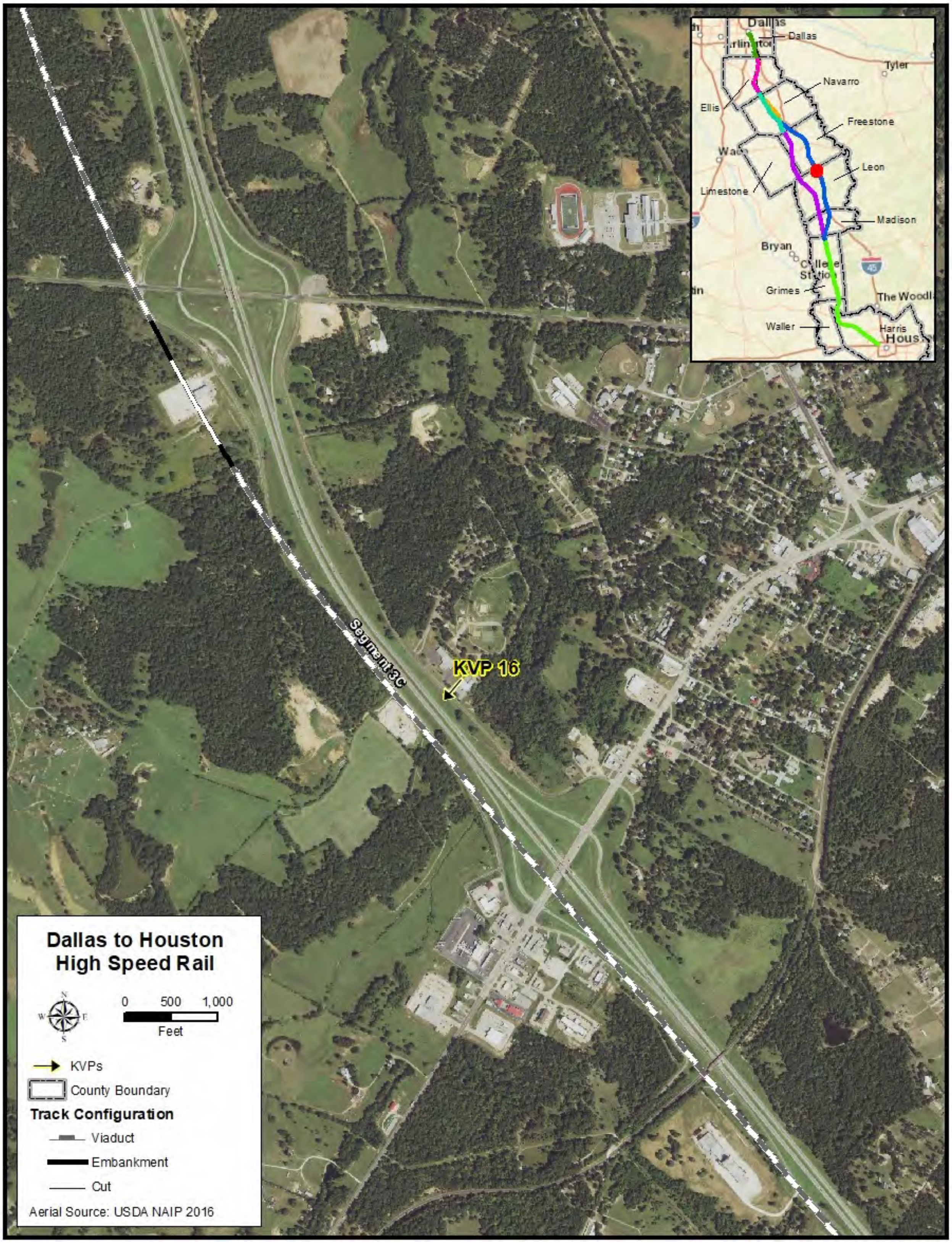
Source: AECOM 2019

Figure 3.10-11: Landscape Unit #6 (KVP #15)



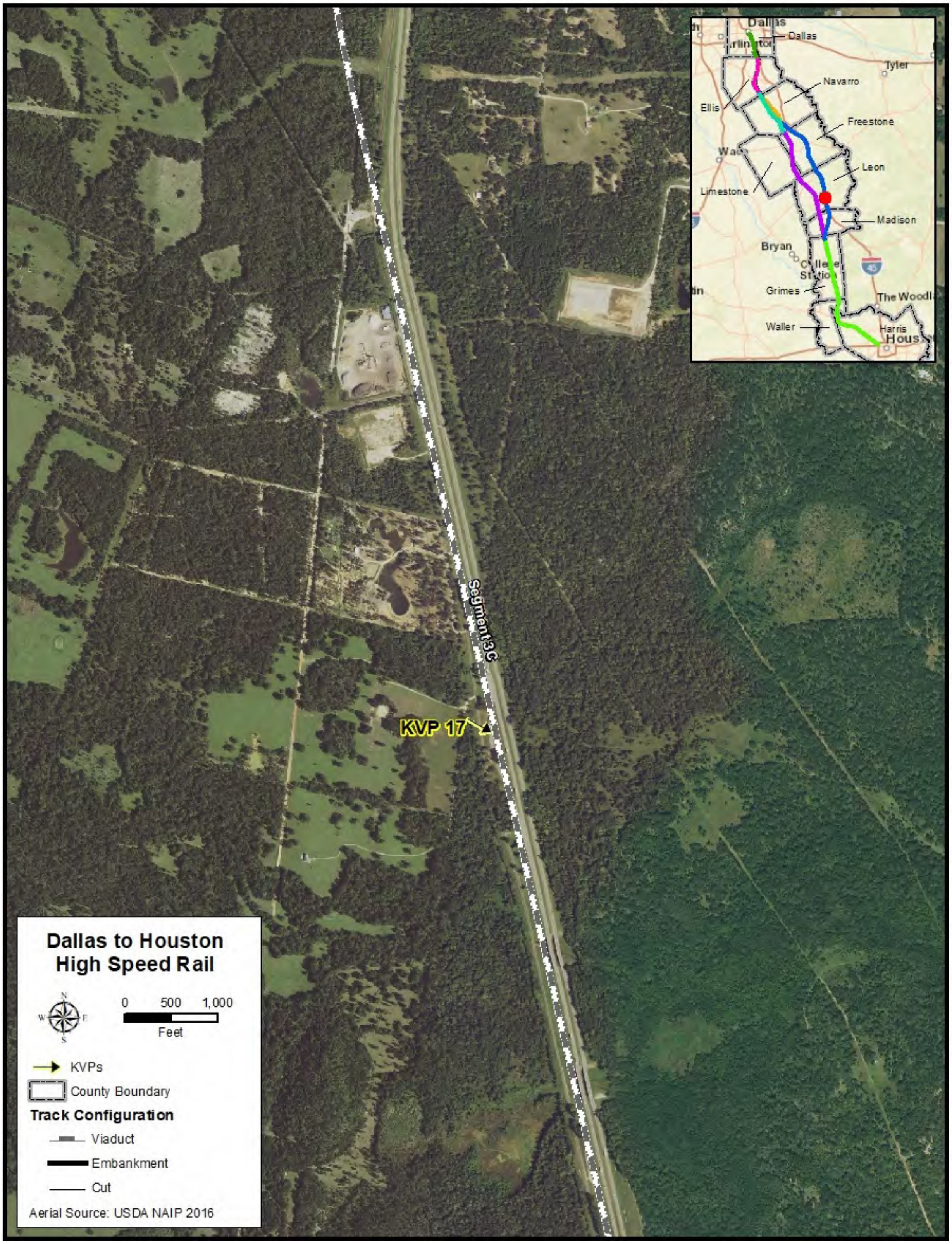
Source: AECOM 2019

Figure 3.10-12: Landscape Unit #6 (KVP #16)



Source: AECOM 2019

Figure 3.10-13: Landscape Unit #6 (KVP #17)



Source: AECOM, 2019

3.10.4.6.2 Visual Resources in Landscape Unit #6

Table 3.10-16 identifies visual resources in Landscape Unit #6.

Table 3.10-16: Visual Resources – Landscape Unit #6

Segment	Resource Name	Resource Type	Special Designation	Distance from LOD (feet)	Mapbook Page #[a]
3C	General Joseph Burton Johnson	Historic Marker	Official Texas Historical Marker	900	102
3C	Johnson African American	Cemetery	HTC	1,234	102
3C	J. B. Johnson	Cemetery	HTC	645	102
3C	Mount Zion Missionary Baptist Church	Religious Facility	No	0	106
3C	El Camino Real de los Tejas	Recreational Trail	National Historic Trail	0	116
3C	Shelley Pate Memorial Park	Recreation	USACE	371	117
3C	Buffalo Public Library	Community Facility	No	547	117
3C	Miracle Christian Center	Religious Facility	No	478	117
3C	Fred Graham	Cemetery	No	1,195	119
3C	Nettles	Cemetery	No	0	120
3C	Liberty	Cemetery	No	470	123
3C	Hopewell Church	Religious Facility	No	5	126
3C	Fort Boggy	Historic Marker	Official Texas Historical Marker	194	133, 134, 135
3C	Fort Boggy State Park	Recreation/Natural	State Park	0	133, 134, 135

Source: AECOM, 2019

HTC – Historic Texas Cemeteries; USACE – United States Army Corps of Engineers

[a] Refer to Appendix D Community and Cultural Resources Mapbook

3.10.4.7 Landscape Unit #7 Central Western Rural, Teague to Old San Antonio Road (Freestone, Limestone and Leon Counties)

Landscape Unit #7 includes Segment 4 in Freestone County, Limestone County and Leon County. This landscape unit’s character is mostly agricultural with some low density residential. Operational oil and gas wells are located on nearly all parcels. Additionally, a large coal mine exists approximately in the center of the landscape unit. The natural environment in this area transitions from prairie to the Post Oak Savannah ecosystem, an ecosystem comprised of woods and forest. The terrain is mostly flat but has some subtle elevation changes.

Three KVPs were identified in this landscape unit:

- KVP #40 is a specific view from Furney-Richardson School, which is now only used as a community space for special events and does not provide educational space.
- KVP #18 is a typical view of a large parcel of land with cleared land, mature dense trees, and oil and gas infrastructure.
- KVP #19 is a specific view from the Leon Independent School District (ISD) campus. The campus houses all grades from elementary through high school, as well as the ISD administrative offices.

3.10.4.7.1 Landscape Unit #7 Visual Quality

KVP #40 is the view at the Furney-Richardson School (**Figure 3.10-14**), which is an official Texas Historical Commission Marker located in western Freestone County, approximately 3 miles west of the City of Teague. The area is rural with some areas of dense forest and some parcels partially or mostly cleared of trees. To the west of the historic marker, a large transmission line is visible. The site is located along FM 1365, which is a two-lane road. There are no memorable or designated views from this site; therefore, vividness is moderately low. Natural harmony is moderate, and cultural order is moderately low.

KVP #18 is a typical view along Segment 4 (**Figure 3.10-15**). The area includes scattered residences with oil and gas infrastructure on most parcels. Parcel boundaries are generally lined with trees, limiting views. Vividness is moderately low, lacking memorable or distinct features and broken up by oil and gas infrastructure. Natural harmony is moderate, and cultural order is moderately low.

KVP #19 represents the view at Leon ISD campus located on US 79 **(Figure 3.10-16**). The land around the school campus is mostly cleared with some trees along the edges of the campus that restrict the viewshed. Existing utility lines along US 79 run through the viewshed. There are no memorable or designated scenic views, although the natural harmony and cultural order of the landscape are uniform. There is moderate vividness, natural harmony and cultural order.

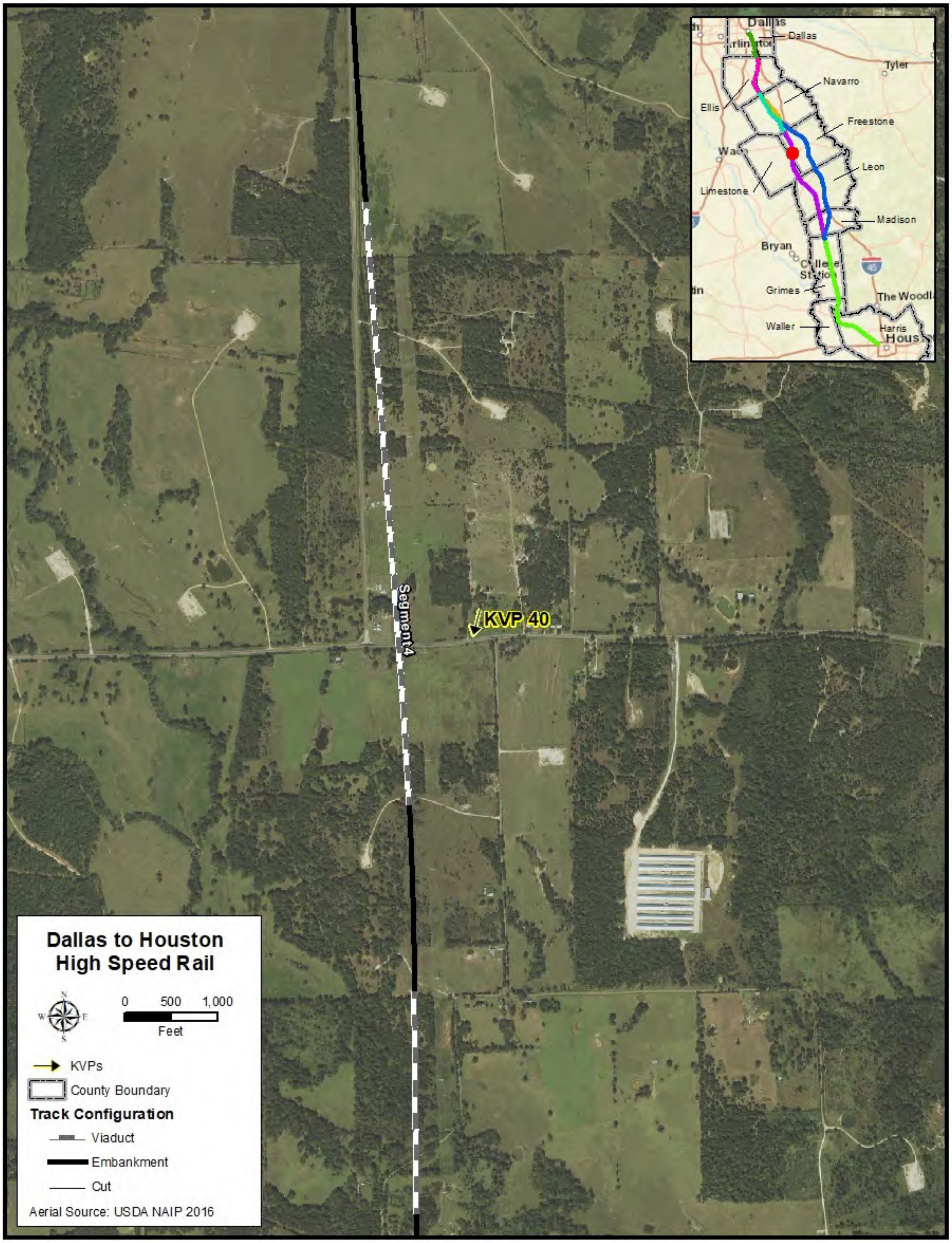
The vividness of the landscape unit ranges from moderately low to moderate. Much of the landscape unit is occupied by oil and gas pad sites, which takes away from the character of rural residential communities located on large lots. The natural harmony of the landscape unit is moderate. There are some pleasing dense forests breaking up large cleared parcels, as well as the Lake Limestone area. The large lake provides residential lots and recreational area for the region. The cultural order of the landscape unit is mostly moderately low, but there are some areas with fewer oil and gas infrastructure sites that have a moderate cultural order. The overall visual quality of Landscape Unit #7 is moderately low. **Table 3.10-17** summarizes the visual quality for the KVPs and landscape unit.

Table 3.10-17: Visual Quality Assessment – Landscape Unit #7

KVP	KVP Location	Vividness	Natural Harmony	Cultural Order	Visual Quality
40	Furney Richardson High School	Moderately low (2)	Moderate (3)	Moderately low (2)	**Moderately low (2.3)**
18	Agriculture with oil & gas (CR 880)	Moderately low (2)	Moderate (3)	Moderately low (2)	**Moderately low (2.3)**
19	Leon ISD Campus	Moderate (3)	Moderate (3)	Moderate (3)	**Moderate (3)**
LU 7	**Landscape Unit #7**	**Moderately low (2)**	**Moderate (3)**	**Moderately low (2)**	**Moderately low (2.3)**

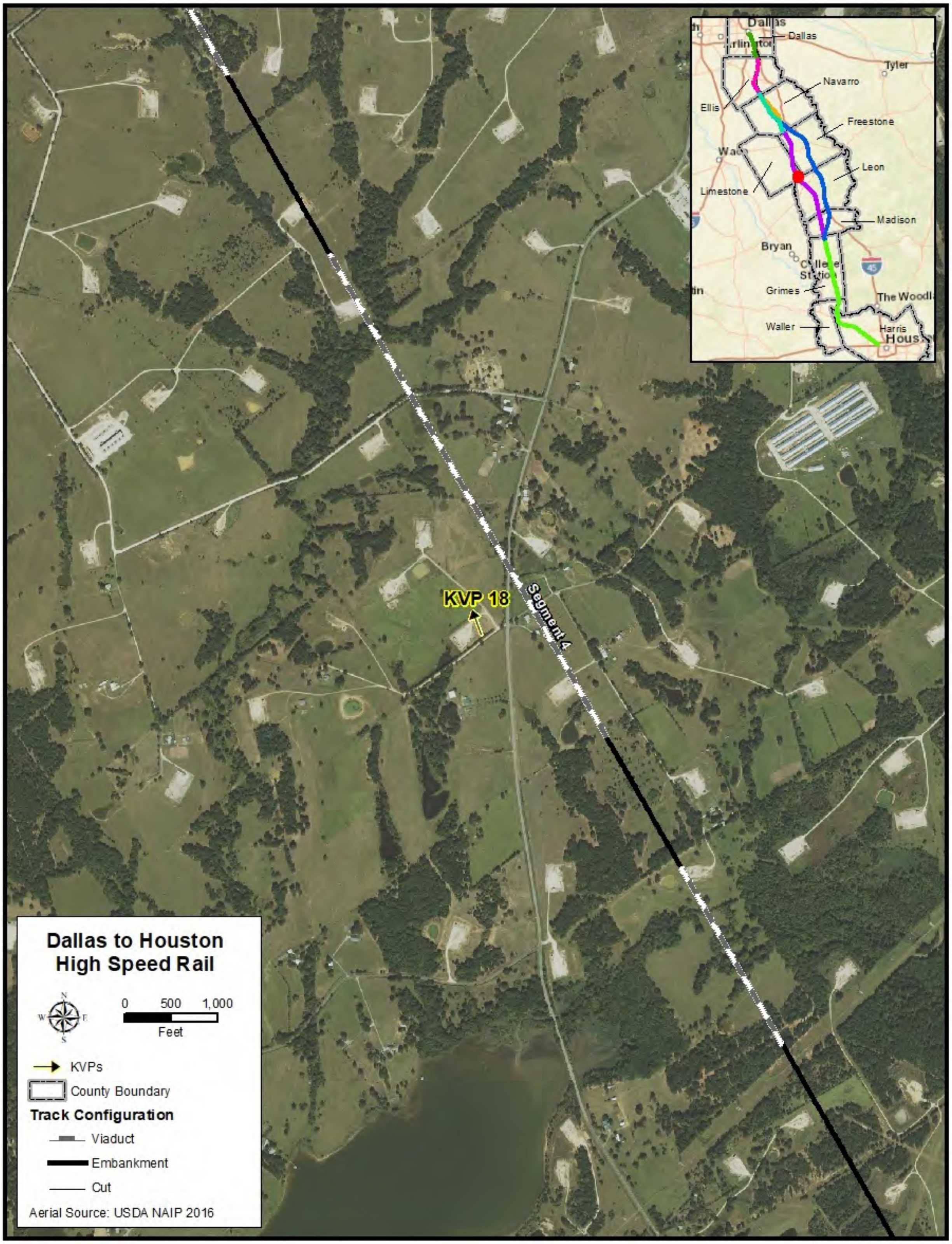
Source: AECOM 2019

Figure 3.10-14: Landscape Unit #7 (KVP #40)



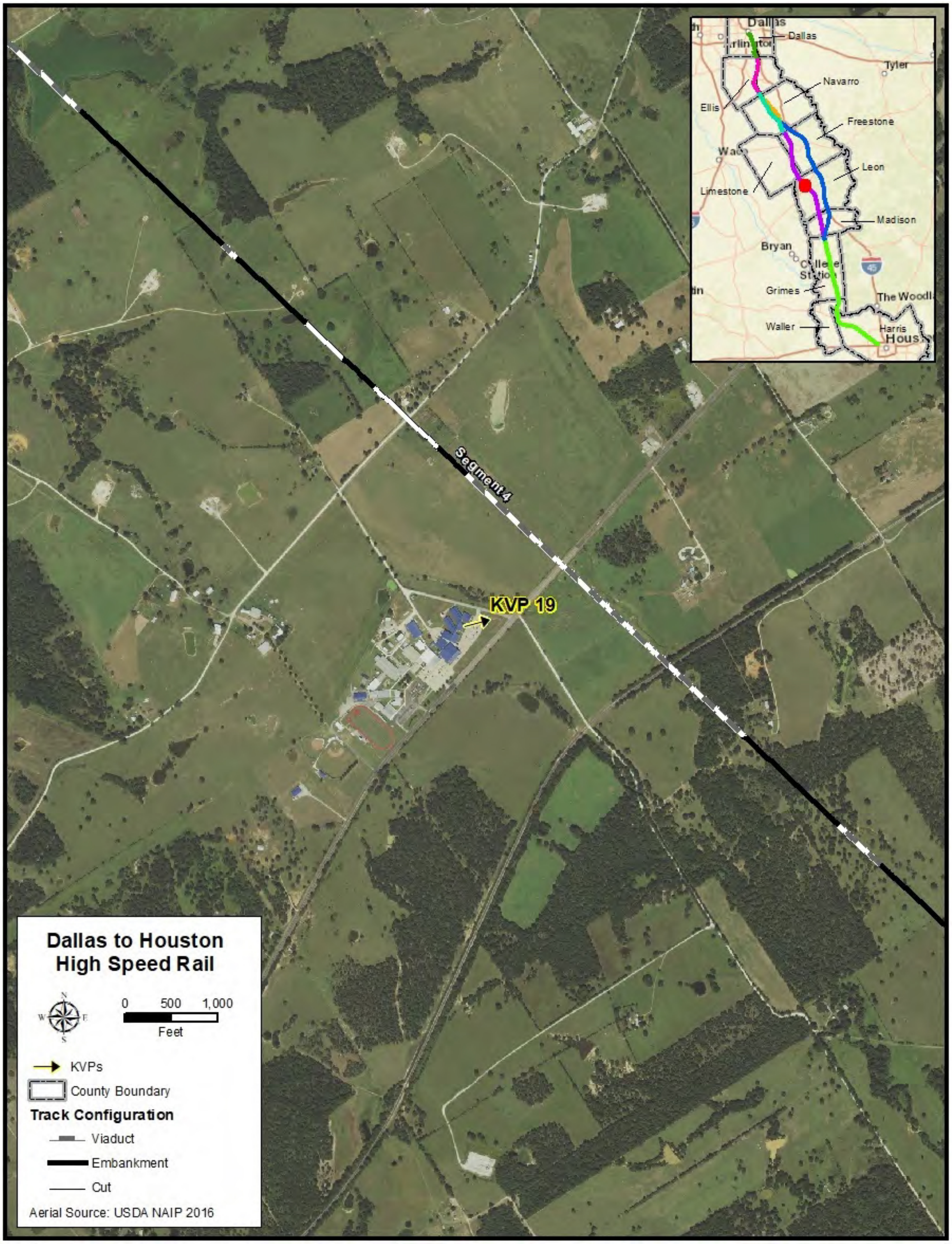
Source: AECOM 2019

Figure 3.10-15: Landscape Unit #7 (KVP #18)



Source: AECOM 2019

Figure 3.10-16: Landscape Unit #7 (KVP #19)



Source: AECOM 2019

3.10.4.7.2 Visual Resources in Landscape Unit #7

Table 3.10-18 lists visual resources in Landscape Unit #7, which include historic markers, cemeteries and community resources.

Table 3.10-18: Visual Resources – Landscape Unit #7					
Segment	**Resource Name**	**Resource Type**	**Special Designation**	**Distance from LOD (feet)**	**Mapbook Page #[a]**
4	Furney-Richardson School	Historic Marker	Official Texas Historical Marker	821	162
4	Asia	Cemetery	No	280	164
4	Personville	Historic Marker	Official Texas Historical Marker	575	168
4	Personville/Ebenezer	Cemetery	HTC	525	168
4	Unknown (New Hope)	Cemetery	No Designation	524	172
4	Leon ISD Campus	Community Facility	No	982	177
4	Little Flock	Cemetery	HTC	682	174
4	Little Flock	Historic Marker	Official Texas Historical Marker	750	174
4	Perry	Cemetery	No	504	187

Source: AECOM 2019

HTC – Historic Texas Cemeteries

[a] Refer to **Appendix D, Community and Cultural Resources Mapbook**

3.10.4.8 Landscape Unit #8 Rural Brazos Valley, Old San Antonio Road to Plantersville (Leon, Madison and Grimes Counties)

Landscape Unit #8 includes Segments 3C, 4 and 5 within Madison County and Grimes County. Landscape Unit #8 is primarily rural and agricultural. The natural environment is less forested than the than Landscape Units #6 or #7 and is primarily a blend of prairie and trees. Most individual parcels are still bordered by trees and vegetation; however, a few areas have cleared off trees and views can extend across multiple parcels. IH-45 is present in a small portion of the northern segment, but the landscape unit is primarily composed of state highways and farm roads. The Project would follow a large utility transmission corridor.

Four KVPs were identified for this landscape unit:

- KVP #20 is a typical view of the rural area in Segment 3C with some scattered residences.
- KVP #21 is a specific view from Oxford Cemetery at US 190 in Segment 4.
- KVPs #22 is a specific view facing northeast toward the proposed Brazos Valley Intermediate Station from SH-30 in Segment 5. This view is specific because it is intentionally placed across the highway from the station entrance.
- KVP #23 is a typical view of the proposed Brazos Valley Intermediate Station facing southwest from SH-90 in Segment 5.

3.10.4.8.1 Landscape Unit #8 Visual Quality

KVP #20 represents a typical view of the rural character in Segment 3C in an area without major transportation or utility infrastructure (**Figure 3.10-17**). The visual quality is moderate for KVP #20 with moderate vividness, moderately high natural harmony, and moderate cultural order. There are no memorable or unique views, but the natural harmony of the area is pleasing, primarily due to the low number of residential or industrial infrastructure in the area. The area is primarily composed of dense trees following creek beds and scattered around the large parcels of land. Some oil and gas infrastructure in the area results in a moderate cultural order.

KVP #21 is a specific view at Oxford Cemetery on US 190, which is a historical cemetery near Madisonville in Segment 4 (**Figure 3.10-18**). The area is rural with scattered homes and agricultural fields bounded by trees. The trees and wooded areas generally limit views. A large transmission line ROW crosses US 190 in this area. The visual quality is moderate with moderate vividness, natural harmony and cultural order.

KVP #22 and KVP #23 are located in the vicinity of the proposed Brazos Valley Intermediate Station and provide specific views of the proposed station location from surrounding areas (**Figure 3.10-19**). KVP #22 faces toward the proposed Brazos Valley Intermediate Station from SH-30, and KVP #23 faces the proposed station from SH-90. Views along SH-30 and SH-90 are limited by trees lining the road with views of surrounding agricultural lands between trees. Vividness, natural harmony and cultural order are moderate, consistent with visual quality for rural areas.

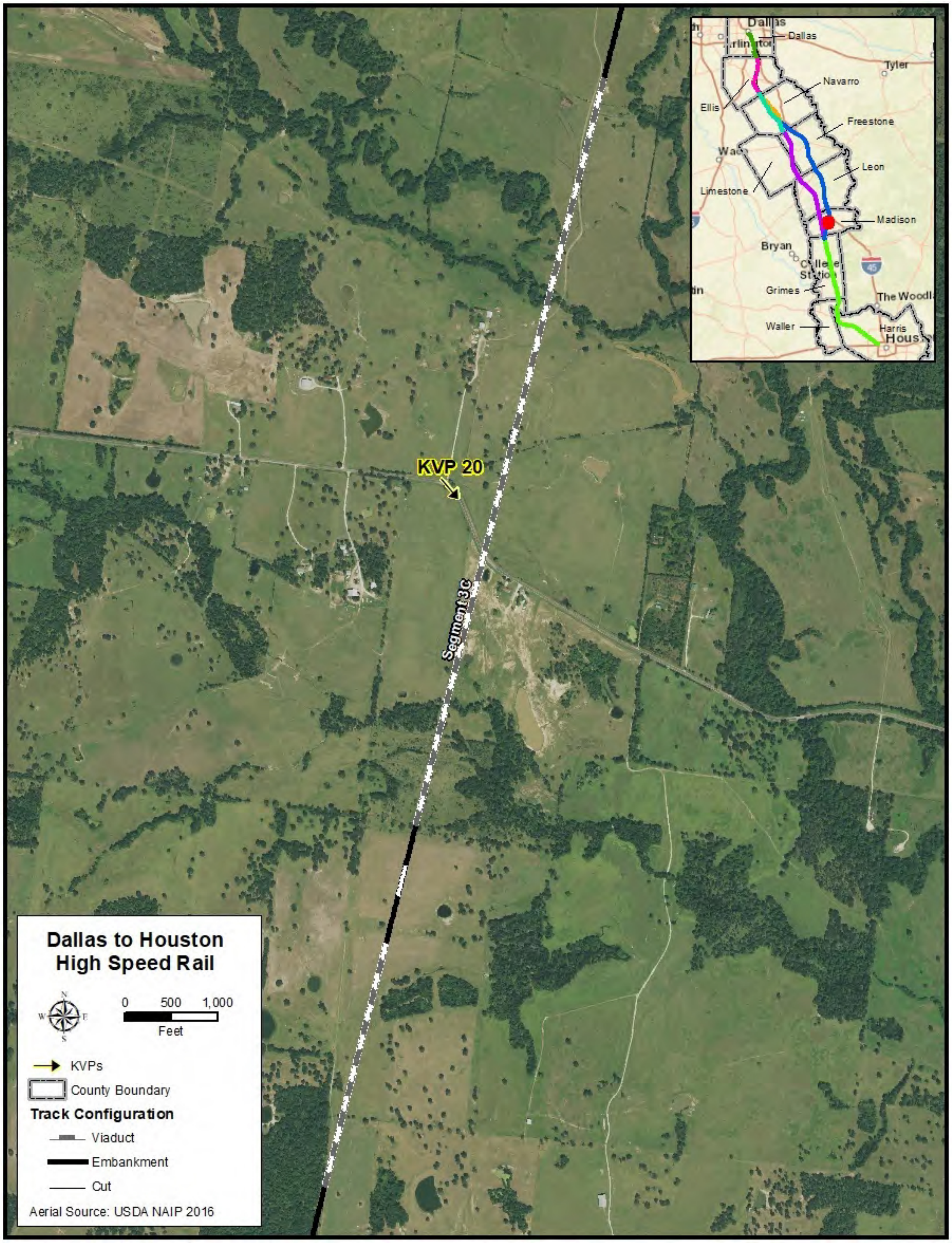
The vividness of this landscape unit is generally moderate. There are no memorable views. The rural landscape is pleasing; however, it can be disrupted when utility infrastructure is present. The natural harmony is moderate to moderately high. In some areas of the landscape unit there are pockets of dense forest along creeks, as well as cleared areas for pasture or crops with no oil and gas infrastructure or large utility corridors; however, the area generally follows large utility corridors or transportation infrastructure. The cultural order is generally moderate; however, there are a few large utility transmission corridors, one of which runs through the middle of the landscape unit. The overall visual quality of this landscape unit is moderate. **Table 3.10-19** summarizes the KVP and landscape unit ratings.

Table 3.10-19: Visual Quality Assessment – Landscape Unit #8

KVP	KVP Location	Vividness	Natural Harmony	Cultural Order	Visual Quality
20	Low Density Ag/Residential (FM 1452)	Moderate (3)	Moderately high (4)	Moderate (3)	**Moderate (3.3)**
21	Oxford Cemetery	Moderate (3)	Moderate (3)	Moderate (3)	**Moderate (3)**
22	Brazos Valley Intermediate Station Entrance	Moderate (3)	Moderate (3)	Moderate (3)	**Moderate (3)**
23	Brazos Valley Intermediate Station Approach	Moderate (3)	Moderate (3)	Moderate (3)	**Moderate (3)**
LU 8	**Landscape Unit #8**	**Moderate (3)**	**Moderate (3)**	**Moderate (3)**	**Moderate (3)**

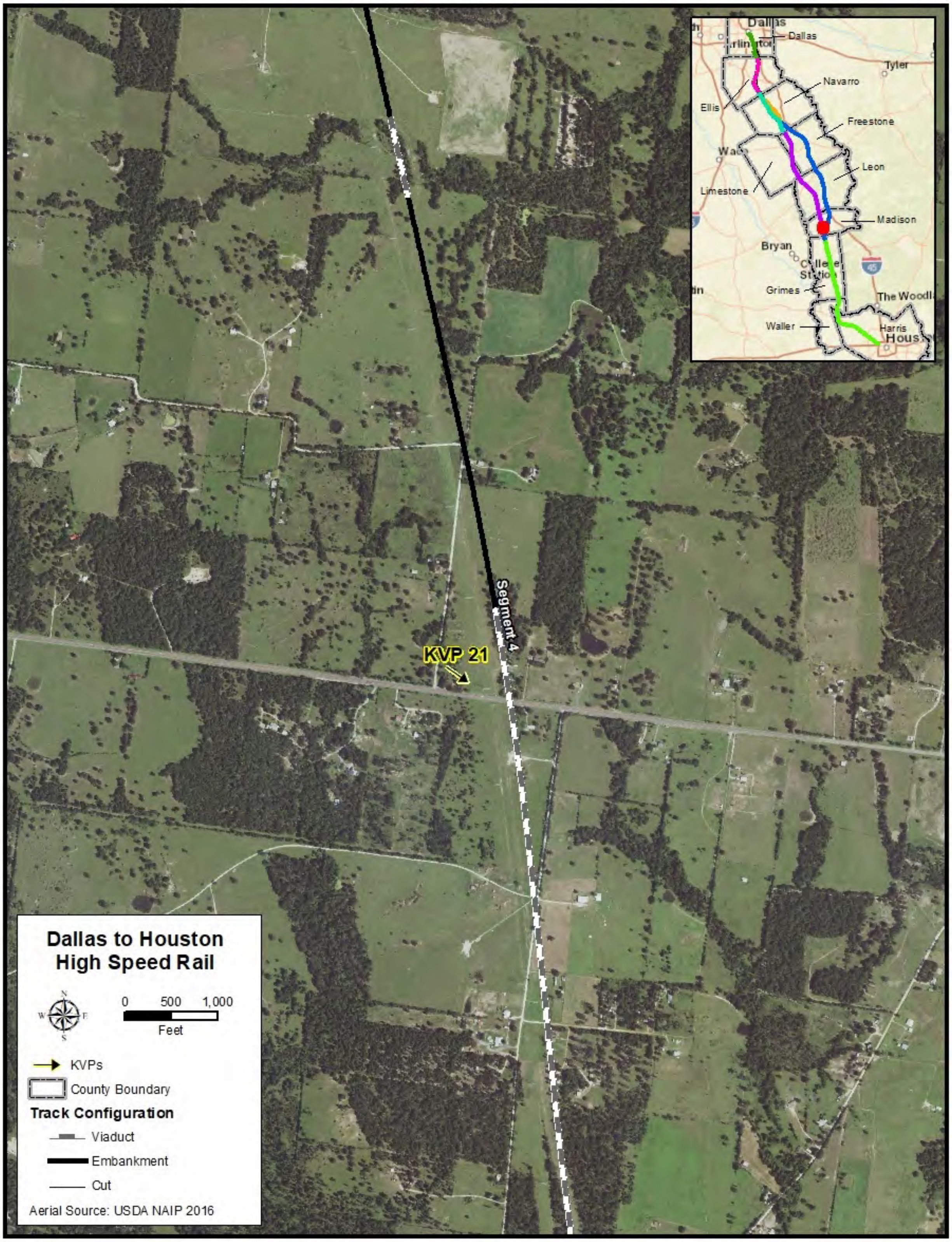
Source: AECOM 2019

Figure 3.10-17: Landscape Unit #8 (KVP #20)



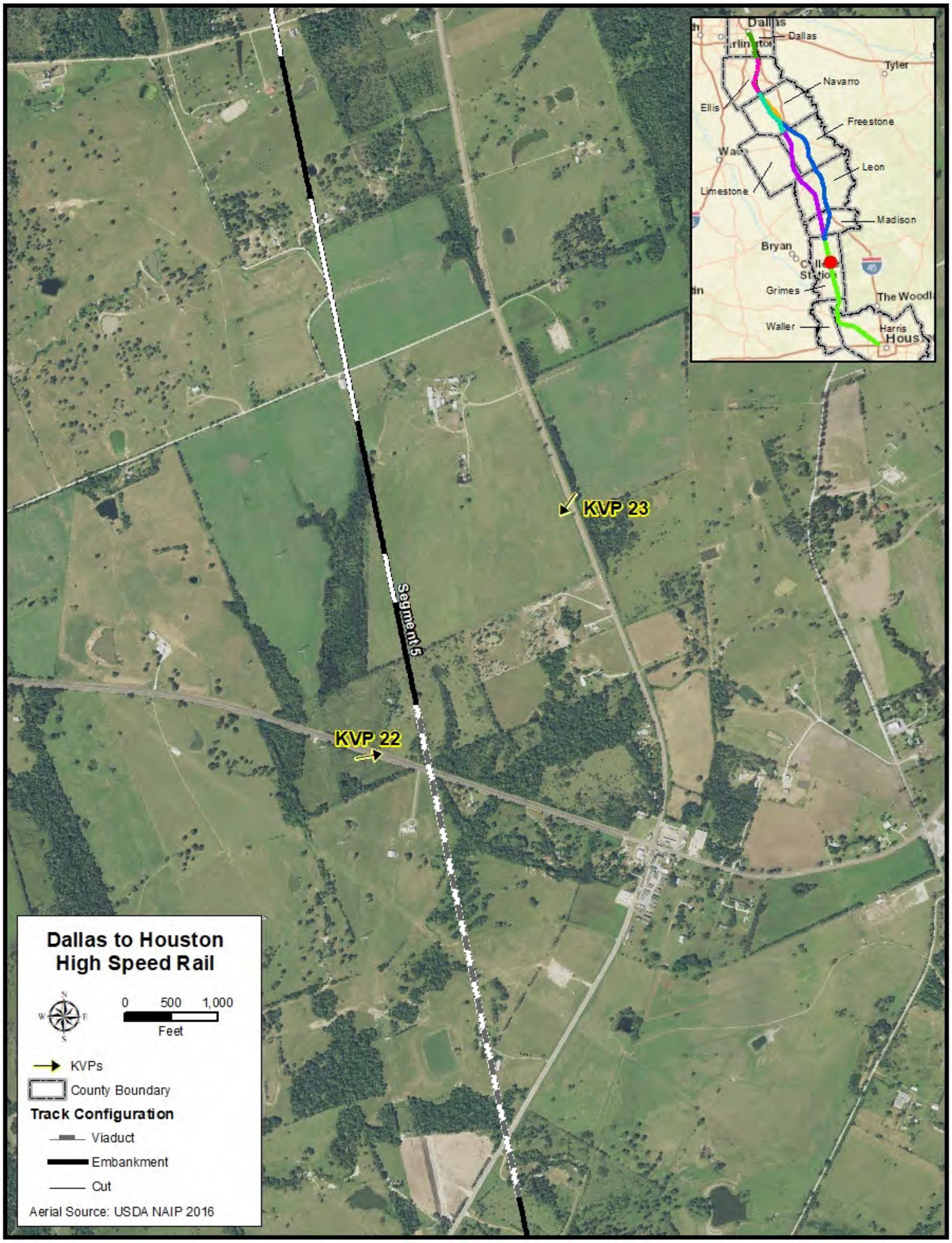
Source: AECOM 2019

Figure 3.10-18: Landscape Unit #8 (KVP #21)



Source: AECOM 2019

Figure 3.10-19: Landscape Unit #8 (KVPs #22 and #23)



Source: AECOM 2019

3.10.4.8.2 Visual Resources in Landscape Unit #8

Table 3.10-20 identifies the visual resources within Landscape Unit #8. Visual resources include primarily cemeteries and religious facilities.

Table 3.10-20: Visual Resources – Landscape Unit #8

Segment	Resource Name	Resource Type	Special Designation	Distance from LOD (feet)	Mapbook Page #[a]
3C	Sweet Home	Cemetery	No	1,269	140
3C	Fellowship Church	Religious Facility	No	772	145
3C	Fellowship Church Grave	Cemetery	No	498	145
4	Randolph	Cemetery	No	64	190
4	Ten Mile	Cemetery	HTC	56	191
3C	Grimes County Bethel Cemetery	Cemetery	HTC	180	199
4	Oxford Cemetery	Cemetery	NRHP Eligible	399	196
4	Union Hill	Cemetery	No	102	206
5	Pankey –Shiloh	Cemetery	No	759	152, 202
5	Shiloh Church	Religious Facility	No	1,296	152, 202
5	Singleton	Cemetery	No	751	208, 209
5	Ratliff	Cemetery	HTC	101	212
5	Old Oakland – Roans Prairie	Cemetery	No	1,113	212
5	Oakland Baptist Church	Historic Marker	RTHL	2,209[b]	212
5	Mason	Cemetery	No	1,004	216

Source: AECOM 2019

HTC – Historic Texas Cemeteries; NRHP – National Register of Historic Places; RTHL – Record Texas Historic Landmark

[a] Refer to **Appendix D, Community and Cultural Resources Mapbook**

[b] These resources are outside of the ¼-mile study for this resource; however, they are included in this section because they are evaluated in **Section 3.19, Cultural Resources**, as the site is a historic landmark.

3.10.4.9 Landscape Unit #9 Rural to Suburban, Plantersville to Harris County Line (Grimes and Waller Counties)

Landscape Unit #9 includes Segment 5 in Grimes County and Waller County. Landscape Unit #9 is a rural agricultural area with some newer low-density planned residential communities. The natural landscape is a mosaic of croplands and forested areas and is more densely forested than any other landscape unit. The densest parts of the forest are located in the northern half of the landscape unit, while the southern half is slightly less densely forested.

Two KVPs were identified in this landscape unit:

- KVP #24 is a typical view in the northern portion of Landscape Unit #9 of residences and wooded areas adjacent to an existing utility transmission corridor.
- KVP #25 is a typical view in the southern portion of Landscape Unit #9 from a road in a residential community.

3.10.4.9.1 Landscape Unit #9 Visual Quality

KVP #24 is typical view representing the northern portion of Landscape Unit #9, which is generally densely forested (**Figure 3.10-20**) with scattered residences and mobile homes and a large cleared utility corridor. Vividness is moderate as the views do not offer any memorable or unique natural features and are limited by the dense tree cover except for the utility corridor. Due to the dense forest, views of the utility corridor are generally limited to those adjacent to the corridor or travelling across the corridor on a local road. Natural harmony and cultural order are moderate because the presence of the utility corridor divides parts of the forest and some communities.

KVP #25 is a typical view representing the southern portion of the landscape unit, which has more extensive viewsheds than KVP #24 because more land has been cleared of trees for agricultural uses (**Figure 3.10-21)**. The vividness of this area is generally moderate. The area is generally well-maintained but does not provide any particular unique views. The natural harmony and cultural order in the area are moderate.

The overall visual quality of Landscape Unit #9 is moderate, as shown in **Table 3.10-21**.

Table 3.10-21: Visual Quality Assessment – Landscape Unit #9

KVP	KVP Location	Vividness	Natural Harmony	Cultural Order	Visual Quality
24	Riley Road Utility Corridor	Moderate (3)	Moderate (3)	Moderate (3)	**Moderate (3)**
25	Rural/Suburban Transition	Moderate (3)	Moderate (3)	Moderate (3)	**Moderate (3)**
LU 9	**Landscape Unit #9**	**Moderate (3)**	**Moderate (3)**	**Moderate (3)**	**Moderate (3)**

Source: AECOM 2019

3.10.4.9.2 Visual Resources in Landscape Unit #9

One visual resource was identified in Landscape Unit #9 and is summarized in **Table 3.10-22**.

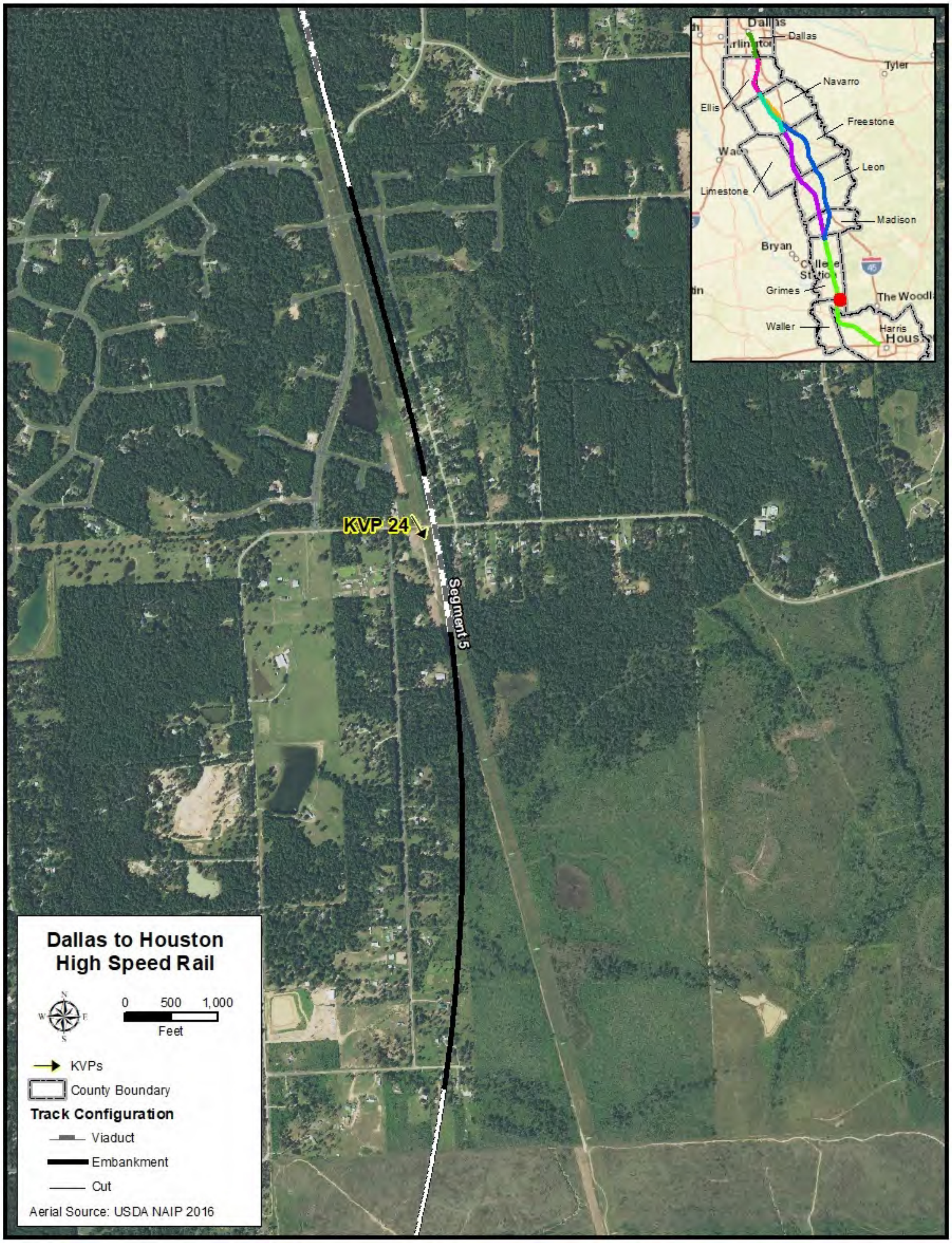
Table 3.10-22: Visual Resources – Landscape Unit #9

Segment	Resource Name	Resource Type	Special Designation	Distance from LOD (feet)	Mapbook Page #[a]
5	Science of the Soul Study Center	Community Center	No	218	233

Source: AECOM, 2019

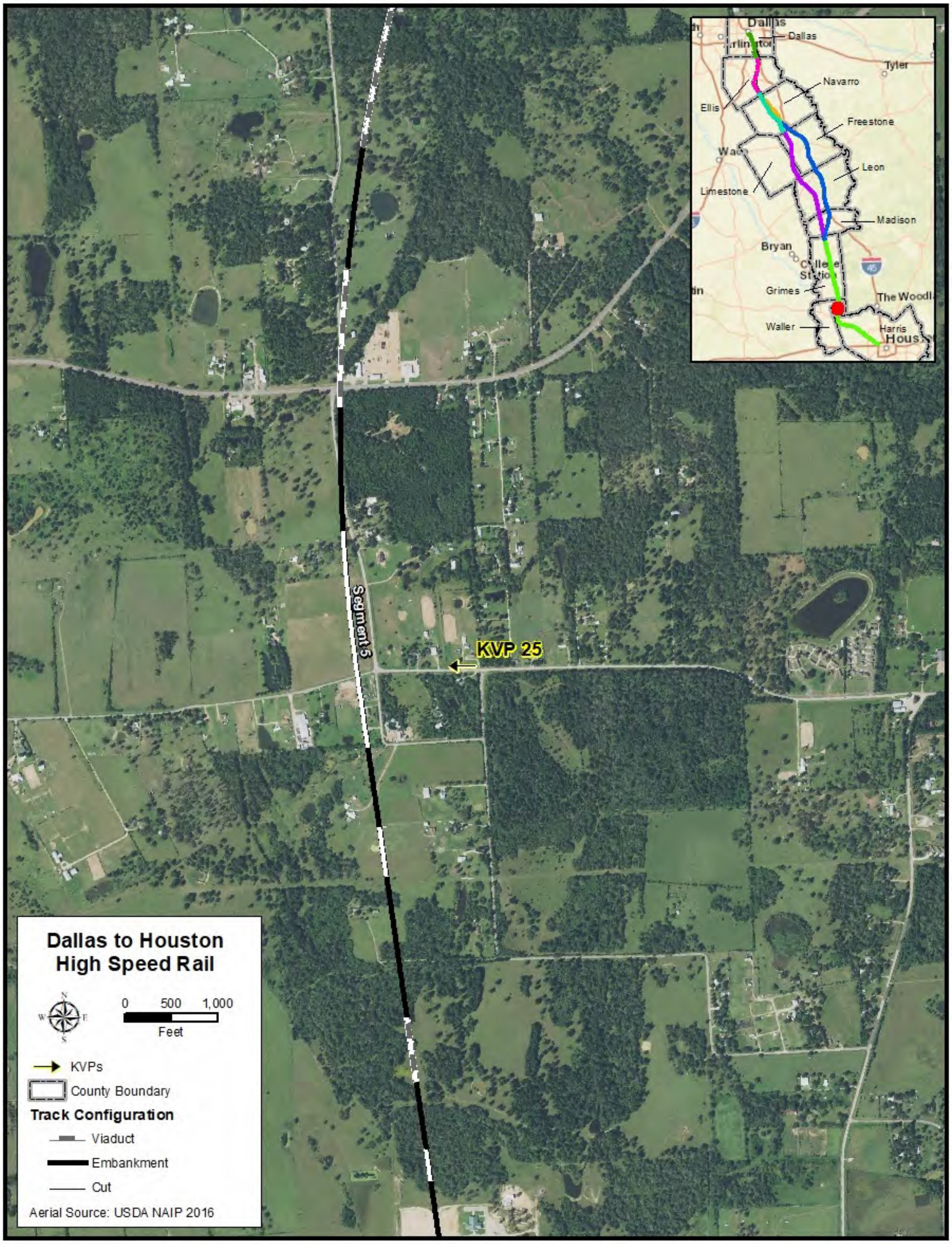
[a] Refer to **Appendix D, Community and Cultural Resources Mapbook**.

Figure 3.10-20: Landscape Unit #9 (KVP #24)



Source: AECOM 2019

Figure 3.10-21: Landscape #9 (KVP #25)



Source: AECOM 2019

3.10.4.10 Landscape Unit #10 Northwest Suburban, Harris County line to Grand Parkway (Harris County)

Landscape Unit #10 is located in Segment 5 within Harris County. Landscape Unit #10 is an agricultural area transitioning to suburban on the edge of the Houston metropolitan area. While agricultural land uses still dominate the landscape, residential communities become denser, and commercial and industrial land uses become more common adjacent to the US 290 corridor. Compared to Landscape Unit #9, the area becomes flatter and contains more open grassland, and some marshes near waterbodies, indicative of the Gulf Prairie ecosystem. There are some pockets of dense woodland, but most of the landscape unit is cleared for crops or pasture. US 290 and a freight rail corridor traverse the landscape unit.

Three KVPs were identified in this landscape unit:

- KVP #26 is a typical view from an established suburban residential community in Segment 5.
- KVP #41 is a specific view from the Katy Prairie Conservancy Wildlife Viewing Platform.
- KVP #27 is a typical view near a suburban development and cleared open land.

3.10.4.10.1 Landscape Unit #10 Visual Quality

KVP #26 is a typical view representing a rural community in Harris County **(Figure 3.10-22)**. The area has clusters of residential development on smaller lots surrounded by larger agricultural parcels. Lack of trees allows for more expansive views. Vividness is moderately low with no memorable or distinctive features and some degraded properties. Natural harmony and cultural order are moderate.

KVP #41 is a specific view from the Katy Prairie Conservancy **(Figure 3.10-23)** near Warren Lake**.** The landscape is mostly flat and open for pastures or crops with small densely treed areas throughout. The view overlooks a lake and prairies and is crossed by a utility corridor. A two-story viewing platform for watching wildlife provides extensive views of the surrounding area. Vividness, natural harmony and cultural order are moderately high and aesthetically pleasing.

KVP #27 is a typical view near a newer suburban development surrounded by agricultural land (**Figure 3.10-24**). Numerous aerial utility lines and a cell phone tower are located around the residential development, detracting from views of the undeveloped agricultural lands and resulting in moderately low vividness. Natural harmony and cultural order are moderate.

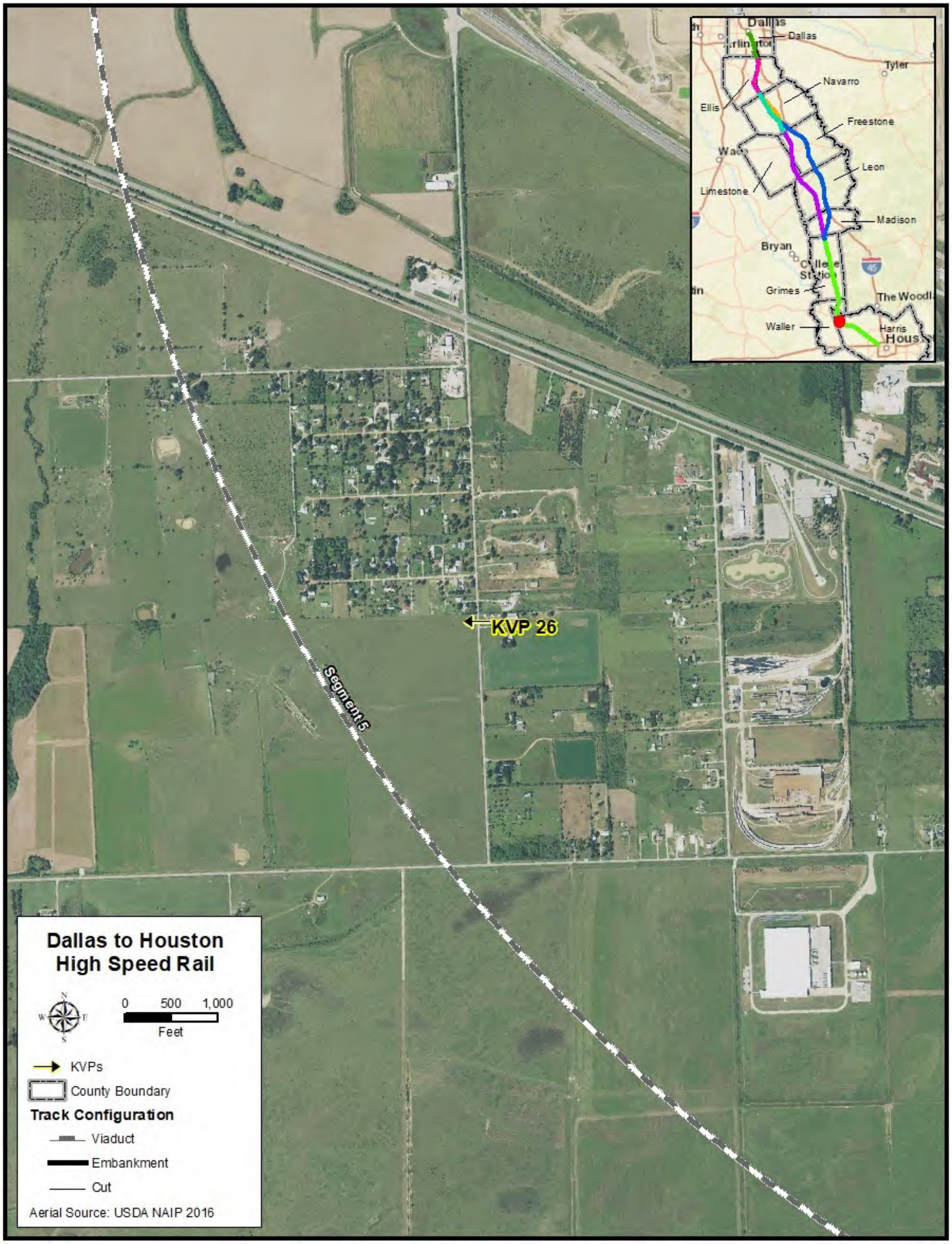
The vividness in this landscape unit ranges from moderately low to moderately high. Some areas are cohesive, but other areas near US 290 and the freight rail corridor have introduced industrial land uses. The natural harmony and cultural order in the landscape unit range from moderate to moderately high. There are some visual distractors, such as transportation corridors (US 290 and freight rail), utility transmission infrastructure, and industrial land uses near rural and suburban communities. The overall visual quality in this landscape unit is moderate as shown in **Table 3.10-23**.

Table 3.10-23: Visual Quality Assessment – Landscape Unit #10

KVP	KVP Location	Vividness	Natural Harmony	Cultural Order	Visual Quality
26	Rural Harris County	Moderately low (2)	Moderate (3)	Moderate (3)	**Moderate (2.7)**
41	Katy Prairie Conservancy Wildlife Viewing Platform	Moderately high (4)	Moderately high (4)	Moderately high (4)	**Moderately high (4)**
27	Stone Creek Ranch	Moderately low (2)	Moderate (3)	Moderate (3)	**Moderate (2.7)**
LU 10	**Landscape Unit #10**	**Moderately low (2)**	**Moderate (3)**	**Moderate (3)**	**Moderate (2.7)**

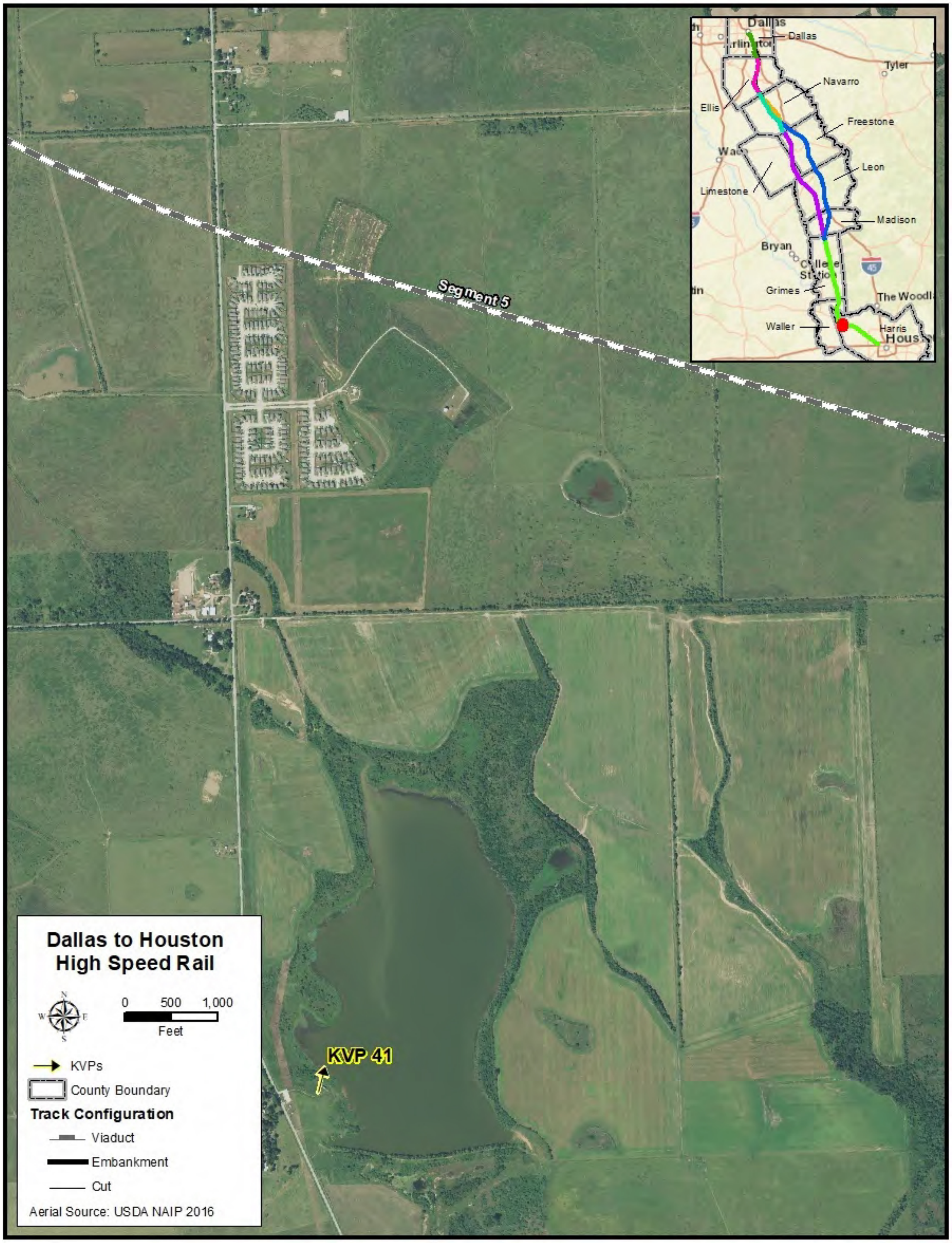
Source: AECOM 2019

Figure 3.10-22: Landscape Unit #10 (KVP #26)



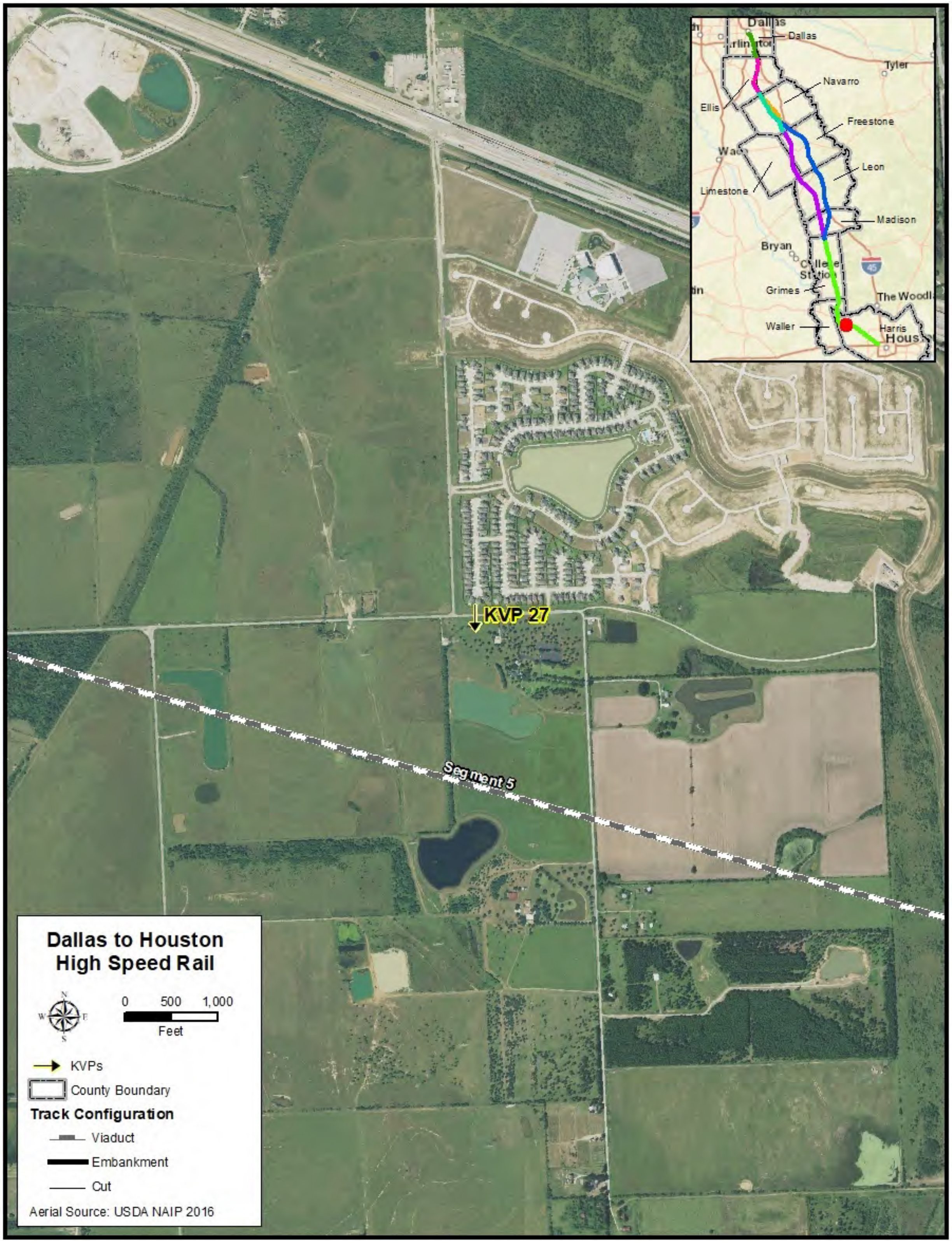
Source: AECOM 2019

Figure 3.10-23: Landscape Unit #10 (KVP #41)



Source: AECOM 2019

Figure 3.10-24: Landscape Unit #10 (KVP #27)



Source: AECOM 2019

3.10.4.10.2 Visual Resources in Landscape Unit #10

Table 3.10-24 identifies the two visual resources noted within Landscape Unit #10.

Table 3.10-24: Visual Resources – Landscape Unit #10

Segment	Resource Name	Resource Type	Special Designation	Distance from LOD (feet)	Mapbook Page #[a]
5	Mallard Crossing Neighborhood Park	Recreation	No	560	239
5	Katy Prairie Conservancy Wildlife Viewing Platform	Recreation	No	8,553[b]	239[c]

Source: AECOM, 2019

[a] Refer to Appendix D Community and Cultural Resources Mapbook

[b] Although the viewing platform is located outside the ¼-mile viewshed, this visual resource is included based on comments received during the Draft EIS.

[c] The viewing platform is not depicted in the figures due to the distance. This mapbook page depicts the nearest point of the Katy Prairie Conservancy Lands to the Project.

3.10.4.11 Landscape Unit #11 Cypress Jersey Village, Grand Parkway to Sam Houston Parkway (Harris County)

Landscape Unit #11 is within Segment 5 in Harris County and includes large suburban communities with low- to medium-density residential neighborhoods. US 290, a highway with eight lanes of traffic and two-lane frontage roads on both sides, along with a parallel UPRR rail line, is located in the landscape unit. Commercial strip centers and industrial land uses buffer residential neighborhoods to the north of US 290; however, some neighborhoods to the south of US 290 are adjacent to the UPRR line, buffered only by a small row of trees. The area has flat topography, characteristic in the Gulf Prairie ecosystem, and woodlands are fewer than in Landscape Unit #10.

Three KVPs were identified in this landscape unit:

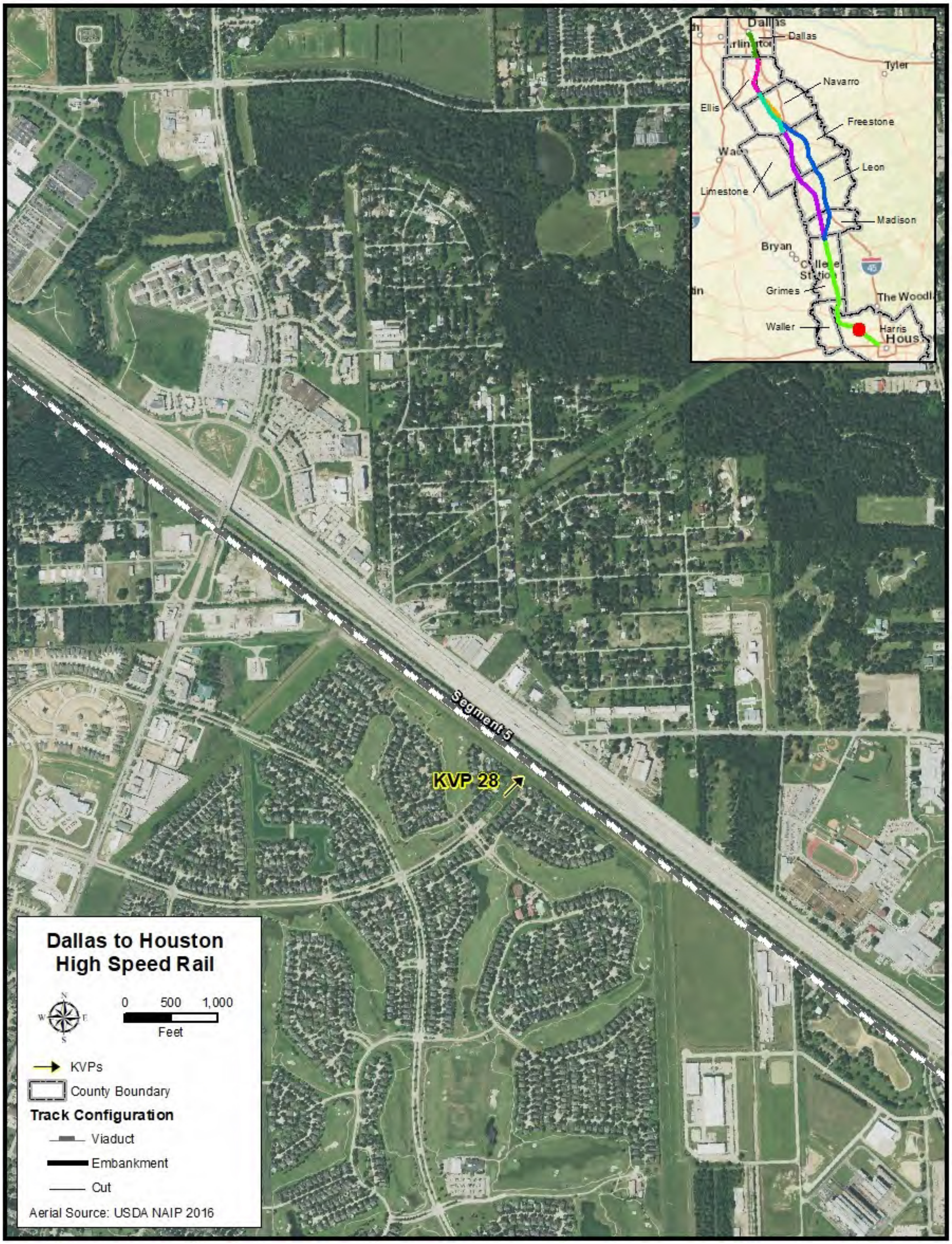
- KVP #28 is a specific view from a park in a master planned neighborhood, and adjacent to a semi-private golf course at Houston National Golf Club.
- KVP #29 is a typical view from a suburban neighborhood adjacent to the Project.
- KVP #30 shows a typical view from US 290 facing southeast.

3.10.4.11.1 Landscape Unit #11 Visual Quality

KVP #28 is specific view from the Stonegate Neighborhood Park **(Figure 3.10-25).** This suburban neighborhood development also contains a semi-private golf course with clubhouse. The development is adjacent to US 290 and the UPRR line; however, trees and houses limit views of these facilities. The neighborhood has a distinct natural and cultural order because it is a planned development. Therefore, the visual quality at this KVP is moderate.

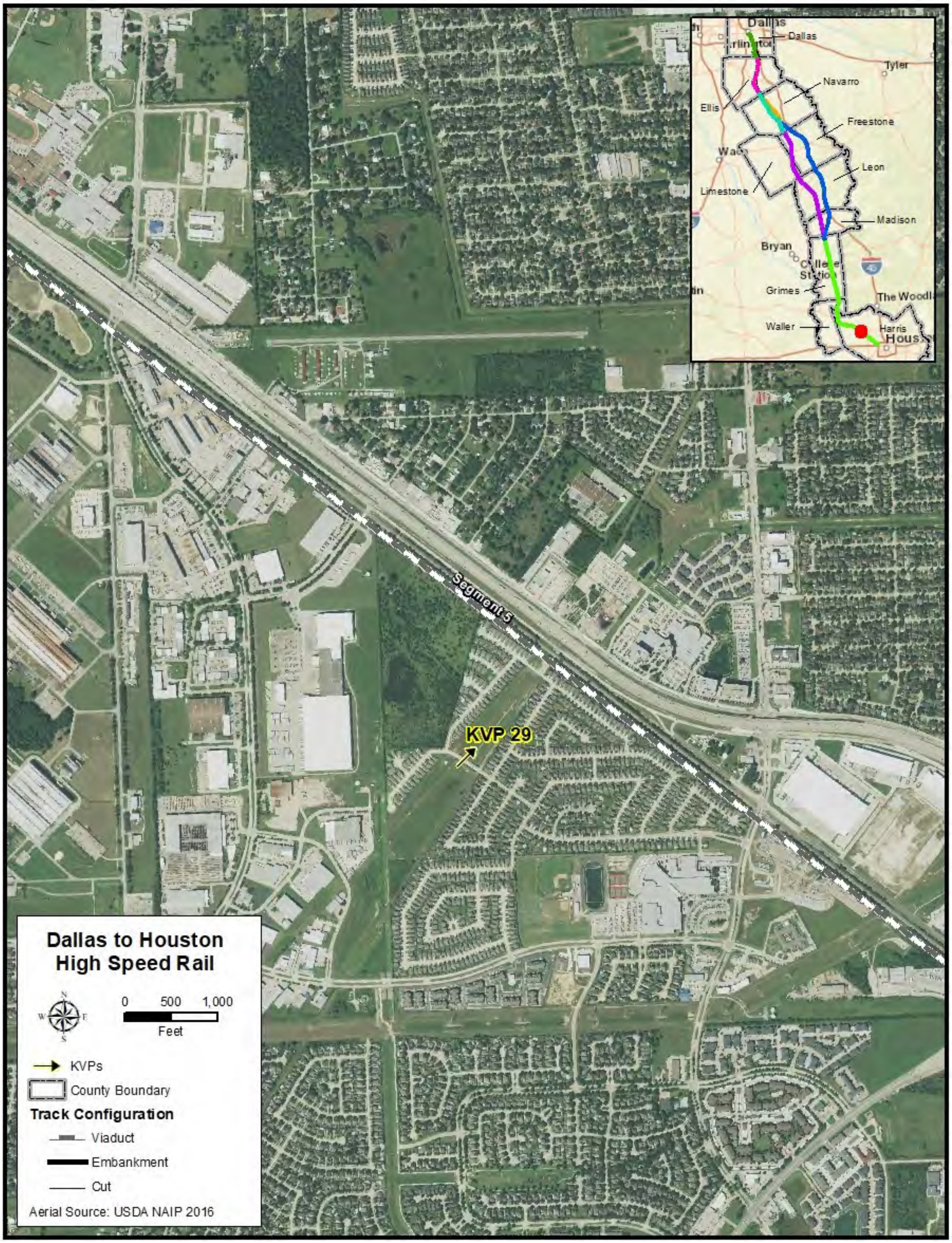
KVP #29 is a typical view from suburban neighborhoods located along US 290, such as White Oak Falls neighborhood **(Figure 3.10-26).** These neighborhoods are generally well-maintained and aesthetically pleasing with moderate vividness, natural harmony and cultural order. Views of surrounding land uses are limited by landscaping and houses.

Figure 3.10-25: Landscape Unit #11 (KVP #28)



Source: AECOM 2019

Figure 3.10-26: Landscape Unit #11 (KVP #29)



Source: AECOM 2019

KVP #30 is a typical view from US 290 of the highway and adjacent commercial strip centers and industrial sites and the UPRR line **(Figure 3.10-27)**. To the south of US 290, the UPRR line is adjacent to the highway. Approximately half of the UPRR line is buffered by a row of trees on both sides. The remaining portions are exposed to views from the highway. Vividness is low due to the mix of adjacent uses and heavy traffic. Natural harmony is moderately low, and cultural order is moderate.

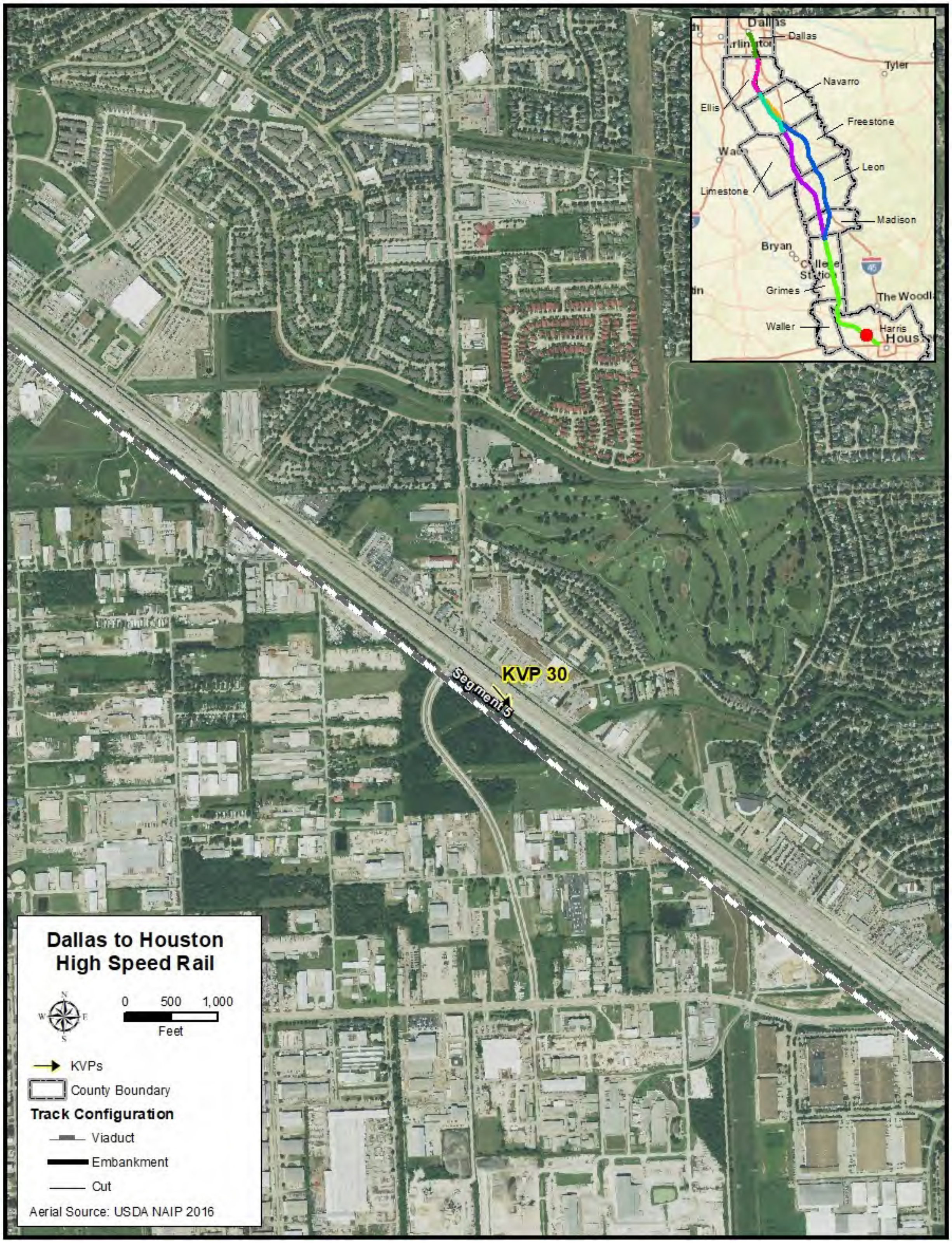
The vividness in this landscape unit ranges from low to moderate. Most of the environment is built out as low to medium density suburban developments, is adjacent to freight rail and US-290, and does not provide any memorable or designated scenic views. The natural harmony in this area ranges from moderately low to moderate. Although most of the natural environment has been replaced by suburban development, there are some areas with organized and maintained recreational areas supporting residents. The cultural order is moderate because the area maintains its suburban character, with retail strip centers and some industrial developments adjacent to US 290 and residential areas behind these uses. The overall visual quality of this landscape unit is moderate, as shown in **Table 3.10-25.**

Table 3.10-25: Visual Quality Assessment – Landscape Unit #11

KVP	KVP Location	Vividness	Natural Harmony	Cultural Order	Visual Quality
28	Stonegate Neighborhood Park	Moderate (3)	Moderate (3)	Moderate (3)	Moderate (3)
29	White Oak Falls neighborhood	Moderate (3)	Moderate (3)	Moderate (3)	Moderate (3)
30	US 290	Low (1)	Moderately low (2)	Moderate (3)	Moderately low (2)
LU 11	Landscape Unit #11	Moderately low (2)	Moderate (3)	Moderate (3)	Moderate (2.7)

Source: AECOM 2019

Figure 3.10-27: Landscape Unit #11 (KVP #30)



Source: AECOM 2019

3.10.4.11.2 Visual Resources in Landscape Unit #11

Table 3.10-26 identifies the visual resources noted within Landscape Unit #11, which include numerous community facilities and resources.

Table 3.10-26: Visual Resources – Landscape Unit #11

Segment	Resource Name	Resource Type	Special Designation	Distance from LOD (feet)	Mapbook Page #[a]
5	Cypress Top Historic Park	Recreation/Cultural	No	199	244
5	Houston National Golf Club	Community Business	No	200	245[b]
5	Stonegate Neighborhood Park	Recreation	No	205	245[b]
5	Jersey Meadow Golf Course	Recreation	No	1,367	248
5	The Connection School of Houston	School	No	0	244
5	St. Aidan's Episcopal Church	Religious Facility	No	368	244
5	Cy-Fair High School	School	No	759	246
5	Arnold Middle School	School	No	602	246
5	North Cypress Medical Center	Hospital	No	964	246
5	Cypress Falls Senior High School	School	No	314	247
5	Veterans of Foreign Wars	Community Facility		580	246
5	Humble Oil Gas Station	Building	NRHP Eligible	308	244
5	Jersey Village Baptist Church	Religious Facility	No	44	249

Source: AECOM 2019

NRHP - National Register of Historic Places

[a] Refer to **Appendix D, Community and Cultural Resources Mapbook**.

[b] While these facilities are not labeled on the mapbooks as community facilities due to their private ownership, they can still be found on the referenced pages.

3.10.4.12 Landscape Unit #12 Hempstead Corridor, Sam Houston Parkway to Tex-Tube (Harris County)

Landscape Unit #12 is within Segment 5 in Harris County and is characterized by suburban development with residential, commercial and industrial uses. The terrain is similar to Landscape Unit #11 and generally flat, but this unit contains more industrial development, especially adjacent to the UPRR freight rail corridor. Hempstead Road is the major highway in this unit and is a four-lane, undivided road. It is a major thoroughfare that operates parallel to and south of US 290. Large commercial parks line Hempstead Road and provide a buffer for the residential areas from the transportation infrastructure.

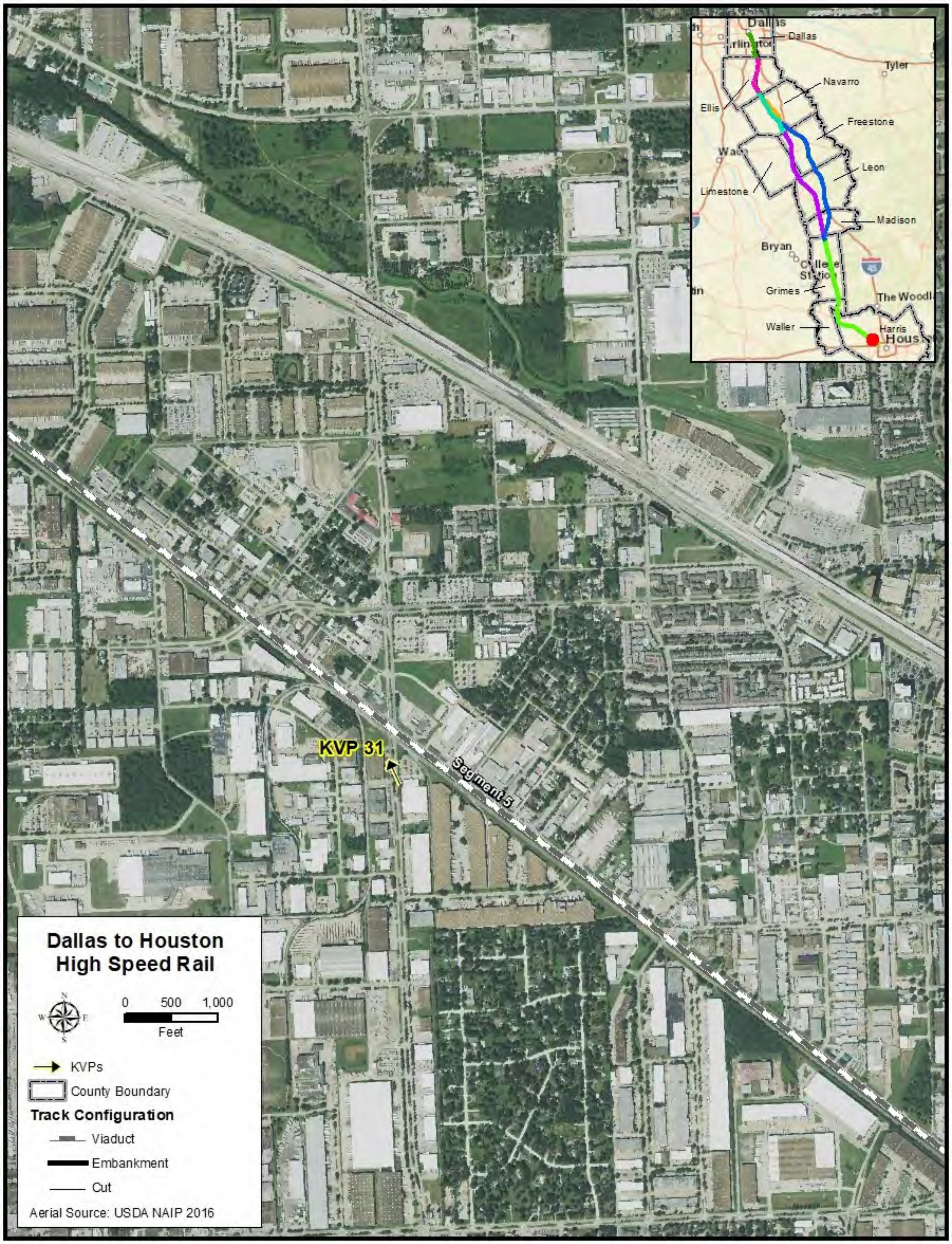
Two KVPs were identified in this landscape unit:

- KVP #31 is a typical view from a commercial business park located south of Hempstead Road.
- KVP #32 is a typical view from a commercial and industrial area located north of Hempstead Road.

3.10.4.12.1 Landscape Unit #12 Visual Quality

KVP #31 is a typical view from a commercial area of large warehouse buildings located south of Hempstead Road (**Figure 3.10-28**). Due to the height and density of the built environment as well as the surrounding landscape, views are restricted. Although the area is primarily commercial, it is generally well maintained and orderly, with moderately low vividness and natural harmony, and moderate cultural order.

Figure 3.10-28: Landscape Unit #12 (KVP #31)



Source: AECOM 2019

KVP #32 is a typical view from a commercial and industrial area north of Hempstead Road (**Figure 3.10-29**). The development in this area is older and not as well maintained. Vividness is low. Natural harmony is moderately low, and cultural order is moderate.

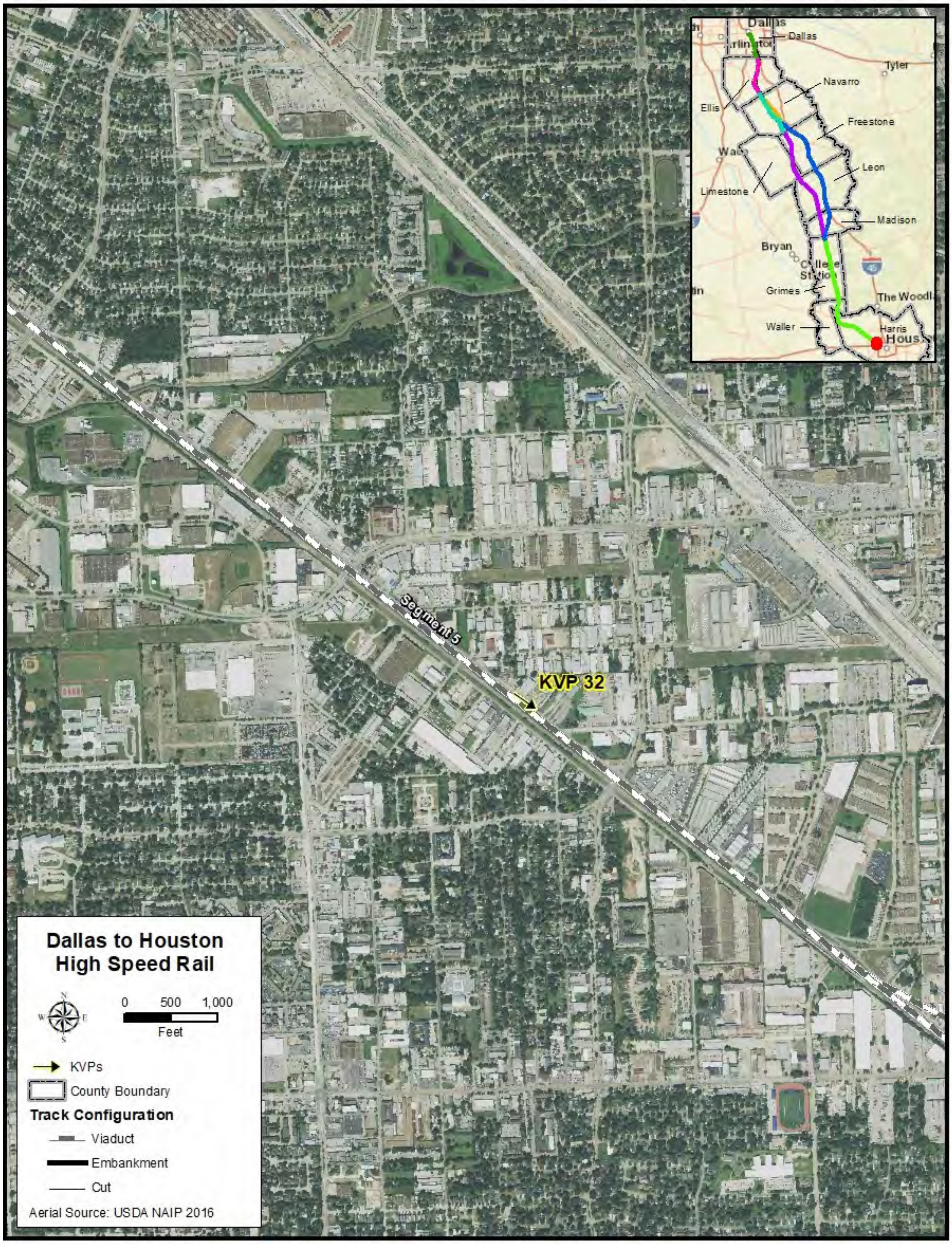
The vividness in this landscape unit is moderately low. The area is a mix of land use composition, including residential, industrial, commercial and some recreational land uses. The natural harmony is moderately low. Most of the natural environment has been replaced by built environment, including two large transportation corridors. The cultural order of the area is moderate. Most of the industrial and commercial land uses are adjacent to the busier transportation facilities, while neighborhoods are located behind the main roads. The overall visual quality in this landscape unit is moderately low, as shown in **Table 3.10-27**.

Table 3.10-27: Visual Quality Assessment – Landscape Unit #12

KVP	KVP Location	Vividness	Natural Harmony	Cultural Order	Visual Quality
31	Commercial business park	Moderately low (2)	Moderately low (2)	Moderate (3)	Moderately low (2.3)
32	Urban commercial/industrial	Low (1)	Moderately low (2)	Moderate (3)	Moderately low (2)
LU 12	Landscape Unit #12	Moderately low (2)	Moderately low (2)	Moderate (3)	Moderately low (2.3)

Source: AECOM 2019

Figure 3.10-29: Landscape Unit #12 (KVP #32)



Source: AECOM, 2019

3.10.4.12.2 Visual Resources in Landscape Unit #12

Table 3.10-28 identifies the visual resources noted within Landscape Unit #12.

Table 3.10-28: Visual Resources – Landscape Unit #12

Segment	Resource Name	Resource Type	Special Designation	Distance from LOD (feet)	Mapbook Page #[a]
5	Mountain of Faith Christian Center Church	Religious Facility	No	1,110	250
5	Fairbanks United Methodist Church	Religious Facility	No	363	250
5	Fairbanks	Cemetery	No	265	250
5	Christian Family Church	Religious Facility	No	49	250
5	First United Methodist Korean Church	Religious Facility	No	873	250
5	Dean Middle School	School	No	1,103	250
5	Bane Elementary School	School	No	696	250
5	The Panda Path School Spring Branch ISD	School	No	538	251
5	Housman Elementary	School	No	1,434	253
5	T.C. Jester Park	Recreation	No	180	253, 254
5	Spring Spirit Sports and Education Complex	Community Center	No	1,254	251
5	Spring Branch Family Development Center	Community Center	No	493	251
5	Northwest Educational Center	Community Center	No	696	252
5	Hindu Worship Society	Religious Facility	No	856	252
5	Assurance of Hope Church of God in Christ	Religious Facility	No	1,014	252
5	Church of Christ – Brookhollow	Religious Facility	No	758	252
5	Templo Pentecostal Gestemani	Religious Facility	No	1,094	252
5	Templo El Buen Samaritano	Religious Facility	No	1,025	253

Source: AECOM 2019

[a] Refer to **Appendix D, Community and Cultural Resources Mapbook**.

3.10.4.13 Landscape Unit #13 Northwest/Post Oak (Harris County)

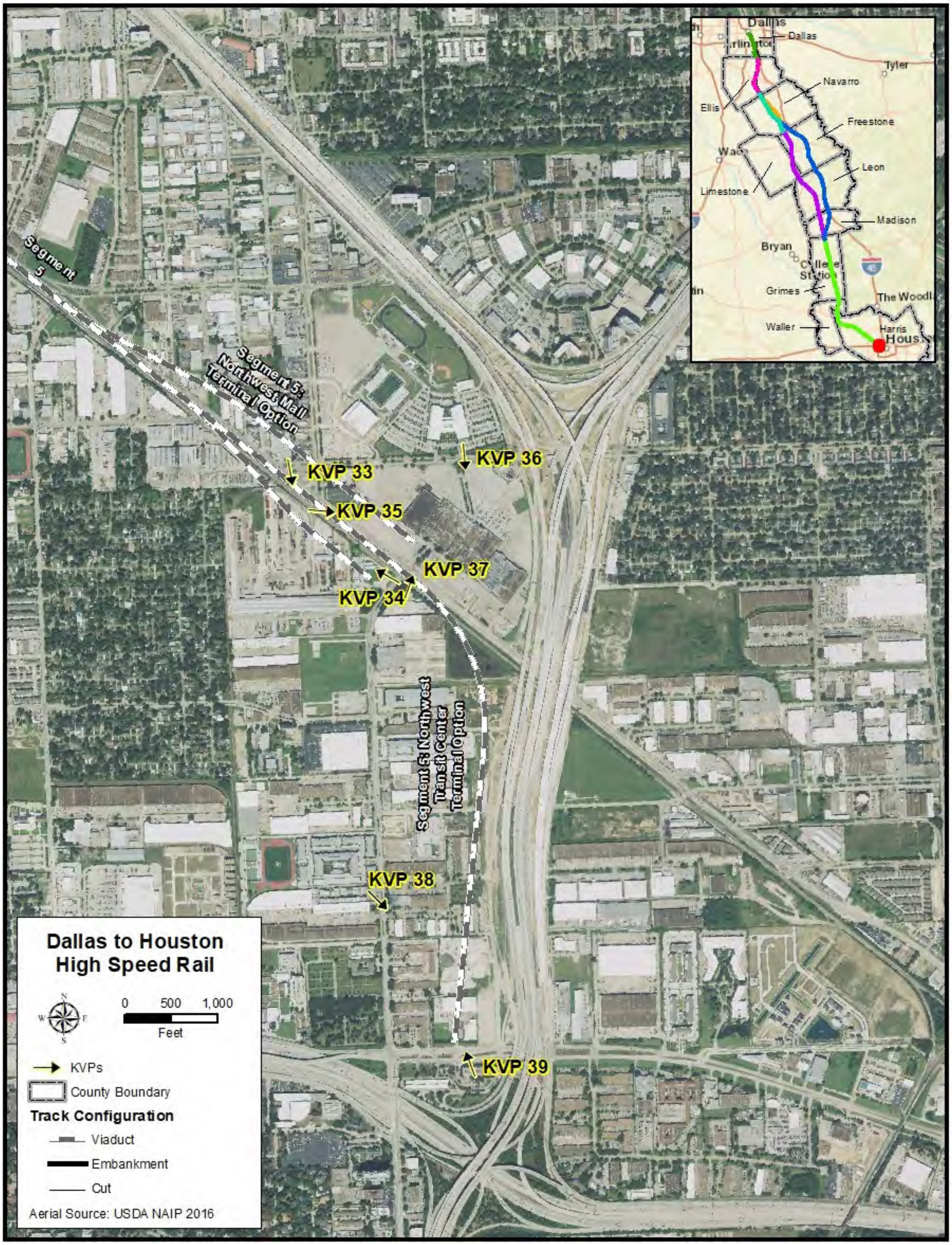
3.10.4.13.1 Landscape Unit #13 Visual Quality

Landscape Unit #13 is located within Segment 5 in Harris County in the area around the three Houston Terminal Station options. Landscape Unit #13 includes the urban area near IH-610, US 290 and IH-10. The land use in this area is primarily composed of commercial and industrial uses. Although much of the area is industrial, new construction is revitalizing the established neighborhood to the west.

The KVPs in this landscape unit are shown on **Figure 3.10-30**.

The northern part of the landscape unit is mostly industrial or abandoned, and the visual quality is low to moderately low. The viewshed contains the Tex-Tube industrial facility, the UPRR line and Hempstead Road, as well as IH-610, US 290 and IH-10. The area is composed of an abandoned mall, a large industrial site, the Houston ISD Delmar Sports Complex and Hattie Mae White Educational Support Center.

Figure 3.10-30: Landscape Unit #13 (KVP #33 to #39)



Source: AECOM 2019

KVP #33 and KVP #34 are typical views of the location of the Houston Industrial Site Terminal Station Option. KVP#33 is from the north side of Hempstead Road, and KVP #34 is from Post Oak Road. This area includes mostly industrial development with moderately low vividness, natural harmony and cultural order.

KVPs #35, #36 and #37 are specific views of the location of the Houston Northwest Mall Terminal Station Option. KVP #35 is from Hempstead Road facing northeast; KVP #36 is from West 18th Street facing south and KVP #37 is from the intersection at Hempstead Road and Post Oak Road. This area includes the abandoned Northwest Mall site and athletic and academic facilities for Houston ISD. The vacant mall, industrial land uses and elevated highways contribute to moderately low vividness and cultural order; however, the natural harmony is moderate.

KVPs #38 and #39 are specific views of the Northwest Transit Center Terminal Station Option. KVP #38 is from Post Oak Road facing south and KVP #39 is from Old Katy Road facing north. This area includes commercial business parks, residential complexes, Awty International School and the Beth Yeshurum historic cemetery. The Houston Metro Northwest Transit Facility is located at Old Katy Road and Post Oak Road, represented by KVP #39. The area is generally aesthetically pleasing with landscaping, trees along the roads and newer construction. Vividness, natural harmony and cultural order are moderate.

The vividness in this landscape unit ranges from moderately low to moderate. There are no memorable or designated views within the landscape area. The natural harmony and cultural order in the area are moderately low along Hempstead Road and moderate for the areas outside of the immediate Hempstead Road corridor. The areas farther away from Hempstead Road tend to have more pleasing composition of natural environment elements. Additionally, there are less industrial land uses breaking up the cultural order of urban neighborhoods. Overall visual quality of Landscape Unit #13 is moderate, as shown in **Table 3.10-29**.

Table 3.10-29: Visual Quality Assessment – Landscape Unit #13

KVP	KVP Location	Vividness	Natural Harmony	Cultural Order	Visual Quality
33	Hempstead Tex Tube	Moderately low (2)	Moderately low (2)	Moderately low (2)	Moderately low (2)
34	Post Oak Tex Tube	Moderately low (2)	Moderately low (2)	Moderately low (2)	Moderately low (2)
35	Hempstead NW Mall	Moderately low (2)	Moderate (3)	Moderately low (2)	Moderately low (2.3)
36	18th St. NW Mall	Moderately low (2)	Moderate (3)	Moderately low (2)	Moderately low (2.3)
37	Post Oak NW Mall	Moderately low (2)	Moderate (3)	Moderately low (2)	Moderately low (2.3)
38	Post Oak NW Transit	Moderate (3)	Moderate (3)	Moderate (3)	Moderate (3)
39	NW Transit Station	Moderate (3)	Moderate (3)	Moderate (3)	Moderate (3)
LU 13	Landscape Unit #13	Moderately low (2)	Moderate (3)	Moderate (3)	Moderate (2.7)

Source: AECOM 2019

3.10.4.13.2 *Visual Resources in Landscape Unit #13*

Table 3.10-30 identifies the visual resources noted within this Landscape Unit.

Table 3.10-30: Visual Resources – Landscape Unit #13

Segment	Resource Name	Resource Type	Special Designation	Distance from LOD (feet)	Mapbook Page #[a]
5	Tex-Tube	Building	NRHP Eligible	0	253, 254
5	Beth Yeshurum-Post Oak	Cemetery	HTC	10	253, 254
5	Awty International School	Community facility	No	988	253, 254
5	Awty International School Early Learning Campus	School	No	0	253, 254
5	HISD Delmar Sports Complex	Community Center	No	273	253, 254
5	HISD Hattie Mae White Educational Support Center	School	No	186	253, 254

Source: AECOM 2019

NRHP - National Register of Historic Places; HTC – Historic Texas Cemeteries

[a] Refer to **Appendix D, Community and Cultural Resources Mapbook**.

3.10.5 Environmental Consequences

This section describes the future visual quality of landscape units and KVPs that represent a typical or special view of the respective landscape unit and contribute to overall impact assessment of the landscape unit. Potential impacts to visual resources associated with the No Build Alternative, Build Alternatives and Houston Terminal Station options are described in this section. Impacts are organized by construction and operational impacts. Operational impacts are further defined by lighting impacts as well as overall impacts per landscape unit.

3.10.5.1 No Build Alternative

Under the No Build Alternative, the HSR system would not be constructed or operated. Existing trends affecting natural resources would be expected to continue without the contribution of Project. Continued population growth and development in suburban and transition areas (southeastern Dallas County, Ellis County, Waller County and northwestern Harris County) could potentially alter the visual quality of existing viewsheds and the viewer sensitivity of the neighbor viewer groups. Visual quality impacts would be expected as a result of other planned projects, such as the IH-35 East roadway improvement project in Dallas County, Waxahachie Line rail project in Dallas and Ellis Counties, Cross Texas Transmission Line Project and Integrated Pipeline Project in Navarro and Ellis Counties. The impacts of these projects are discussed in **Section 4.4, Indirect and Cumulative Impacts, Cumulative Impacts**.

3.10.5.2 Build Alternative

This section describes impacts to visual quality. Refer to the methodology in **Section 3.10.3** for a description of how visual impacts are assessed.

3.10.5.2.1 *Construction Impacts*

The construction of the Project would introduce temporary, visual impacts from fencing, lighting and clearing of trees. These impacts are categorized by visual characteristics in three environment classifications, urban, suburban and rural. For more detailed description, refer to **Appendix F, TCRR Final**

Conceptual Engineering Design and Constructability Reports and **Appendix G, TCRR Final Conceptual Engineering Plans and Details.**

Urban

Existing artificial lighting levels in urban environments are the highest among the three environments (urban, suburban and rural). The locations of the Dallas Terminal Station and the Houston Terminal Station options already contain a high density of structures and transportation infrastructure. Lighting from construction activities would not create a nuisance during the day in these environments. At night, light travels shorter distances in urban environments because of taller and denser structures, as well as elevated light levels from the number of structures with night lighting. In Dallas County, several key skyline features – Reunion Tower, Omni Convention Center Hotel, Bank of America Building and Margaret Hunt Hill Bridge – use LED lighting every night to paint the skyline and the urban center of the city. Additionally, the multi-level intersection of IH 35E and IH 30 adds more artificial light to the environment. Similarly, in Houston, the terminal station options would be in proximity to US 290, IH 610 and IH 10, all of which contain overhead lighting with poles approximately 100 feet above ground. Given the current lighting conditions of the Houston Terminal Station options, lighting from construction, including nighttime construction, would not create adverse impacts to the visual quality of the viewshed.

Material stockpiles and equipment could cause changes to the harmony and order of the surroundings from clearing and flattening of the land in order to prepare the site for material stockpiles and equipment. Stockpiles and equipment would create less of a nuisance in urban environments that are already experiencing construction activity. Construction sites located in, or adjacent to, primarily residential communities, could create adverse impacts to the visual quality of the area, particularly if mature trees are cleared.

Materials stockpiles and equipment on construction sites are typically surrounded by temporary security fencing. That security fencing would screen and minimize visual impacts to the surrounding area. Viewers in urban areas are familiar with these types of security fencing and the associated visual quality of such fencing. Therefore, viewers in urban areas would be less sensitive to the appearance of security fencing around construction sites.

Suburban

Within the Viewshed, the suburban areas consist of an urban to suburban transition, as well as a suburban to rural transition; therefore, impacts in these areas would be mixed. In suburban areas transitioning from urban areas, elevated light levels come from residential homes, retail strip centers and major thoroughfares and highways. These communities typically have the highest light levels near heavily trafficked roadways. Although light travels farther at night in suburban areas, the areas around heavily trafficked roadways would be less impacted by nighttime construction. The opposite could be true for the suburban to rural transition areas. If these areas contain open space with less dense development, the construction lighting impacts could be greater; however, there may be few viewers impacted and trees or other types of vegetation may limit the lighting impacts. Depending on the location of the construction site, nighttime construction may also be limited or prohibited by local ordinances, which could reduce or eliminate adverse lighting impacts.

For both the Dallas and Houston metropolitan areas, urban sprawl has created suburban areas that extend from Dallas and Harris Counties into Ellis and Waller Counties, respectively. The continued development in these urban to suburban areas, particularly adjacent to existing highway infrastructure, would minimize the impact of clearing land for construction areas. Construction sites located near existing cleared land, major thoroughfares and highways would not adversely impact the visual quality of the suburban communities. In suburban areas where the land has not been developed, new construction sites or land clearing would adversely impact the visual quality.

Similar to urban areas, security fencing around construction sites in suburban areas would minimize the visual impact of material stockpiles and equipment. Local ordinances may restrict the type (type of material and height) and appearance (painted or screened, as well as the use of signage) of construction fencing to minimize any temporary visual degradation.

Rural

Rural areas have the lowest levels of artificial light. This is a result of a low density of structures and transportation infrastructure in the area. The rural areas near IH-45 have the highest levels of artificial lighting due to their proximity to highways and interstates. Nighttime construction lighting would travel long distances in areas with little tree or vegetative cover and would be an adverse impact in these areas.

Clearing and grading land for construction site material stockpiles and equipment would impact rural areas differently depending on the location. Construction sites located in areas with few homes or businesses, along major roadways and areas with existing cleared land would not have adverse impacts. Additionally, there would be fewer viewers in these areas. Security fencing may help minimize the overall visual impact of construction sites or equipment by screening views.

3.10.5.2.2 Operational Components

A detailed description of the Project, including descriptions of the trainset, operational components, and typical sections, is found in **Section 2.2, Alternatives Considered, Proposed HSR Infrastructure and Operations**, as well as **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports,** and **Appendix G, TCRR Final Conceptual Engineering Plans and Details.** Various components of the HSR system including lighting, fencing, OCS and operational facilities were considered in the analysis of visual impacts. The following paragraphs provide descriptions of these components.

Lighting

The lighting of the HSR infrastructure would be consistent across all the landscape units. Permanent lighting along the rail line would include headlights on the front of the trainset, as well as lighting at stairways serving elevated sections of the Project. Lights will be provided at emergency access/egress points along the alignment, including the ground-level landing. Lighting from the front of the trainset would be directed downward to focus on the track, which would limit its projection outward to the community.

At stations, lighting would be optimized through architectural design to encourage natural sunlight, as well as adaptable and controllable lighting systems. The lighting system design would help minimize adverse light impacts emanating from station areas.

For more detailed description, refer to **Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports,** and **Appendix G, TCRR Final Conceptual Engineering Plans and Details.**

Fencing

The rail tracks would be within a fully closed system controlled through a combination of grade separation, fencing and intrusion protection barriers or systems as determined by a risk-based hazard analysis. The design and height of fencing will be determined during more detailed design and informed by the risk-based hazard analysis. For more detailed description, refer to**, Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports, Section 3.3, Right-of-Way (ROW).**

Overhead Catenary System

The OCS provides electric power to the trainsets from the power stations located along the Build Alternatives' alignment. The components of the OCS include overhead wires and supporting infrastructure to keep wiring in place. Supporting catenary poles would be located on each side of the HSR track and are approximately 42 feet above the top of the rail. The highest point of the OCS includes the lightning protection wire located at the top of the catenary pole. The distance from the top of the trainset to the top of the OCS is approximately 26 feet. Distance between catenary poles could range from 115 feet to 197 feet, and generally spaced approximately 165 feet.

For more detailed description, as well as images represented by similar technology, refer to **Section 2.2, Proposed HSR Infrastructure and Operations; Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports,** and **Appendix G, TCRR Final Conceptual Engineering Plans and Details.**

Operational Facilities

Operational facilities for the purposes of this analysis include those facilities that support the HSR system's power supply and general maintenance of the trainsets. These facilities include a TMF, MOW facility, TPSS, Sectioning Post (SP), Sub-sectioning Post (SSP), Auto Transformer Post (ATP), Main Signal House (MSH), Intermediate Signal House (ISH), Sub-signal House (SSH) and Communication House (CH). The largest of these facilities are the TMF, MOW, and TPSS. The TMF would require approximately 100 acres each, the MOW facilities would require approximately 20 acres each, and the TPSS would require approximately 11 acres each.

The operational facilities are analyzed in the Final EIS because engineering design has advanced since the publication of the Draft EIS. However, simulations of these facilities are not provided because the design of the facilities is not complete. The design will be completed during more detailed design stages. For more detailed descriptions, as well as images representing similar technology, refer to **Section 2.2, Alternatives Considered, Proposed HSR Infrastructure and Operations; Appendix F, TCRR Final Conceptual Engineering Design and Constructability Reports,** and **Appendix G, TCRR Final Conceptual Engineering Plans and Details.**

3.10.5.2.3 Landscape Unit #1 Southside/Riverfront District (Dallas County)

Landscape Unit #1 Viewers and Viewer Response

The landscape unit generally includes residential neighbors and institutional neighbors comprised of the people who live and work in downtown Dallas. Residential viewers in the apartment buildings and homes nearby would have high exposure and moderate sensitivity; however, these residents live in an urban setting and are accustomed to viewing transportation and other man-made infrastructure. Workers may have unobstructed views from windows elevated in high-rise buildings, but their attention is likely not focused primarily on views out of windows. In addition, there are recreational neighbors using urban parks in this landscape unit. Recreational users in the Riverfront District would have moderate exposure and awareness of the Project. This landscape unit would also have travelers on urban highways who would have high exposure to views but low sensitivity. Overall, viewer response to visual changes in Landscape Unit #1 would be moderate. **Table 3.10-31** provides a summary of the viewer exposure, sensitivity and response within Landscape Unit #1.

Table 3.10-31: Viewer Response – Landscape Unit #1			
Viewer Group	**Exposure**	**Sensitivity**	**Viewer Response**
KVP #1: Downtown Dallas			
Residential neighbors in urban areas	High	Moderate	High
Institutional neighbors – office workers	High	Low	Moderate
Travelers on urban highways	High	Low	Moderate
KVP #2: Southside on Lamar			
Residential neighbors in urban areas	High	Moderate	High
Institutional neighbors – office workers	High	Low	Moderate
Recreational neighbors in urban parks	Moderate	Moderate	Moderate
Travelers on urban highways	High	Low	Moderate
KVP #3: Cadiz Street			
Residential neighbors in urban areas	High	Moderate	High
Institutional neighbors – office workers	High	Low	Moderate
Recreational neighbors in urban parks	Moderate	Moderate	Moderate
Travelers on urban highways	High	Low	Moderate
Landscape Unit #1 Viewer Response			**Moderate**

Source: AECOM 2019

Visual Changes in Landscape Unit #1

Visual changes in Landscape Unit #1 would include the introduction of the Dallas Terminal Station, the HSR track and various operational facilities. The station platform would be elevated approximately 74 feet above ground. The top of the station structure would be 81 feet above the platform and would be covered with a reflective material. From the existing ground to the top of the station structure would be approximately 155 feet. Aerial covered walkways would connect the station to the downtown districts and parking garages, allowing pedestrians to bypass the UPRR line. The location and appearance of these facilities would be compatible with the area because they are consistent with other visual attributes of a downtown urban area. Station area improvements, such as landscaping and additional public amenities (lighting and seating), would enhance an undeveloped and industrial area. This landscape unit would contain one ATP, one MSH, and one CH. The addition of these facilities to the landscape unit would not adversely impact the visual quality of the landscape unit because the facilities would be compatible with the area and viewer response would be moderate.

Table 3.10-32 summarizes the visual changes, and **Figure 3.10-31** through **Figure 3.10-36** provide simulations of the Project from KVPs in this landscape unit.

Table 3.10-32: Visual Changes Summary – Landscape Unit #1				
KVP #	**KVP Location**	**Visual Quality – Existing**	**Visual Quality – Build Alternatives**	**Visual Change**
1	Downtown Dallas	Moderate	Moderately high	Moderate
2	Southside on Lamar	Moderate	Moderately high	Moderate
3	Cadiz Street	Moderate	Moderate	Low
LU 1	Landscape Unit #1	Moderate	Moderately high	Moderate

Source: AECOM 2019

Figure 3.10-31: KVP #1 Existing

Figure 3.10-32: KVP #1 Simulated Views

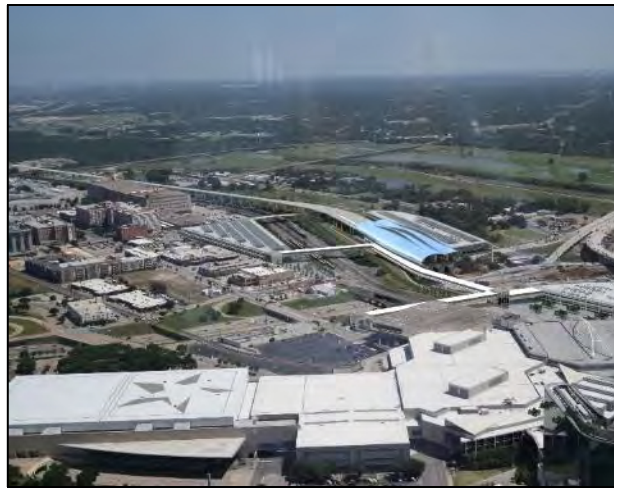


Figure 3.10-33: KVP #2 Existing

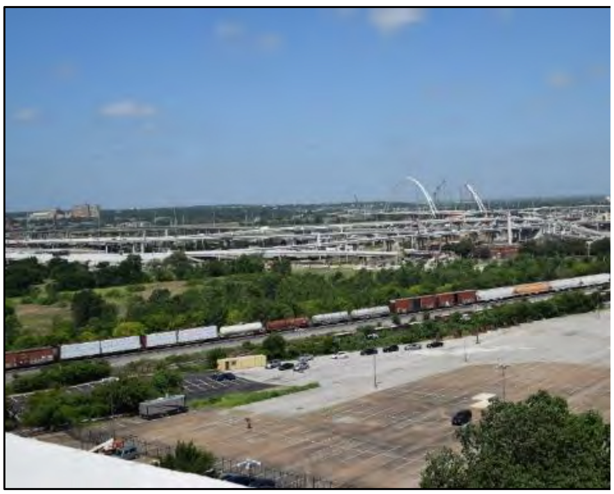


Figure 3.10-34: KVP #2 Simulated View

Figure 3.10-35: KVP #3 Existing

Figure 3.10-36: KVP #3 Simulated View

Source: AECOM 2019

Table 3.10-33 describes the potential visual impacts to visual resources identified in the landscape unit. More detailed descriptions of these facilities can be found in **Section 3.6, Natural Ecological Systems and Protected Species; Section 3.7, Waters of the U.S.; Section 3.11, Transportation; Section 3.13, Land Use; Section 3. 14, Socioeconomics and Community Facilities; Section 3.17, Recreational Facilities; Section 3.19, Cultural Resources;** and **Section 3.20, Soils and Geology**.

Table 3.10-33: Visual Resources – Landscape Unit #1

Build Alternative Alignment	Segment	Resource Name	Potential Visual Impact	Distance to LOD (feet)
A, B, C, D, E, F	1	Downtown Dallas	Neutral; Refer to **Section 3.10.5.2.3, Aesthetics and Scenic Resources.**	0
A, B, C, D, E, F	1	Kay Bailey Hutchinson Convention Center	Neutral; Refer to **Section 3.10.5.2.3, Aesthetics and Scenic Resources**. Station area can improve adjacent undeveloped land uses and help attract visitors to the convention center.	120
A, B, C, D, E, F	1	Reunion Park and Reunion Tower	Neutral; Reunion Park would have a very limited view due to obstructions. Reunion Tower would have a less limited view, but would still have obstructions in sight.	1,620
A, B, C, D, E, F	1	1214 Powhattan Street	Neutral; Limited view due to adjacent buildings obstructing view	336
A, B, C, D, E, F	1	1300 Powhattan Street	Neutral; Limited view due to adjacent buildings obstructing view	311
A, B, C, D, E, F	1	Cadiz Street Overpass and Underpass	Beneficial; Cadiz Street would likely be impacted due to the adjacency to the Dallas Terminal Station. Station area improvements would likely provide enhancement for Cadiz Street.	0
A, B, C, D, E, F	1	Cadiz Street Viaduct	Beneficial; The station area would enhance the character of the undeveloped and industrial area	0
A, B, C, D, E, F	1	Cadiz Pump Station	Neutral; Limited view due to adjacent buildings and infrastructure obstructing view	135
A, B, C, D, E, F	1	Dallas Coffin Company	Beneficial; The station area would enhance the character of the undeveloped and industrial area	186
A, B, C, D, E, F	1	Sears Dining Hall	Beneficial; The station area would enhance the character of the undeveloped and industrial area	245
A, B, C, D, E, F	1	Sears Complex Historic District	Beneficial; The station area would enhance the character of the undeveloped and industrial area; Refer to **Section 3.19, Cultural Resources**.	22
A, B, C, D, E, F	1	Sears Roebuck and Company Catalog Merchandise Distribution Center	Beneficial; The station area would enhance the character of the undeveloped and industrial area	351
A, B, C, D, E, F	1	Oak Cliff Box Company (1212 Riverfront Boulevard)	Beneficial; The station area would enhance the character of the undeveloped and industrial area	208
A, B, C, D, E, F	1	Trinity River	Neutral; No visual impact for viewers at this resource	0
A, B, C, D, E, F	1	Trinity River Greenbelt	Neutral; No visual impact for viewers at this resource	0
A, B, C, D, E, F	1	The Dallas Floodway	Neutral; No visual impact for viewers at this resource	0
A, B, C, D, E, F	1	Dallas Community College District	Beneficial; The station area would enhance the character of the undeveloped and industrial area	707

Table 3.10-33: Visual Resources – Landscape Unit #1				
Build Alternative Alignment	**Segment**	**Resource Name**	**Potential Visual Impact**	**Distance to LOD (feet)**
A, B, C, D, E, F	1	Wayside Missionary Baptist Church	Neutral; Limited view due to adjacent buildings obstructing view	1,235
A, B, C, D, E, F	1	Old City Park	Neutral; Limited view due to adjacent buildings obstructing view	1,044

Source: AECOM 2019

Visual Impact Assessment for Landscape Unit #1

Viewer Response: <u>Moderate</u> + Visual Change: <u>Moderate</u> = Visual Impacts: <u>Moderate (beneficial)</u>

The overall degree of impact to Landscape Unit #1 would be moderate and beneficial. The construction of the Dallas Terminal Station and its ancillary facilities (parking, transportation network updates, pedestrian access and greenspace) would transform unused or undeveloped lots into a modern transportation facility that would serve the urban downtown area. These changes, in conjunction with the redevelopment already occurring in the area and the existing transportation network (vehicular and freight), would improve the vibrancy of the area and enhance the overall visual experience within this landscape unit.

As shown on **Figures 3.10-31** through **3.10-36**, the scale of the Dallas Terminal Station and Build Alternatives A through F would be compatible with the area, as there are several multi-lane elevated roadways, interchanges and bridge structures. The scale and size of the Dallas Terminal Station and HSR track on viaduct would introduce a new element to the Riverfront District; however, there are adjacent areas with structures of similar scale. The two bridge structures in the background also have a modern design and many of the buildings in downtown also have reflective coverings.

3.10.5.2.4 <u>Landscape Unit #2 Trinity River Crossing (Dallas County)</u>

Landscape Unit #2 Viewers and Viewer Response

The primary viewers in this landscape unit are residential, recreational and industrial/commercial neighbors and travelers on urban highways. Residential viewers may have the highest exposure, but they have become accustomed to seeing large transportation and utility infrastructure, which moderates their sensitivity. Some recreational viewers would have higher sensitivities than others; however, these viewers have become accustomed to the surrounding urban setting. Industrial/commercial neighbors are generally workers with moderate exposure and low sensitivity. Travelers on urban highways have high exposure to views but low sensitivity as they are focused on the road and surrounding vehicles. Overall, viewer response to visual changes in Landscape Unit #2 would be moderate. **Table 3.10-34** provides a summary of the viewers and viewer response in Landscape Unit #2.

Table 3.10-34: Viewer Response – Landscape Unit #2			
Viewer Group	**Exposure**	**Sensitivity**	**Viewer Response**
KVP #4: Lamar St & MLK Blvd			
Residential neighbors in urban areas	High	Moderate	High
Industrial/commercial neighbors	Moderate	Low	Moderate
Travelers on urban highways	High	Low	Moderate

Table 3.10-34: Viewer Response – Landscape Unit #2			
Viewer Group	**Exposure**	**Sensitivity**	**Viewer Response**
KVP #5: Santa Fe Trestle Trail			
Residential neighbors in urban areas	High	Moderate	High
Recreational neighbors in urban parks	Moderate	Moderate	Moderate
KVP #6: IH-45/Trinity River			
Industrial/commercial neighbors	Moderate	Low	Moderate
Travelers on urban highways	High	Low	Moderate
Landscape Unit #2 Viewer Response			**Moderate**

Source: AECOM 2019

Visual Changes in Landscape Unit #2

Visual changes in Landscape Unit #2 would include the HSR track, which would be on viaduct elevated above the trees and over some structures. Build Alternatives A through F would be compatible with the urban and industrial area surrounding the alignment. Although some viewers would be able to see the HSR viaduct, the form and materials of the Build Alternatives would be similar to the existing environment.

Residential and recreational viewers at the residences near Martin Luther King, Jr. Boulevard, South Lamar Street, and Forest Park (KVP #4) would have a view of the Project; however, the views would be limited depending on viewer location and by the presence of trees and height of structures.

In the vicinity of KVP #5 Build Alternatives A through F would be elevated above the river levees, approximately at the same height as a large warehouse**.** The HSR track would be on viaduct elevated above the DART light rail tracks approximately 68 feet above the existing ground level, shown on the right side of **Figure 3.10-40**. The top of the OCS would be approximately 42 feet from the top of the track. The views of the downtown Dallas skyline would not be interrupted and the HSR viaduct's form and materials would be compatible with the environment, which contains large transmission towers and the DART light rail.

In the vicinity of KVP #6 the introduction of the HSR track would reduce the existing view of the river and forest. Only the tops of the trees would be visible. The visual quality at KVP #6 would be reduced from moderate to moderately low.

Table 3.10-35 summarizes the visual changes and **Figure 3.10-37** through **Figure 3.10-42** provide simulations of the Project from KVPs in this landscape unit.

Table 3.10-35: Visual Change Summary - Landscape Unit #2				
KVP #	**KVP Location**	**Visual Quality - Existing**	**Visual Quality - Build Alternatives**	**Visual Change**
4	Lamar St & MLK Blvd	Moderately low	Moderately low	Low
5	Santa Fe Trestle Trail	Moderate	Moderate	Low
6	IH-45/Trinity River	Moderate	Moderately low	Moderate
LU 2	Landscape Unit #2	Moderate	Moderate	Low

Source: AECOM 2019

Figure 3.10-37: KVP #4 Existing

Figure 3.10-38: KVP #4 Simulated View

Figure 3.10-39: KVP #5 Existing

Figure 3.10-40: KVP #5 Simulated View

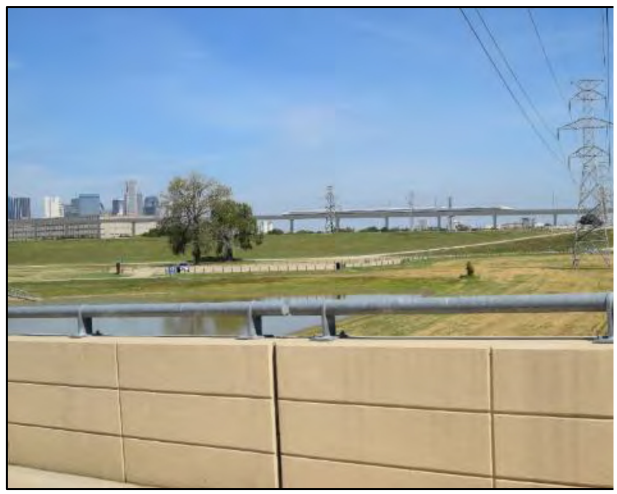


Figure 3.10-41: KVP #6 Existing

Figure 3.10-42: KVP #6 Simulated View

Source: AECOM 2019

Table 3.10-36 describes the potential visual impacts to visual resources identified in the landscape unit. More detailed descriptions of these facilities can be found in **Section 3.6, Natural Ecological Systems and Protected Species; Section 3.7, Waters of the U.S.; Section 3.11, Transportation; Section 3.13, Land Use; Section 3. 14, Socioeconomics and Community Facilities; Section 3.17, Recreational Facilities; Section 3.19, Cultural Resources;** and **Section 3.20, Soils and Geology**.

Table 3.10-36: Visual Resources – Landscape Unit #2

Build Alternative Alignment	Segment	Resource Name	Potential Visual Impact	Distance to LOD (feet)
A, B, C, D, E, F	1	Trinity River	Neutral; No visual impact for viewers at this resource	0
A, B, C, D, E, F	1	Trinity River Forest	Neutral; No visual impact for viewers at this resource	0
A, B, C, D, E, F	1	Corinth Street Underpass and Overpass (Viaduct)	Neutral; No visual impact for viewers at this resource	49
A, B, C, D, E, F	1	Santa Fe Trestle Trail	Neutral; Refer to **Section 3.10.5.2.4, Aesthetics and Scenic Resources**	1,025a
A, B, C, D, E, F	1	Forest Park	Neutral; Refer to **Section 3.10.5.2.4, Aesthetics and Scenic Resources**	948
A, B, C, D, E, F	1	Martin Luther King Median	Neutral; Limited view due to adjacent buildings and utility infrastructure obstructing view	955
A, B, C, D, E, F	1	Dallas Floodway Historic District	Neutral; Limited view due to adjacent buildings and utility infrastructure obstructing view	0
A, B, C, D, E, F	1	Guiberson Corp. Machine Shop	Adverse; The building would likely be directly impacted being within the LOD, where track on viaduct would be constructed.	0
A, B, C, D, E, F	1	Guiberson Corp. Residence	Adverse; The building would likely be indirectly impacted being within the LOD, where track on viaduct would be constructed.	52
A, B, C, D, E, F	1	Proctor and Gamble Complex	Neutral; Some limited view due to infrastructure on the site. No adverse visual impact because viewers on the property would have a low sensitivity.	413
A, B, C, D, E, F	1	Damascus Missionary Baptist Church	Neutral; Limited view due to adjacent buildings and utility infrastructure obstructing view	1,122

Source: AECOM 2019

[a] This distance is from the KVP location. At its closet point Santa Fe Trestle Trail is approximately 750 feet from the LOD.

Visual Impact Assessment for Landscape Unit #2

Viewer Response: Moderate + Visual Change: Low = Visual Impacts: Low (neutral)

The scale of Build Alternatives A through F would be compatible with the elevated height of IH-45, and the form and materials would be compatible with the existing environment. The overall degree of impact for Landscape Unit #2 would be low and neutral, despite a reduction in visual quality at KVP #6, as the Build Alternatives would be compatible with the environment. The low visual impact score is due to most viewers' low sensitivity to visual changes as a result of the urban environment.

3.10.5.2.5 Landscape Unit #3 South Dallas Residential (Dallas County)

Landscape Unit #3 Viewers and Viewer Response

Viewers in Landscape Unit #3 include residential, recreational and institutional neighbors. Residential neighbors would have high exposure but are accustomed to the urban setting and have moderate sensitivity. Recreational users of urban parks have moderate exposure and moderate sensitivity. Institutional neighbors include those at the cemetery and community resources, who have moderate exposure and moderate sensitivity. This landscape unit also has travelers on urban highways with high exposure and low sensitivity. Overall viewer response for Landscape Unit #3 is moderate. **Table 3.10-37** summarizes the viewers and viewer response within Landscape Unit #3.

Table 3.10-37: Viewer Response – Landscape Unit #3

Viewer Group	Exposure	Sensitivity	Viewer Response
KVP #7: Bulova/Homecoming (Honey Springs Cemetery)			
Residential neighbors in urban areas	High	Moderate	High
Recreational neighbors in urban parks	Moderate	Moderate	Moderate
Industrial/commercial neighbors	Moderate	Low	Low
Institutional neighbors – schools, community centers, churches	Moderate	Moderate	Moderate
Travelers on urban highways	High	Low	Moderate
KVP #8: Fruitdale Park			
Residential neighbors in urban areas	High	Moderate	High
Institutional neighbors – schools, community centers, churches	Moderate	Moderate	Moderate
Recreational neighbors in urban parks	Moderate	Moderate	Moderate
Travelers on urban highways	High	Low	Moderate
KVP #9: IH-45			
Travelers on urban highways	High	Low	Moderate
Landscape Unit #3 Viewer Response			**Moderate**

Source: AECOM 2019

Visual Changes in Landscape Unit #3

Visual changes in Landscape Unit $3 would include the introduction of the HSR track/viaduct and various operational facilities. The HSR viaduct would be located west of the frontage roads along IH-45, and the base of the structure would be elevated to the height of the tallest trees. The overhead catenary lines would be at a similar height to the lighting system along the interstate. The interstate, freight rail line and utility lines would still be prevalent in views. This landscape unit would contain one TMF, one TPSS, one SSP, one MSH, one SSH and one CH. The TMF and supporting facilities would require a large amount of land, over 100 acres. The locations for these facilities would be in forested areas between the Project and IH-45.

The visual quality would be reduced from moderate to moderately low at KVP #7. While tree coverage blocks some views, it would not completely shield the cemetery from the HSR infrastructure. The remaining KVP's visual quality would remain unchanged. At KVP #8, visual quality would remain moderate because existing views would not be limited or reduced in quality. At KVP #9, some views of the trees and forested areas may be reduced but overall visual quality would remain moderate.

Table 3.10-38 summarizes the visual changes, and **Figure 3.10-43** through **Figure 3.10-48** provide simulations of the Project from KVPs in this landscape unit.

Table 3.10-38: Visual Change Summary				
KVP #	**KVP Location**	**Visual Quality – Existing**	**Visual Quality – Build Alternatives**	**Visual Change**
7	Bulova/Homecoming (Honey Springs Cemetery)	Moderate	Moderately low	Moderate
8	Fruitdale Park	Moderate	Moderate	Low
9	IH-45	Moderate	Moderate	Low
LU 3	Landscape Unit #3	Moderate	Moderate	Low

Source: AECOM 2019

Figure 3.10-43: KVP #7 Existing

Figure 3.10-44: KVP #7 Simulated View

Figure 3.10-45: KVP #8 Existing

Figure 3.10-46: KVP #8 Simulated View

Figure 3.10-47: KVP #9 Existing

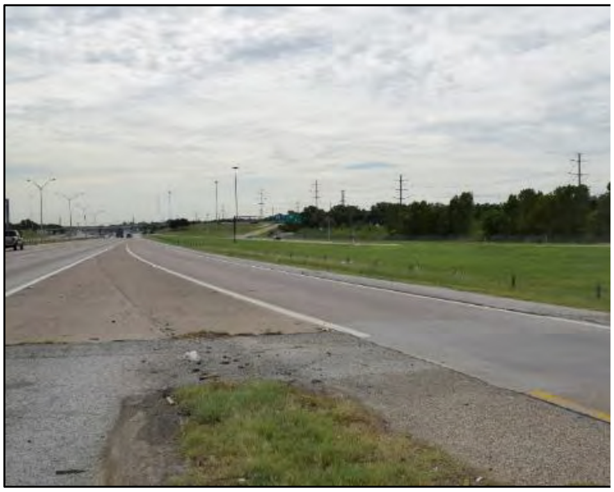
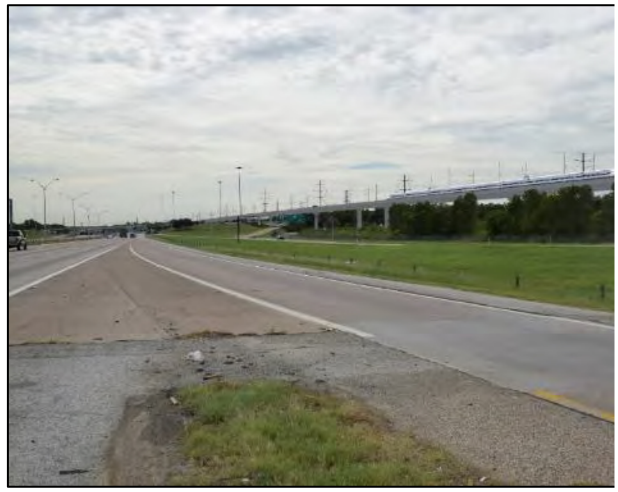


Figure 3.10-48: KVP #9 Simulated View



Source: AECOM 2019

Table 3.10-39 describes the potential visual impacts to visual resources identified in the landscape unit. More detailed descriptions of these facilities can be found in **Section 3.6, Natural Ecological Systems and Protected Species; Section 3.7, Waters of the U.S.; Section 3.11, Transportation; Section 3.13, Land Use; Section 3. 14, Socioeconomics and Community Facilities; Section 3.17, Recreational Facilities; Section 3.19, Cultural Resources;** and **Section 3.20, Soils and Geology**.

Table 3.10-39: Visual Resources – Landscape Unit #3

Build Alternative Alignment	Segment	Resource Name	Potential Visual Impact	Distance to LOD (feet)
A, B, C, D, E, F	1	Honey Springs (Bulova Homecoming Cemetery)	Adverse; See **Section 3.10.5.2.5, Aesthetics and Scenic Resources** and **Section 3.19, Cultural Resources**.	3
A, B, C, D, E, F	1	Railroad Bridge at E. Illinois Ave.	Neutral; Due to the resource being a historic transportation resource, the integrity of the property would not be directly or indirectly diminished.	47
A, B, C, D, E, F	1	Smith Family Cemetery	Adverse; See **Section 3.19, Cultural Resources**.	5
A, B, C, D, E, F	1	Fruitdale Park/Recreation Center	Neutral; Refer to **Section 3.10.5.2.5, Aesthetics and Scenic Resources**	213
A, B, C, D, E, F	1	Seaton Park	Neutral; Limited view due to adjacent buildings and mature trees obstructing view	943
A, B, C, D, E, F	1	J.J. Lemon Park	Neutral; Limited view due to adjacent buildings and mature trees obstructing view	995
A, B, C, D, E, F	1	Paul Quinn College	Neutral; Limited view due to adjacent buildings and mature trees obstructing view	1,526
A, B, C, D, E, F	1	Wiley Chapel Baptist Church	Neutral; Somewhat limited view due to adjacent buildings and mature trees obstructing view. Structure is adjacent to existing freight rail	458
A, B, C, D, E, F	1	Rejoicing Tabernacle Church of God in Christ	Neutral; Limited view due to adjacent buildings and mature trees obstructing view	452
A, B, C, D, E, F	1	Church of Revelation	Neutral; Somewhat limited view due to adjacent buildings and mature trees obstructing view. Structure is adjacent to existing freight rail	163

Table 3.10-39: Visual Resources – Landscape Unit #3				
Build Alternative Alignment	**Segment**	**Resource Name**	**Potential Visual Impact**	**Distance to LOD (feet)**
A, B, C, D, E, F	1	Friendship Missionary Baptist Church	Neutral; Somewhat limited view due to adjacent buildings and mature trees obstructing view. Structure is adjacent to existing freight rail	641
A, B, C, D, E, F	1	Kingdom United Baptist Church	Neutral; Limited view due to adjacent buildings and mature trees obstructing view	1,605
A, B, C, D, E, F	1	Galilee Missionary Baptist Church	Neutral; Limited view due to adjacent buildings and mature trees obstructing view	732
A, B, C, D, E, F	1	College Park Baptist Church	Neutral; Limited view due to adjacent buildings and mature trees obstructing view	576
A, B, C, D, E, F	1	Full Faith Deliverance Church	Neutral; Limited view due to adjacent buildings and mature trees obstructing view	405

Source: AECOM 2019

Visual Impact Assessment for Landscape Unit #3

Viewer Response: <u>Moderate</u> + Visual Change: <u>Low</u> = Visual Impacts: <u>Low (neutral)</u>

Despite the moderate reduction in visual quality at KVP #7, the degree of impact for Landscape Unit #3 on Build Alternatives A through F as a whole is low and neutral because the HSR viaduct and materials would be compatible with the environment, which already includes IH-45, a freight rail line, and overhead utility lines. The low visual impact score is due to lower viewer sensitivity as a result of the industrial and urban environment.

3.10.5.2.6 Landscape Unit #4 Suburban to Rural Transition, IH 20 to Palmer (Dallas and Ellis Counties)

Landscape Unit #4 Viewers and Viewer Response

Viewers in Landscape Unit #4 include residential (suburban/rural) neighbors, institutional neighbors at schools and community facilities, agricultural viewers and travelers on urban highways and rural routes. Rural residential viewers have high exposure and high sensitivity, while those at schools have moderate exposure and moderate sensitivity. Agricultural viewers would have moderate exposure and low sensitivity. Travelers on urban highways would have high exposure with low sensitivity, while travelers on rural routes would have lower exposure and greater sensitivity. The overall viewer response in Landscape Unit #4 would be moderate. **Table 3.10-40** provides a summary of the viewer exposure and sensitivity within Landscape Unit #4.

Table 3.10-40: Viewer Response – Landscape Unit #4			
Viewer Group	**Exposure**	**Sensitivity**	**Viewer Response**
KVP #10: Wilmer-Hutchins High School			
Residential neighbors in suburban/rural areas	High	High	High
Institutional neighbors – schools, community centers, churches	Moderate	Moderate	Moderate
Travelers on urban highways	High	Low	Moderate
KVP #11: Almand Rd (Palmer)			
Residential neighbors in suburban/rural areas	High	High	High
Travelers on rural routes	Moderate	Moderate	Moderate
Agricultural Viewers	Moderate	Low	Moderate

Table 3.10-40: Viewer Response – Landscape Unit #4			
Viewer Group	**Exposure**	**Sensitivity**	**Viewer Response**
Landscape Unit #4 Viewer Response			**Moderate**

Source: AECOM 2019

Visual Changes in Landscape Unit #4

Visual changes in Landscape Unit #4 would include the introduction of the HSR track/viaduct and various operational facilities (including one TPSS, one SP, one ISH and one CH). The largest of these facilities, the TPSS, would be located near an existing power substation for utility networks. Viewers in this area have become accustomed to the presence of large utility infrastructure.

In the vicinity of KVP #10, views of the Project on viaduct would be limited by vegetation and trees, as well as the slope of the terrain. The Project would be partially visible through gaps in tree cover on the west side of campus, where it would extend over Langdon Road. North of Langdon Road, only the top of the trainset and the overhead catenary lines would be visible from the school campus. Visual quality would be unchanged.

Surrounding KVP #11, views from the simulation show the retained cut track configuration, which would be below the existing grade and result in limited visibility of the HSR track. The fencing and electrical wiring would be compatible with the existing electrical utility infrastructure in the area. Visual quality would remain moderate.

Table 3.10-41 summarizes the visual changes, and **Figure 3.10-49** through **Figure 3.10-52** provide simulations of the Project from KVPs in this landscape unit.

Table 3.10-41: Visual Changes Summary				
KVP #	**KVP Location**	**Visual Quality – Existing**	**Visual Quality - Build Alternatives**	**Visual Changes**
10	Wilmer-Hutchins High School	Moderate	Moderate	Low
11	Almand Rd (Palmer)	Moderate	Moderate	Low
LU 4	Landscape Unit #4	Moderate	Moderate	Low

Source: AECOM 2019

Figure 3.10-49: KVP #10 Existing

Figure 3.10-50: KVP #10 Simulated View

Figure 3.10-51: KVP #11 Existing

Figure 3.10-52: KVP #11 Simulated View

Source: AECOM 2019

Table 3.10-42 describes the potential visual impacts to visual resources identified in the landscape unit. More detailed descriptions of these facilities can be found in **Section 3.6, Natural Ecological Systems and Protected Species; Section 3.7, Waters of the U.S.; Section 3.11, Transportation; Section 3.13, Land Use; Section 3. 14, Socioeconomics and Community Facilities; Section 3.17, Recreational Facilities; Section 3.19, Cultural Resources;** and **Section 3.20, Soils and Geology**.

Table 3.10-42: Visual Resources – Landscape Unit #4

Build Alternative Alignment	Segment	Resource Name	Potential Visual Impact	Distance to LOD (feet)
A, B, C, D, E, F	1	Wilmer-Hutchins High School	Neutral; Refer to **Section 3.10.5.2.6, Aesthetics and Scenic Resources**	2,018
A, B, C, D, E, F	1	AIA Lancaster Elementary School	Neutral; Direct view of the Project on embankment construction. Approximately ½-mile to the Project's centerline. Large utility corridor would still occupy a large part of the viewshed.	764

Source: AECOM 2019

Visual Impact Assessment for Landscape Unit #4

Viewer Response: Moderate + Visual Change: Low = Visual Impacts: Moderate (neutral)

The overall visual impact for Landscape Unit #4 would be moderate and neutral. Most viewers would have limited views of Build Alternatives A through F and its form and materials would be compatible with the existing environment, which includes other transportation and utility infrastructure.

3.10.5.2.7 Landscape Unit #5 Northern Rural, Palmer to Fairfield/Teague (Ellis, Navarro and Freestone Counties)

Landscape Unit #5 Viewers and Viewer Response

Viewers in Landscape Unit #5 are limited to residential neighbors in suburban/rural areas, agricultural viewers and travelers on rural routes. Because of the rural setting and potential for larger viewsheds, residential neighbors, agricultural viewers and travelers would typically have higher sensitivity than those in urban areas; however, mature trees and vegetation along property boundaries, as well as seasonal height of crops, may limit views. Therefore, the overall viewer response for Landscape Unit #5 is moderate. **Table 3.10-43** provides a summary of the viewers and viewer response in Landscape Unit #5.

Table 3.10-43: Viewer Response – Landscape Unit #5

Viewer Group	Exposure	Sensitivity	Viewer Response
KVP #12: Old Waxahachie Road (Ennis)			
Residential neighbors in suburban/rural areas	High	High	High
Agricultural Viewers	Moderate	Low	Moderate
Travelers on rural routes	Moderate	Moderate	Moderate
KVP #13: TX-31 Segment 3A/3B			
Residential neighbors in suburban/rural areas	Moderate	Moderate	Moderate
Agricultural Viewers	Moderate	Low	Moderate
Travelers on rural routes	Moderate	Moderate	Moderate
KVP #14: Spikes Rd/Love Bridge Rd			
Residential neighbors in suburban/rural areas	Moderate	Moderate	Moderate
Agricultural Viewers	Moderate	Low	Moderate
Travelers on rural routes	Moderate	Moderate	Moderate
Landscape Unit #5 Viewer Response			**Moderate**

Source: AECOM 2019

Visual Changes in Landscape Unit #5

Visual changes in Landscape Unit #5 would include the introduction of the HSR track as well as various operational facilities. The location of the MOW facilities would not change the visual quality of the landscape unit because they are either located in areas with few viewers and/or have views that are limited as a result of adjacent trees and vegetation.

Due to location of the TPSS facilities, the addition of these facilities could adversely impact the visual quality for residents near the TPSSs, unless existing vegetation or trees could limit views, or a similar facility existed near the TPSS locations. Mitigation would be necessary to minimize visual impacts for existing residents near these facilities; however, the introduction of the operational facilities within the entire landscape unit would not adversely impact visual quality.

Views surrounding KVP #12 would be degraded due to the proximity to the Project to existing agricultural lands. Views would include a viaduct track configuration elevated above the existing ground approximately 35 feet to the top of the rail. The OCS for the Project would appear lower than the existing utility infrastructure. Visual quality at this KVP would decrease from moderate to moderately low.

Views surrounding KVP #13 would see the HSR viaduct below the height of the existing transmission wires. Visual quality at this KVP would be remain moderate because the viaduct’s form and materials would be compatible with the existing transmission towers and environment.

At KVP #14, the HSR track would be on embankment Due to the height of the embankment, views of the forest in the background would be reduced. As a result, visual quality would be slightly reduced from moderate to moderately low. In addition, the Project form and materials would not be compatible with the environment in this area due to the lack of existing large infrastructure in the majority of views.

Table 3.10-44 summarizes the visual changes, and **Figure 3.10-53** through **Figure 3.10-58** provide simulations of the Project from KVPs in this landscape unit.

Table 3.10-44: Visual Changes Summary

KVP #	KVP Location	Visual Quality – Existing	Visual Quality – Build Alternatives	Visual Changes
12	Old Waxahachie Road (Ennis)	Moderate	Moderately low	Moderate
13	TX 31 Segment 3A/3B	Moderate	Moderate	Low
14	Spikes Rd/Love Bridge Road	Moderate	Moderately low	Moderate
LU 5	Landscape Unit #5	Moderate	Moderate	Moderate

Source: AECOM 2019

Figure 3.10-53: KVP #12 Existing

Figure 3.10-54: KVP #12 Simulated View

Figure 3.10-55: KVP #13 Existing

Figure 3.10-56: KVP #13 Simulated View

Figure 3.10-57: KVP #14 Existing

Figure 3.10-58: KVP #14 Simulated View

Source: AECOM 2019

Table 3.10-45 describes the potential visual impacts to visual resources identified in the landscape unit. More detailed descriptions of these facilities can be found in **Section 3.6, Natural Ecological Systems and Protected Species; Section 3.7, Waters of the U.S.; Section 3.11, Transportation; Section 3.13, Land Use; Section 3. 14, Socioeconomics and Community Facilities; Section 3.17, Recreational Facilities; Section 3.19, Cultural Resources;** and **Section 3.20, Soils and Geology**.

Table 3.10-45: Visual Resources – Landscape Unit #5

Build Alternative Alignment	Segment	Resource Name	Potential Visual Impact	Distance to LOD (feet)
A, B, C	2A	Boren	Neutral; No view of the HSR system	301
D, E, F	2B	Lake Bardwell Wildlife Management Area (WMA)	Neutral; limited view of the HSR system from multi-use trails typically used for horseback. Trails are surrounded by dense forest and vegetation. Some trails are overgrown and may not be accessible.	0
A, D	3A	Anderson Family	Neutral; No view of the HSR system	216
B, E	3B	Shelton Family	Neutral; No view of the HSR system	554
B, E	3B	Red	Neutral; No view of the HSR system	336

Source: AECOM 2019

Visual Impact Assessment for Landscape Unit #5

Viewer Response: Moderate + Visual Change: Moderate = Visual Impacts: Moderate (neutral)

The overall degree of visual impact for the landscape unit would be moderate and neutral. Some viewers in the landscape unit (primarily surrounding KVP #12 and KVP #14) would experience adverse visual quality impacts, especially where the Build Alternatives divert away from the large utility corridors or near residential communities; however, the majority of viewers in this landscape unit would have a moderate and neutral response to visual changes. Mitigation measures for visual impacts are described in **Section 3.10.6.**

3.10.5.2.8 Landscape Unit #6 Central Eastern Rural, Fairfield to Old San Antonio Road (Freestone, Limestone and Leon Counties)

Landscape Unit #6 Viewers and Viewer Response

Viewers in Landscape Unit #6 include primarily residential neighbors in suburban/rural areas and travelers on urban highways (IH-45). In addition, there are institutional viewers in Buffalo and recreational neighbors at Fort Boggy Park. There are few residential neighbors in the landscape unit; however, residential neighbors adjacent to the IH-45 corridor would have high exposure, but low sensitivity due to the proximity to a heavily traveled interstate highway. Recreational viewers at Fort Boggy Park would have low exposure and high sensitivity. The park is densely forested and views of the Project would only be possible in limited areas west of IH-45. The overall viewer response for Landscape Unit #6 is moderate. **Table 3.10-46** provides a summary of the viewers and viewer response in Landscape Unit #6.

Table 3.10-46: Viewer Response – Landscape Unit #6			
Viewer Group	**Exposure**	**Sensitivity**	**Viewer Response**
KVP #15: IH-45 Corridor			
Residential neighbors in suburban/rural areas	High	Low	Moderate
Travelers on urban highways	High	Low	Moderate
KVP #16: Buffalo Public Library/Shelley Pate Park			
Residential neighbors in suburban/rural areas	High	High	High
Institutional neighbors – schools, community centers, churches	Moderate	Low	Moderate
Travelers on urban highways	High	Low	Moderate
KVP #17: Fort Boggy Park (IH-45)			
Residential neighbors in suburban/rural areas	Moderate	Low	Moderate
Recreational neighbors in rural areas	Low	High	Moderate
Travelers on urban highways	High	Low	Moderate
Landscape Unit #6 Viewer Response			**Moderate**

Source: AECOM 2019

Visual Changes in Landscape Unit #6

Visual changes in Landscape Unit #6 would include the introduction of the Project on elevated viaduct as well as various operational facilities (two MOW facilities, three TPSSs, four SPs, two SSPs, two MSHs and three CHs).

The addition of these facilities to the landscape unit would not adversely impact the visual quality due to the small number of sensitive viewers impacted; however, the most northern TPSS would adversely impact residents adjacent to the facility. Although, many views near this TPSS would be limited due to the existing mature trees and vegetation.

KVP #15 shows a typical view for southbound travelers on IH-45. Views surrounding KVP #15 would include the Project on viaduct elevated approximately 30 feet above grade and located between IH-45 and the frontage road. The viaduct would be compatible with the area and would be similar to the existing highway infrastructure. There are several elevated structures and bridges along the interstate and at road crossings; however, the length of the viaduct would be more prominent than other surrounding structures. Visual quality would remain moderate.

Views surrounding KVP #16 from the parking lot at the Buffalo Public Library and Shelley Pate Park along IH-45 would include the introduction of the Project on elevated viaduct. Views of the trees and skyline would be reduced due to the height of the viaduct; however, the windows of the library are shielded with blinds to block the view of existing interstate traffic and most library patrons are focused on reading rather than views outside. Visitors to Shelley Pate Park would have reduced views. Visual quality would be slightly reduced from moderate to moderately low.

Surrounding KVP 17, the viaduct would parallel IH-45 on the west side between the southbound lanes and the frontage road. The viaduct would be elevated above the existing ground by approximately 40 feet to the top of the rail, almost to the height of the tallest trees. The large trees in the median of IH-45 would reduce the views from northbound travel lanes and viewers on the east side of IH-45 at Fort Boggy State Park. Visual quality would remain moderate.

Table 3.10-47 summarizes the visual changes, and **Figure 3.10-59** through **Figure 3.10-64** provide simulations of the Project from KVPs in this landscape unit.

Table 3.10-47: Visual Changes Summary				
KVP #	**KVP Location**	**Visual Quality - Existing**	**Visual Quality - Build Alternatives**	**Visual Changes**
15	IH-45 Corridor	Moderate	Moderate	Low
16	Buffalo Public Library/Shelley Pate Park	Moderate	Moderately low	Moderate
17	Fort Boggy Park (IH-45)	Moderate	Moderate	Low
LU 6	**Landscape Unit #6**	**Moderate**	**Moderate**	**Low**

Source: AECOM 2019

Figure 3.10-59: KVP #15 Existing

Figure 3.10-60: KVP #15 Simulated View

Figure 3.10-61: KVP #16 Existing

Figure 3.10-62: KVP #16 Simulated View

Figure 3.10-63: KVP #17 Existing

Figure 3.10-64: KVP #17 Simulated View

Source: AECOM 2019

Table 3.10-48 describes the potential visual impacts to visual resources identified in the landscape unit. More detailed descriptions of these facilities can be found in **Section 3.6, Natural Ecological Systems and Protected Species; Section 3.7, Waters of the U.S.; Section 3.11, Transportation; Section 3.13, Land Use; Section 3. 14, Socioeconomics and Community Facilities; Section 3.17, Recreational Facilities; Section 3.19, Cultural Resources;** and **Section 3.20, Soils and Geology**.

Table 3.10-48: Visual Resources – Landscape Unit #6

Build Alternative Alignment	Segment	Resource Name	Potential Visual Impact	Distance to LOD (feet)
C, F	3C	General Joseph Burton Johnson	Neutral; Limited view due existing mature trees obstructing view	900
C, F	3C	Johnson African American	Neutral; Limited view due existing mature trees obstructing view	1,234
C, F	3C	J. B. Johnson	Neutral; Limited view due existing mature trees obstructing view	645
C, F	3C	Mount Zion Missionary Baptist Church	This property is within the LOD and would be acquired by TCRR.	0
C, F	3C	El Camino Real de los Tejas	Neutral; No public access to the trail at this location. The trail is not maintained on private land near the HSR system.	0
C, F	3C	Shelley Pate Memorial Park	Neutral; Refer to **Section 3.10, Aesthetics and Scenic Resources**	371
C, F	3C	Buffalo Public Library	Neutral; Refer to **Section 3.10, Aesthetics and Scenic Resources**	547
C, F	3C	Miracle Christian Center	Neutral; Refer to **Section 3.10, Aesthetics and Scenic Resources**	478
C, F	3C	Fred Graham	Neutral; Limited view due existing mature trees obstructing view	3,195
C, F	3C	Nettles	Adverse; The cemetery is adjacent to the HSR system and has little tree or vegetation coverage to limit or reduce views.	0
C, F	3C	Liberty	Neutral; Limited view due existing mature trees obstructing view	470

Table 3.10-48: Visual Resources – Landscape Unit #6				
Build Alternative Alignment	Segment	Resource Name	Potential Visual Impact	Distance to LOD (feet)
C, F	3C	Hopewell Church	This property is within the LOD and would be acquired by TCRR.	5
C, F	3C	Fort Boggy	Neutral; Refer to **Section 3.10.5.2.8, Aesthetics and Scenic Resources**	194
C, F	3C	Fort Boggy State Park	Neutral; Refer to **Section 3.10.5.2.8, Aesthetics and Scenic Resources**	0

Source: AECOM 2019

Visual Impact Assessment for Landscape Unit #6

Viewer Response: <u>Moderate</u> + Visual Change: <u>Low</u> = Visual Impacts: <u>Moderate (neutral)</u>

Overall the degree of visual impact for Landscape Unit #6 on Build Alternatives C and F would be moderate and neutral. While there would be reduction in visual quality at KVP #16, the primary viewers within the landscape unit are travelers who have a low to moderate viewer response. Mitigation measures for visual impacts are described in **Section 3.10.6**.

3.10.5.2.9 Landscape Unit #7 Central Western Rural, Teague to Old San Antonio Road (Freestone, Limestone and Leon Counties)

Landscape Unit #7 Viewers and Viewer Response

Viewers in Landscape Unit #7 include residential (rural) neighbors, institutional neighbors at schools and community facilities, industrial and commercial neighbors, recreational viewers in rural areas and travelers on rural routes. Rural residential viewers would have moderate exposure and high sensitivity, while those at schools and travelers on rural routes would have moderate exposure and moderate sensitivity. Industrial and commercial viewers would have moderate exposure and low sensitivity. Recreational viewers in rural areas would have low exposure and high sensitivity. The overall viewer response in Landscape Unit #7 would be moderate. **Table 3.10-49** provides a summary of the viewer exposure and sensitivity within Landscape Unit #7.

Table 3.10-49: Viewer Response – Landscape Unit #7			
Viewer Group	**Exposure**	**Sensitivity**	**Viewer Response**
KVP #40: Furney Richardson Highschool			
Residential neighbors in suburban/rural areas	Low	High	Moderate
Recreational neighbors in rural areas	Low	High	Moderate
KVP #18: Agriculture with oil and gas (CR 880)			
Residential neighbors in suburban/rural areas	Moderate	High	High
Industrial/commercial neighbors	Moderate	Low	
Travelers on rural routes	Moderate	Moderate	Moderate
KVP #19: Leon ISD Campus			
Institutional neighbors – schools, community centers, churches	Moderate	Moderate	Moderate
Landscape Unit #7 Viewer Response			**Moderate**

Source: AECOM 2019

Visual Changes in Landscape Unit #7

Visual changes in Landscape Unit #7 would include the introduction of the Project and viaduct and various operational facilities (one MOW facility, three TPSSs, three SPs, one SSP, one MSH, one ISH and three CHs). The TPSS in the north and south of the landscape unit would be adjacent to rural residential viewers; however, the majority of views would be limited by existing trees and vegetation. The addition of all the supporting Project facilities to the landscape unit would not adversely impact the visual quality of the entire landscape unit.

KVP #40 includes a specific view facing southwest from an official Texas Historical Commission (THC) marker on the Furney Richardson High School property. Views of the Project may be restricted by mature trees and vegetation. In the areas where views of the viaduct would not be restricted by trees and vegetation, there would be a small degradation in visual quality. The presence of the existing transmission lines would allow the Project to be compatible with the area.

In the vicinity of KVP #18, views of the Project would be limited by trees and vegetation. In areas where views of the viaduct may not be limited by trees and vegetation, there would be a small degradation in visual quality; however, the area represented by this KVP has several oil and gas operations, which contain equipment that also degrades the visual quality, and a large coal power plant that has large towers and exhaust, which can be seen for miles.

KVP #19 includes a specific view from the Leon ISD Campus and would include views of the Project. The Project would be located approximately 1,000 feet away from the edge of the Leon ISD Campus property line and would appear at a similar height as the immediately adjacent electric power transmission line. Additionally, trees along the edge of the school property would buffer views of the viaduct.

Table 3.10-50 summarizes the visual changes, and **Figure 3.10-65** through **Figure 3.10-70** provide simulations of the Project from KVPs in this landscape unit.

Table 3.10-50: Visual Changes Summary

KVP #	KVP Location	Visual Quality – Existing	Visual Quality – Build Alternatives	Visual Changes
18	Agriculture with oil & gas (CR 880)	Moderately low	Moderately low	Low
19	Leon ISD Campus	Moderate	Moderately low	Moderate
40	Furney Richardson High School	Moderately low	Moderately low	Low
LU 7	Landscape Unit #7	Moderately low	Moderately low	Low

Source: AECOM 2019

Figure 3.10-65: KVP #40 Existing

Figure 3.10-66: KVP #40 Simulated View

Figure 3.10-67: KVP #18 Existing

Figure 3.10-68: KVP #18 Simulated View

Figure 3.10-69: KVP #19 Existing

Figure 3.10-70: KVP #19 Simulated View

Source: AECOM 2019

Table 3.10-51 describes the potential visual impacts to visual resources identified in the landscape unit. More detailed descriptions of these facilities can be found in **Section 3.6, Natural Ecological Systems and Protected Species; Section 3.7, Waters of the U.S.; Section 3.11, Transportation; Section 3.13, Land Use; Section 3. 14, Socioeconomics and Community Facilities; Section 3.17, Recreational Facilities; Section 3.19, Cultural Resources;** and **Section 3.20, Soils and Geology**.

Table 3.10-51: Visual Resources – Landscape Unit #7

Build Alternative Alignment	Segment	Resource Name	Potential Visual Impact	Distance to LOD (feet)
A, B, D, E	4	Furney Richardson High School	Neutral; Refer to **Section 3.10.5.2.9, Aesthetics and Scenic Resources**	821
A, B, D, E	4	Asia	Neutral; Limited view due existing mature trees and vegetation obstructing view	280
A, B, D, E	4	Personville	Neutral; Not likely to have a view of the HSR system due to existing dense forest	575
A, B, D, E	4	Personville/Ebenezer	Neutral; Not likely to have a view of the HSR system due to existing dense forest	525
A, B, D, E	4	Unknown (New Hope)	Neutral; Limited view due existing mature trees and vegetation obstructing view	524
A, B, D, E	4	Leon ISD Campus	Neutral; Refer to **Section 3.10.5.2.9, Aesthetics and Scenic Resources**	982
A, B, D, E	4	Little Flock (Cemetery)	Potential reduced visual quality; Property has direct sight to HSR system with embankment and viaduct construction. Some existing trees and vegetation may reduce views but not completely.	682
A, B, D, E	4	Little Flock (Historic Marker)	Potential reduced visual quality; Property has direct sight to HSR system with embankment and viaduct construction. Some existing trees and vegetation may reduce views but not completely.	750
A, B, D, E	4	Perry	Neutral; Not likely to have a view of the HSR system	504

Source: AECOM, 2019

Visual Impact Assessment for Landscape Unit #7

Viewer Response: Moderate + Visual Change: Low = Visual Impacts: Moderate (neutral)

The overall degree of visual impact for Landscape Unit #7 would be moderate and neutral. Most viewers would have limited views of the Project, and its form and materials would be compatible with the utility, oil and gas or coal mining operations currently in the area.

3.10.5.2.10 Landscape Unit #8 Rural Brazos Valley, Old San Antonio Road to Plantersville (Leon, Madison and Grimes Counties)

Landscape Unit #8 Viewers and Viewer Response

Viewers in Landscape Unit #8 include travelers on rural routes, agricultural viewers and scattered residential neighbors in rural areas. Travelers along the highway would not have a long exposure to the Project. Due to the rural and agricultural character of the views, agricultural viewers and rural residential viewers would have high exposure and high sensitivity, while travelers on the rural routes would have moderate exposure and moderate sensitivity. The overall viewer response in Landscape Unit #8 would be moderate. **Table 3.10-52** provides a summary of the viewer response in Landscape Unit #8.

Table 3.10-52: Viewer Response – Landscape Unit #8			
Viewer Group	**Exposure**	**Sensitivity**	**Viewer Response**
KVP #20: Low Density Agriculture/Residential (FM 1452)			
Residential neighbors in suburban/rural areas	Moderate	High	High
Agricultural viewers	Moderate	High	High
Travelers on rural routes	Moderate	Moderate	Moderate
KVP #21: Oxford Cemetery			
Residential neighbors in suburban/rural areas	High	High	High
Travelers on rural routes	Moderate	Moderate	Moderate
KVP #22: Brazos Valley Intermediate Station Entrance			
Residential neighbors in suburban/rural areas	High	High	High
Travelers on rural routes	Moderate	Moderate	Moderate
KVP #23: Brazos Valley Intermediate Station Approach			
Residential neighbors in suburban/rural areas	High	High	High
Landscape Unity #8 Viewer Response			**Moderate**

Source: AECOM 2019

Visual Changes in Landscape Unit #8

Visual changes in Landscape Unit #8 would include the introduction of the HSR track on viaduct as well as various operational facilities. Most views around the largest operational facilities, the MOW facility and TPSS, would be limited by existing trees and vegetation and/or include views of power substations for utility providers.

Views surrounding KVP #20 include the Project. The viewshed would be reduced due to the Project, which would be approximately 30 feet from the top of the rail to the existing road, FM 978. In addition, the Project's form and materials would not be compatible with the environment as there are no major infrastructure corridors in the area. Therefore, the visual quality would be reduced from moderate to low.

KVP #21 includes a specific view from Oxford Cemetery, a NRHP eligible cemetery, which would be located approximately 500 feet from the Project. Views surrounding KVP #21 would change moderately with the inclusion of the Project, but the structure and materials would be compatible with the area due to the large utility infrastructure that still maintain a prominent view despite the Project operating on viaduct. Some of the views in the background would change, as some trees would be cleared and would no longer be visible in the distance.

Views surrounding KVP #22 are from SH 30 facing northeast. The Project and proposed Brazos Valley Intermediate Station have a low compatibility with the existing environment. The height and scale of the Project would have no comparison in the area. The HSR tracks would be on viaduct elevated approximately 20 feet above the existing ground, and the top of the station structure would reach approximately 87 feet above the existing ground. The station's structures, materials and finishes would be designed to integrate into the environment as best as possible. As indicated during Brazos Valley stakeholder meetings with the Texas Forestry Association, TCRR would incorporate regional materials, products and character as part of the final design and construction. The framing of the roof structure would be intended to evoke the low-profile visual imagery of barns and storage sheds.

Views surrounding KVP #23 are from SH 90 facing southwest towards the proposed Brazos Valley Intermediate Station. The Project would appear near to at-grade from the distance of the image. Electrical wires would blend in with the utility infrastructure in the background. However, the station would rise above the height of the tallest trees. Therefore, the station area would not be compatible due to the scale of the Brazos Valley Intermediate Station.

Table 3.10-53 summarizes the visual changes, and **Figure 3.10-71** through **Figure 3.10-78** provide simulations of the Project from KVPs in this landscape unit.

Table 3.10-53: Visual Changes Summary

KVP #	KVP Location	Visual Quality – Existing	Visual Quality – Build Alternatives	Visual Changes
20	Low Density Ag/Residential (FM 1452)	Moderate	Low	Moderate
21	Oxford Cemetery	Moderate	Moderately low	Moderate
22	Brazos Valley Intermediate Station Entrance	Moderate	Low	High
23	Brazos Valley Intermediate Station Approach	Moderate	Moderately low	High
LU 4	Landscape Unit #8	Moderate	Moderately low	High

Source: AECOM 2019

Figure 3.10-71: KVP #20 Existing

Figure 3.10-72: KVP #18 Simulated View

Figure 3.10-73: KVP #21 Existing

Figure 3.10-74: KVP #21 Simulated View

Figure 3.10-75: KVP #22 Existing

Figure 3.10-76: KVP #22 Simulated View

Figure 3.10-77: KVP #23 Existing

Figure 3.10-78: KVP #23 Simulated View

Source: AECOM 2019

Table 3.10-54 describes the potential visual impacts to visual resources identified in the landscape unit. More detailed descriptions of these facilities can be found in **Section 3.6, Natural Ecological Systems and Protected Species; Section 3.7, Waters of the U.S.; Section 3.11, Transportation; Section 3.13, Land Use; Section 3. 14, Socioeconomics and Community Facilities; Section 3.17, Recreational Facilities; Section 3.19, Cultural Resources;** and **Section 3.20, Soils and Geology**.

Table 3.10-54: Visual Resources – Landscape Unit #8

Build Alternative Alignment	Segment	Resource Name	Potential Visual Impact	Distance to LOD (feet)
C, F	3C	Sweet Home	Neutral; Limited view due existing mature trees and raised land near the IH-45 obstructing view. Property is east of IH-45.	1,269
C, F	3C	Fellowship Church	Neutral; limited view facing southwest. Most of the viewshed has mature trees which would limit the view of most of the HSR system on embankment construction.	772

Table 3.10-54: Visual Resources – Landscape Unit #8				
Build Alternative Alignment	**Segment**	**Resource Name**	**Potential Visual Impact**	**Distance to LOD (feet)**
C, F	3C	Fellowship Church Grave	Neutral; limited view facing southwest. Most of the viewshed has mature trees which would limit the view of most of the HSR system on embankment construction.	498
A, B, D, E	4	Randolph	Adverse; cemetery is adjacent to the LOD.	64
A, B, D, E	4	Ten Mile	Adverse; cemetery is adjacent to the LOD.	56
C, F	3C	Grimes County Bethel Cemetery	Neutral; if there is any view of the HSR system it is very limited. Dense forest restricts most views.	180
A, B, D, E	4	Oxford Cemetery	Neutral; Refer to **Section 3.10.5.2.10, Aesthetics and Scenic Resources**	175
A, B, D, E	4	Union Hill	Neutral; Cemetery is in the middle of existing utility corridor. View of the HSR system is not likely due to dense forest blocking views.	102
A, B, C, D, E, F	5	Pankey –Shiloh	Adverse; cemetery is near to the LOD.	759
A, B, C, D, E, F	5	Shiloh Church	Adverse; church is near to the LOD and would have a direct view of the HSR system on viaduct construction.	1,296
A, B, C, D, E, F	5	Singleton	Neutral; if there is any view of the HSR system it is very limited. Mature forest restricts most views.	751
A, B, C, D, E, F	5	Ratliff	Adverse; cemetery is adjacent to the LOD.	101
A, B, C, D, E, F	5	Old Oakland – Roans Prairie	Neutral; if there is any view of the HSR system it is very limited. Dense forest restricts most views.	1,113
A, B, C, D, E, F	5	Oakland Baptist Church	Neutral; if there is any view of the HSR system it is very limited. Dense forest restricts most views.	2,209
A, B, C, D, E, F	5	Mason	Neutral; Limited view due to existing mature trees restricting views of the HSR system on viaduct construction.	1,004

Source: AECOM 2019

Visual Assessment for Landscape Unit #8

Viewer Response: Moderate + Visual Change: High = Visual Impacts: High (adverse)

Based on the degradation of visual quality and lack of compatibility of the Project and Brazos Valley Intermediate Station represented by the majority of KVPs, the degree of impact to visual quality in this landscape unit would be high and adverse. Mitigation measures for visual impacts are described in **Section 3.10.6**.

3.10.5.2.11 Landscape Unit #9 Rural to Suburban, Plantersville to Harris County line (Grimes and Waller Counties)

Landscape Unit #9 Viewers and Viewer Response

Viewers in Landscape Unit #9 include residential (suburban/rural) neighbors and travelers on rural routes. Dense tree vegetation over the northern half of the landscape unit shields viewers not adjacent to the utility corridor. Rural residential viewers have high exposure and high sensitivity, depending on their location. Some residential viewers near KVP #24 may have limited or no views of the Project, due to dense forest, and would have moderate exposure and sensitivity. Travelers on rural routes have moderate exposure and moderate sensitivity. The overall viewer response in Landscape Unit #9 would be moderate. **Table 3.10-55** provides a summary of the viewer exposure and sensitivity within Landscape Unit #9.

Table 3.10-55: Viewer Response – Landscape Unit #9			
Viewer Group	**Exposure**	**Sensitivity**	**Viewer Response**
KVP #24: Riley Road Utility Corridor			
Residential neighbors in suburban/rural areas	Moderate	Moderate	Moderate
Travelers on rural routes	Moderate	Moderate	Moderate
KVP #25: Rural/Suburban Transition			
Residential neighbors in suburban/rural areas	High	High	High
Travelers on rural routes	Moderate	Moderate	Moderate
Landscape Unit #9 Viewer Response			**Moderate**

Source: AECOM 2019

Visual Changes in Landscape Unit #9

Visual changes in Landscape Unit #9 would include the introduction of the HSR track/viaduct and various operational facilities (including one SP and one CH). The addition of these facilities would not adversely impact the visual quality of this landscape unit. Views of the SP and CH would be limited due to the dense forest, and thus most viewers would not see these facilities.

Views of KVP #24 would include the introduction of the Project facing south from Riley Road in Waller County. The Project would operate on viaduct transitioning from embankment. The HSR ROW would be surrounded by security fencing around the embankment. The HSR infrastructure would be compatible with the area. The overhead catenary lines would be shorter than the existing high-voltage electrical transmission line and would have a compatible appearance.

Views surrounding KVP #25 would include the HSR tracks on embankment, level with the existing ground. The trainset would be surrounded by security fencing. Due to the height of the fencing and overhead catenary lines, the viewshed for residents would be slightly restricted by the Project; however, when the trainset is not passing through, the view would not be completely restricted.

Table 3.10-56 summarizes the visual changes, and **Figure 3.10-79** through **Figure 3.10-82** provide simulations of the Project from KVPs in this landscape unit.

Table 3.10-56: Visual Changes Summary				
KVP #	**KVP Location**	**Visual Quality – Existing**	**Visual Quality – Build Alternatives**	**Visual Changes**
24	Riley Road Utility Corridor	Moderate	Moderate	Low
25	Rural/Suburban Transition	Moderate	Low	Moderate
LU 9	Landscape Unit #9	Moderate	Moderate	Moderate

Source: AECOM 2019

Figure 3.10-79: KVP #24 Existing

Figure 3.10-80: KVP #24 Simulated View

Figure 3.10-81: KVP #25 Existing

Figure 3.10-82: KVP #25 Simulated View

Source: AECOM 2019

Table 3.10-57 describes the potential visual impacts to visual resources identified in the landscape unit. More detailed descriptions of these facilities can be found in **Section 3.6, Natural Ecological Systems and Protected Species; Section 3.7, Waters of the U.S.; Section 3.11, Transportation; Section 3.13, Land Use; Section 3. 14, Socioeconomics and Community Facilities; Section 3.17, Recreational Facilities; Section 3.19, Cultural Resources;** and **Section 3.20, Soils and Geology**.

Table 3.10-57: Visual Resources – Landscape Unit #9

Build Alternative Alignment	Segment	Resource Name	Potential Visual Impact	Distance to LOD (feet)
A, B, C, D, E, F	5	Science of the Soul Study Center	Adverse; church is near to the LOD and would have a direct view of the HSR system on embankment construction.	218

Source: AECOM, 2019

Visual Impact Assessment for Landscape Unit #9

Viewer Response: <u>Moderate</u> + Visual Change: <u>Moderate</u> = Visual Impacts: <u>Moderate (neutral)</u>

The degree of impact in this landscape unit would be moderate and neutral because the majority of viewers in this landscape would have moderate exposure and sensitivity to the Project. The Project would not dominate the majority of views due to the dense forest. Additionally, the Project would be compatible with the majority of the landscape unit due to the adjacent electrical transmission line; however, the degree and value of visual quality change for some areas within the landscape unit, represented by KVP #25, would be moderate and adverse. As stated in **Section 3.10.3, Methodology**, KVPs do not reflect every view in the landscape unit; therefore, an adverse or beneficial impact to a KVP does not necessarily equate to an adverse or beneficial impact to the entire landscape unit. Mitigation measures for visual impacts are described in **Section 3.10.6**.

3.10.5.2.12 <u>Landscape Unit #10 Northwest Suburban, Harris County line to Grand Parkway (Harris County)</u>

Landscape Unit #10 Viewers and Viewer Response

Viewers in Landscape Unit #10 include residential (suburban/rural) neighbors, travelers on rural and urban routes, and recreational neighbors visiting the Katy Prairie Conservancy. Rural residential viewers would have high exposure and high sensitivity, while travelers on nearby rural routes would have moderate exposure and moderate sensitivity. Recreational viewers would have moderate exposure and high sensitivity. A specialized group of viewers attending weddings at The House Estate, located approximately 700 feet southeast of KVP #27, would have high exposure and high sensitivity. The House Estate is located approximately 1,200 feet north of the Project's centerline. Many ceremonies utilize a gazebo located south of the main structure. The ceremonies provide a view of a large pond in the foreground, open field in the middle ground, and large evergreen trees in the background. **Table 3.10-58** provides a summary of the viewer exposure and sensitivity within Landscape Unit #10.

Table 3.10-58: Viewer Response – Landscape Unit #10

Viewer Group	Exposure	Sensitivity	Viewer Response
KVP #26: Rural Harris County			
Residential neighbors in suburban/rural areas	High	High	High
Travelers on rural routes	Moderate	Moderate	Moderate
KVP #41: Katy Prairie Conservancy Wildlife Viewing Platform			
Recreational neighbors in rural areas	Moderate	High	Moderate
Travelers on rural routes	Moderate	Moderate	Moderate
KVP #27: Stone Creek Ranch			
Residential neighbors in suburban/rural areas	High	Moderate	High
Landscape Unit #10 Viewer Response			**Moderate**

Source: AECOM 2019

Visual Changes in Landscape Unit #10

Visual changes in Landscape Unit #10 would include the introduction of the Project as well as various operational facilities (one TMF, two TPSSs, one SP, one SSP, one MSH and one CH). Several residents located near the proposed TMF would experience adverse visual impacts, due to a lack of compatible infrastructure in the area and few trees and vegetation to limit views.

Views surrounding KVP #26 include the Project elevated above the existing ground by approximately 30 feet to the top of the rail. The viewshed for residents located nearest to the viaduct would be limited by the Project and would therefore have a moderate response to visual changes. Those residents located at a distance would have less impacts to their viewshed because they could see over, or under, the Project. The Project would be compatible with the area at the KVP because large transportation corridors and frequent freight rail operations are located nearby.

The Katy Prairie Conservancy wildlife viewing platform is represented by KVP #41, providing a view facing north from the platform**.** This KVP provides a specific view for recreational viewers located approximately 1.6 miles south of the Project. The viewing platform is open to the public 365 days a year from 7:00 AM to dusk. The tallest platform is located approximately 15 to 20 feet above the ground. The elevated view provides an expanded viewshed covering the entire Warren Lake and many of the prairies located adjacent to the lake. While dense tree cover limits background views, as well as most views of the Project, large utility transmission lines are visible from the platform.

KVP #27 provides a typical view of the landscape unit for all Build Alternatives from Becker Road facing south. The Project would be compatible with the area, which includes two large communications towers. The Project would be in the distance, and views would be partially limited by trees. Viewers would be expected to have a moderate response to visual changes.

Table 3.10-59 summarizes the visual changes, and **Figure 3.10-83** through **Figure 3.10-88** provide simulations of the Project from KVPs in this landscape unit.

Table 3.10-59: Visual Changes Summary

KVP #	KVP Location	Visual Quality – Existing	Visual Quality – Build Alternatives	Visual Changes
26	Rural Harris County	Moderate	Moderately low	Moderate
41	Katy Prairie Conservancy Wildlife Viewing Platform	Moderately high	Moderately high	Low
27	Stone Creek Ranch	Moderate	Moderate	Low
LU 10	Landscape Unit #10	Moderate	Moderate	Moderate

Source: AECOM 2019

Figure 3.10-83: KVP #26 Existing

Figure 3.10-84: KVP #26 Simulated View

Figure 3.10-85: KVP #41 Existing

Figure 3.10-86: KVP #41 Simulated View

Figure 3.10-87: KVP #27 Existing

Figure 3.10-88: KVP #27 Simulated View

Source: AECOM 2019

Table 3.10-60 describes the potential visual impacts to visual resources identified in the landscape unit. More detailed descriptions of these facilities can be found in **Section 3.6, Natural Ecological Systems and Protected Species; Section 3.7, Waters of the U.S.; Section 3.11, Transportation; Section 3.13, Land Use; Section 3. 14, Socioeconomics and Community Facilities; Section 3.17, Recreational Facilities; Section 3.19, Cultural Resources;** and **Section 3.20, Soils and Geology**.

Table 3.10-60: Visual Resources – Landscape Unit #10				
Build Alternative Alignment	**Segment**	**Resource Name**	**Potential Visual Impact**	**Distance to LOD (feet)**
A, B, C, D, E, F	5	Mallard Crossing Neighborhood Park	Neutral; The park would have a direct view of the HSR system on viaduct construction; however, the park is approximately one-quarter mile away from the Project and there is some vegetation and trees to help limit views of the Project.	560
A, B, C, D, E, F	5	Katy Prairie Conservancy Wildlife Viewing Platform	Neutral; Refer to **Section 3.10.5.2.12, Aesthetics and Scenic Resources**	8,553

Source: AECOM 2019

Visual Impact Assessment for Landscape Unit #10

Viewer Response: Moderate + Visual Change: Moderate = Visual Impacts: Moderate (adverse)

The overall degree of visual impact for Landscape Unit #10 would be moderate and adverse because several residents would have reductions in visual quality as the Project and associated operational facilities would bisect communities. Mitigation measures for visual impacts are described in **Section 3.10.6**.

3.10.5.2.13 Landscape Unit #11 Cypress Jersey Village, Grand Parkway to Sam Houston Parkway (Harris County)

Landscape Unit #11 Viewers and Viewer Response

Viewers in Landscape Unit #11 include residential (suburban) neighbors, travelers on urban highways, recreational neighbors of urban parks and institutional office workers. Viewers surrounding KVP #28 would be mostly residents and recreational users (i.e., golfers). Suburban residential viewers would have high exposure and moderate sensitivity, while travels on urban highways, such as US 290, and office workers would have high exposure and low sensitivity. Recreational neighbors of urban parks, such as the Houston National Golf Course, would have moderate exposure and moderate sensitivity. The overall viewer response in Landscape Unit #11 would be moderate. **Table 3.10-61** provides a summary of the viewer exposure and sensitivity within Landscape Unity #11.

Table 3.10-61: Viewer Response – Landscape Unit #11			
Viewer Group	**Exposure**	**Sensitivity**	**Viewer Response**
KVP #28: Houston National Golf Course			
Residential neighbors in suburban/rural areas	High	Moderate	Moderate
Recreational neighbors in urban parks	Moderate	Moderate	Moderate
Travelers on urban highways	High	Low	Moderate
KVP #29: White Oak Falls Neighborhood			
Residential neighbors in suburban/rural areas	High	Moderate	Moderate
Travelers on urban highways	High	Low	Moderate
KVP #30: US 290			
Institutional neighbors – office workers	High	Low	Moderate
Travelers on urban highways	High	Low	Moderate
Landscape Unit #11 Viewer Response			**Moderate**

Source: AECOM 2019

Visual Changes in Landscape Unit #11

Visual changes in Landscape Unit 11 would include the introduction of the Project as well as various operational facilities (one TMF, one MOW facility, one TPSS, one SP, one MSH and one CH). The designs and functions of the operational facilities are compatible with their surrounding areas and would not cause a change in visual quality.

KVP #28 shows a specific view from a neighborhood recreational area facing north towards the Project. The viaduct would be elevated approximately 60 feet in the air and would be visible above the trees and billboards. The utilities would be relocated in order to pass under the Project's structure. Only parts of three holes of the nearby Houston National Golf Club would have similar views this close to the Project. Golfers' views are dynamic and the golf course contains several large trees and adjacent homes, which would help to limit views of the Project. The remaining parts of the golf course would have limited views due the presence of homes, trees and vegetation.

Views surrounding KVP #29 show a typical view from a suburban neighborhood, White Oak Falls, facing northeast from Clover Crest Drive. The view would include the Project elevated approximately 45 feet. The visual quality at KVP #29 would be reduced from moderate to moderately low. The Project's form and materials would be compatible with the area as it would operate adjacent to freight rail line and a large transportation corridor with elevated structures.

Views surrounding KVP #30 show a typical view for the landscape unit and travelers along US 290. The Project would be elevated adjacent to the UPRR line. The structure and materials would be compatible with the environment, as there is a utility corridor, freight rail line and several elevated highways and interchanges in the viewshed.

Table 3.10-62 summarizes the visual changes, and **Figure 3.10-89** through **Figure 3.10-94** provide simulations of the Project from KVPs in this landscape unit.

Table 3.10-62: Visual Changes Summary

KVP #	KVP Location	Visual Quality – Existing	Visual Quality – Build Alternatives	Visual Changes
28	Stonegate Neighborhood Park	Moderate	Moderately low	Low
29	White Oak Falls neighborhood	Moderate	Moderately low	Low
30	US 290	Moderately low	Moderately low	Low
LU 11	Landscape Unit #11	Moderate	Moderately low	Low

Source: AECOM 2019

Figure 3.10-89: KVP #28 Existing

Figure 3.10-90: KVP #28 Simulated View

Figure 3.10-91: KVP #29 Existing

Figure 3.10-92: KVP #29 Simulated View

Figure 3.10-93: KVP #30 Existing

Figure 3.10-94: KVP #30 Simulated View

Source: AECOM 2019

Table 3.10-63 describes the potential visual impacts to visual resources identified in the landscape unit. More detailed descriptions of these facilities can be found in **Section 3.6, Natural Ecological Systems and Protected Species; Section 3.7, Waters of the U.S.; Section 3.11, Transportation; Section 3.13, Land Use; Section 3. 14, Socioeconomics and Community Facilities; Section 3.17, Recreational Facilities; Section 3.19, Cultural Resources;** and **Section 3.20, Soils and Geology**.

Table 3.10-63: Visual Resources – Landscape Unit #11

Build Alternative Alignment	Segment	Resource Name	Potential Visual Impacts	Distance to LOD (feet)
A, B, C, D, E, F	5	Cypress Top Historic Park	Neutral; Limited view due existing mature trees and buildings on the property obstructing views.	199
A, B, C, D, E, F	5	Houston National Golf Club	Neutral; Refer to **Section 3.10.5.2.13, Aesthetics and Scenic Resources.**	200
A, B, C, D, E, F	5	Stonegate Neighborhood Park	Neutral; Refer to **Section 3.10.5.2.13, Aesthetics and Scenic Resources.**	205
A, B, C, D, E, F	5	Jersey Meadow Golf Course	Neutral; if there is any view of the HSR system it is very limited. Several buildings, utility lines, and trees restrict most views.	1,367
A, B, C, D, E, F	5	The Connection School of Houston	This property is within the LOD and would be acquired by TCRR.	0
A, B, C, D, E, F	5	St. Aidan's Episcopal Church	Reduced visual quality; church is near to the LOD and would have a direct view of the HSR system on viaduct construction.	368
A, B, C, D, E, F	5	Cy-Fair High School	Neutral; the school is on the north side of the US 290 corridor along the northbound service road. Viewers would have direct views of the HSR system on viaduct construction; however, the Project is compatible with the area and viewers would not view the Project for long durations.	759
A, B, C, D, E, F	5	Arnold Middle School	Neutral; the school is on the north side of the US 290 corridor along the northbound service road. Viewers would have direct views of the HSR system on viaduct construction; however, the Project is compatible with the area and viewers would not view the Project for long durations.	602
A, B, C, D, E, F	5	North Cypress Medical Center	Neutral; the medical center is on the north side of the US 290 corridor along the northbound service road. Viewers would have direct views of the HSR system on viaduct construction; however, the Project is compatible with the area and viewers would not view the Project for long durations.	964
A, B, C, D, E, F	5	Cypress Falls Senior High School	Neutral; the school is near to the LOD. Viewers would have direct views of the HSR system on viaduct construction, as well as supporting operational infrastructure; however, the Project is compatible with the area and viewers would not view the Project for long durations.	314
A, B, C, D, E, F	5	Veterans of Foreign Wars	Neutral; Limited view due to adjacent buildings and utility infrastructure obstructing view	580
A, B, C, D, E, F	5	Humble Oil Gas Station	Neutral; Limited view due existing mature trees and buildings on the property obstructing views.	308

Table 3.10-63: Visual Resources – Landscape Unit #11				
Build Alternative Alignment	**Segment**	**Resource Name**	**Potential Visual Impacts**	**Distance to LOD (feet)**
A, B, C, D, E, F	5	Jersey Village Baptist Church	Neutral; the church is near to the LOD. Viewers would have direct views of the HSR system on viaduct construction, as well as supporting operational infrastructure; however, the Project is compatible with the area and viewers would not view the Project for long durations.	44

Source: AECOM, 2019

Visual Impact Assessment for Landscape Unit #11

Viewer Response: Moderate + Visual Change: Low = Visual Impacts: Moderate (neutral)

While the Project would result in an adverse visual impact at some views represented by KVPs #28 and #29, these views do not make up the majority of the landscape unit. Other parts of these communities not located near the Project would have limited views, if any view at all, due to the height of adjacent homes, trees and vegetation. Therefore, the overall degree of impact to this landscape unit would be moderate and neutral. Mitigation measures for visual impacts are described in **Section 3.10.6**.

3.10.5.2.14 Landscape Unit #12 Hempstead Corridor, Sam Houston Parkway to Tex Tube (Harris County)

Landscape Unit #12 Viewers and Viewer Response

Viewers in Landscape Unit #12 include travelers on urban highways, institutional office workers, and a small number of residential (urban) neighbors. Travelers on urban highways and office workers have high exposure and low sensitivity, while any residential neighbors in the area would have high exposure and moderate sensitivity. The overall viewer response in Landscape Unit #12 would be moderate. **Table 3.10-64** provides a summary of the viewer exposure and sensitivity within Landscape Unit #12.

Table 3.10-64: Viewer Response – Landscape Unit #12			
Viewer Group	**Exposure**	**Sensitivity**	**Viewer Response**
KVP #31: Commercial business park			
Institutional neighbors – office workers	High	Low	Moderate
Travelers on urban highways	High	Low	Moderate
Residential neighbors in urban areas	High	Moderate	Moderate
KVP #32: Urban commercial/industrial			
Institutional neighbors – office workers	High	Low	Moderate
Travelers on urban highways	High	Low	Moderate
Landscape Unit #12 Viewer Response			**Moderate**

Source: AECOM 2019

Visual Changes in Landscape Unit #12

Visual changes in Landscape Unit #12 would include the introduction of the Project as well as various operational facilities (one TMF and one SSP). The TMF would be located in an industrial area along Sam Houston Tollway and, thus, would blend in with the exiting visual and aesthetic environment.

The views surrounding KVP #31 would include the Project, elevated approximately 30 feet to the top of the rail from the existing ground, which would reduce views of the skyline, but maintain the view of the urban environment underneath the viaduct. The Project would be compatible with the environment because it is mostly an industrial and business center area that contains freight rail, utility lines and busy roadways. Additionally, an elevated transportation infrastructure, US 290, is within 1 mile of the Project.

The views surrounding KVP #32 would include the Project elevated approximately 30 feet above grade and would operate between Hempstead Road and the UPRR line. Changes to Hempstead Road and the immediate environment would include adding a center turn lane, and providing sidewalks or a bike lane adjacent to Hempstead Road next to the existing land uses along the north side of the street. The introduction of the Project would include large-scale infrastructure in this area; however, the area is composed of elevated highways and interchanges, distribution lines, commercial and industrial structures and the UPRR freight rail line. Additionally, the structure and materials of the Project would be compatible with the environment.

Table 3.10-65 summarizes the visual changes, and **Figure 3.10-95** through **Figure 3.10-98** provide simulations of the Project from KVPs in this landscape unit.

Table 3.10-65: Visual Changes Summary

KVP #	KVP Location	Visual Quality – Existing	Visual Quality – Build Alternatives	Visual Changes
31	Commercial business park	Moderately low	Moderately low	Low
32	Urban commercial/industrial	Moderately low	Moderately low	Low
LU 12	Landscape Unit #12	Moderately low	Moderately low	Low

Source: AECOM 2019

Figure 3.10-95: KVP #31 Existing

Figure 3.10-96: KVP #31 Simulated View

Figure 3.10-97: KVP #32 Existing

Figure 3.10-98: KVP #32 Simulated View

Source: AECOM 2019

Table 3.10-66 describes the potential visual impacts to visual resources identified in the landscape unit. More detailed descriptions of these facilities can be found in **Section 3.6, Natural Ecological Systems and Protected Species; Section 3.7, Waters of the U.S.; Section 3.11, Transportation; Section 3.13, Land Use; Section 3. 14, Socioeconomics and Community Facilities; Section 3.17, Recreational Facilities; Section 3.19, Cultural Resources;** and **Section 3.20, Soils and Geology**.

Table 3.10-66: Visual Resources – Landscape Unit #12

Build Alternative Alignment	Segment	Resource Name	Potential Visual Impact	Distance to LOD (feet)
A, B, C, D, E, F	5	Mountain of Faith Christian Center Church	Neutral; if there is any view of the HSR system it is very limited. Several buildings and trees restrict most views.	1,110
A, B, C, D, E, F	5	Fairbanks United Methodist Church	Neutral; limited view because buildings and trees restrict views of the HSR system on viaduct construction.	363
A, B, C, D, E, F	5	Fairbanks (cemetery)	Neutral; limited view because buildings and trees restrict views of the HSR system on viaduct construction.	265
A, B, C, D, E, F	5	Christian Family Church	Adverse; the church is adjacent to the LOD and would also be near a temporary construction lay down area.	49
A, B, C, D, E, F	5	First United Methodist Korean Church	Neutral; limited view because buildings and trees restrict views of the HSR system on viaduct construction.	873
A, B, C, D, E, F	5	Dean Middle School	Neutral; limited view because buildings and trees restrict views of the HSR system on viaduct construction.	1,103
A, B, C, D, E, F	5	Bane Elementary School	Neutral; limited view because buildings and trees restrict views of the HSR system on viaduct construction.	696
A, B, C, D, E, F	5	The Panda Path School Spring Branch ISD	Neutral; limited view because buildings and trees restrict views of the HSR system on viaduct construction.	538

Table 3.10-66: Visual Resources – Landscape Unit #12				
Build Alternative Alignment	Segment	Resource Name	Potential Visual Impact	Distance to LOD (feet)
A, B, C, D, E, F	5	Housman Elementary	Neutral; very limited view, if any view at all, because buildings and trees restrict views of the HSR system on viaduct construction.	1,434
A, B, C, D, E, F	5	T.C. Jester Park	Neutral; very limited view, if any view at all, because buildings and trees restrict views of the HSR system on viaduct construction.	180
A, B, C, D, E, F	5	Spring Spirit Sports and Education Complex	Neutral; limited view because buildings and trees restrict views of the HSR system on viaduct construction.	1,254
A, B, C, D, E, F	5	Spring Branch Family Development Center	Neutral; limited view because buildings and trees restrict views of the HSR system on viaduct construction.	493
A, B, C, D, E, F	5	Northwest Educational Center	Neutral; limited view because buildings and trees restrict views of the HSR system on viaduct construction.	696
A, B, C, D, E, F	5	Hindu Worship Society	Neutral; very limited view, if any view at all, because buildings restrict views of the HSR system on viaduct construction.	856
A, B, C, D, E, F	5	Assurance of Hope Church of God in Christ	Neutral; very limited view, if any view at all, because buildings restrict views of the HSR system on viaduct construction.	1,014
A, B, C, D, E, F	5	Church of Christ – Brookhollow	Neutral; very limited view, if any view at all, because buildings restrict views of the HSR system on viaduct construction.	758
A, B, C, D, E, F	5	Templo Pentecostal Gestemani	Neutral; very limited view, if any view at all, because buildings restrict views of the HSR system on viaduct construction.	1,094
A, B, C, D, E, F	5	Templo El Buen Samaritano	Neutral; very limited view, if any view at all, because buildings restrict views of the HSR system on viaduct construction.	1,025

Source: AECOM 2019

Visual Impact Assessment for Landscape Unit #12

Viewer Response: <u>Moderate</u> + Visual Change: <u>Low</u> = Visual Impacts: <u>Moderate (neutral)</u>

Only those residential viewers within this landscape area closest to the Project would experience a reduction in visual quality due to the higher sensitivity rating residential viewers experience compared to other workers within the landscape unit. However, these viewers do not compose the majority of viewers and the degree of impact for the landscape unit as a whole would be moderate. The value of visual impact would be neutral. The residential areas located farther away from the Project would have limited views of Project because of the flat terrain and other homes, trees and structures would reduce viewsheds.

3.10.5.2.15 <u>Landscape Unit #13 Northwest Mall/Post Oak Road (Harris County)</u>

Landscape Unit #13 Viewers and Viewer Response

Viewers in Landscape Unit #13 include residential (urban) neighbors, institutional office workers, travelers on urban highways, as well as schools, community centers and churches. Urban residential neighbors would have a high exposure and moderate sensitivity. Travelers on urban highways and office workers would have high exposure and low sensitivity, while institutional neighbors of schools, community centers and churches would have moderate exposure and moderate sensitivity. The overall viewer response in Landscape Unit #13 would be moderate. **Table 3.10-67** provides a summary of the viewer exposure and sensitivity within Landscape Unit #13.

Table 3.10-67: Viewer Response – Landscape Unit #13

Viewer Group	Exposure	Sensitivity	Viewer Response
KVP #33: Hempstead Tex Tube			
Residential neighbors in urban areas	High	Moderate	Moderate
Institutional neighbors – office workers	Moderate	Moderate	Moderate
Travelers on urban highways	High	Low	Moderate
KVP #34: Post Oak Tex Tube			
Residential neighbors in urban areas	High	Moderate	Moderate
Institutional neighbors – office workers	Moderate	Moderate	Moderate
Travelers on urban highways	High	Low	Moderate
KVP #35: Post Oak Tex Tube			
Residential neighbors in urban areas	High	Moderate	Moderate
Institutional neighbors – office workers	Moderate	Moderate	Moderate
Travelers on urban highways	High	Low	Moderate
KVP #36: 18th Street NW Mall			
Residential neighbors in urban areas	High	Moderate	Moderate
Institutional neighbors – office workers	Moderate	Moderate	Moderate
Travelers on urban highways	High	Low	Moderate
Institutional neighbors – schools, community centers, churches	Moderate	Moderate	Moderate
KVP #37: Post Oak NW Mall			
Residential neighbors in urban areas	High	Moderate	Moderate
Institutional neighbors – office workers	Moderate	Moderate	Moderate
Travelers on urban highways	High	Low	Moderate
KVP #38: Post Oak NW Transit			
Transit Travelers	Moderate	Low	Low
Institutional neighbors – office workers	Moderate	Moderate	Moderate
Travelers on urban highways	High	Low	Moderate
KVP #39: NW Transit Station			
Transit Travelers	Moderate	Low	Low
Institutional neighbors – office workers	Moderate	Moderate	Moderate
Travelers on urban highways	High	Low	Moderate
Landscape Unit #13 Viewer Response			**Moderate**

Source: AECOM 2019

Visual Changes in Landscape Unit #13

Visual changes in Landscape Unit #13 would include the introduction of a new Houston Terminal Station with the Project. KVP #33 shows the typical view of the Houston Industrial Site Terminal Station Option from the eastern part of the station site along Post Oak Road. KVP #34 shows the typical view of the Houston Industrial Site Terminal Station Option from Post Oak Road facing northwest.

The Houston Industrial Site Terminal Station Option would be located on an existing industrial site, adjacent to other industrial, commercial and abandoned properties. The station platform would be elevated approximately 52 feet above the existing ground and the top of the station would reach an additional 73 feet. In total, the top of the station would be approximately 125 feet above the existing ground. The materials and design of the station would be modern and more characteristic of buildings and new construction in adjacent urban districts. Therefore, the station's structure and materials would be compatible with the area. Parking configuration and design would be coordinated with the City of Houston during design development to integrate with local traffic management planning.

KVP #35 includes the typical view of the Houston Northwest Mall Terminal Station Option from Hempstead Road facing southeast. KVP #36 shows the typical view of the Houston Northwest Mall Terminal Station Option from West 18th Street facing south. KVP #37 shows the typical view of the Houston Northwest Mall Terminal Station Option from the Post Oak Boulevard and Hempstead Road intersection facing north. These KVPs provide views from the west, north and south of this station. The Houston Northwest Mall Terminal Station Option would be located on an abandoned mall site, adjacent to industrial, commercial and highway infrastructure. The station platform would be elevated approximately 52 feet above the existing ground and the top of the station would reach an additional 73 feet. In total, the top of the station would be approximately 125 feet above the existing ground. The materials and design of the station and parking structures would be modern and more characteristic of buildings in the Galleria area and downtown Houston. Therefore, the station's structure and materials would be compatible with the area. Parking configuration and design would be coordinated with the City of Houston during design development to integrate with local traffic management planning. As shown in the visual simulations, the parking structure would be located northeast of the platform along West 18th Street and US 290 feeder road. In this station option, there would be two potential parking facilities. The parking garage is currently shown with four covered levels and one deck level.

KVP #38 shows the typical view of the Houston Northwest Transit Center Terminal Station Option from Post Oak Road facing southeast. KVP #39 shows the typical view of the Houston Northwest Transit Center Terminal Station Option from the Houston METRO Northwest Transit Center facing north. These KVPs provide views from the northwest and south of this station. The Houston Northwest Transit Center Terminal Station Option would be located in an existing business park, adjacent to a variety of land uses and highway infrastructure and interchanges. The station platform would be elevated approximately 52 feet above the existing ground and the top of the station would reach an additional 73 feet. In total, the top of the station would be approximately 125 feet above the existing ground. The materials and design of the station would be modern and more characteristic of buildings and new construction in adjacent urban districts. Therefore, the HSR infrastructure would be compatible with the area. Parking configuration and design would be coordinated with the City of Houston during design development to integrate with local traffic management planning. As shown in the visual simulations, the parking structure would be located west of the platform along Post Oak Road, from Old Katy Road to a new road approximately near Post Oak Green Lane. There would only be one parking garage in this station option. The parking garage is currently shown with four covered levels and one deck level.

Table 3.10-68 summarizes the visual changes, and **Figure 3.10-99** through **Figure 3.10-112** provide simulations of the Project from KVPs in this landscape unit.

Table 3.10-68: Visual Changes Summary

KVP #	KVP Location	Visual Quality – Existing	Visual Quality – Build Alternatives	Visual Changes
33	Hempstead Tex Tube	Moderately low	Moderate	Moderate
34	Post Oak Tex Tube	Moderately low	Moderate	Moderate
35	Hempstead NW Mall	Moderately low	Moderate	Moderate
36	18th St. NW Mall	Moderately low	Moderate	Moderate
37	Post Oak NW Mall	Moderately low	Moderate	Moderate
38	Post Oak NW Transit	Moderate	Moderately high	Moderate
39	NW Transit Station	Moderate	Moderately high	Moderate
LU 13	Landscape Unit #13	Moderately low	Moderate	Moderate

Source: AECOM 2019

Figure 3.10-99: KVP #33 Existing

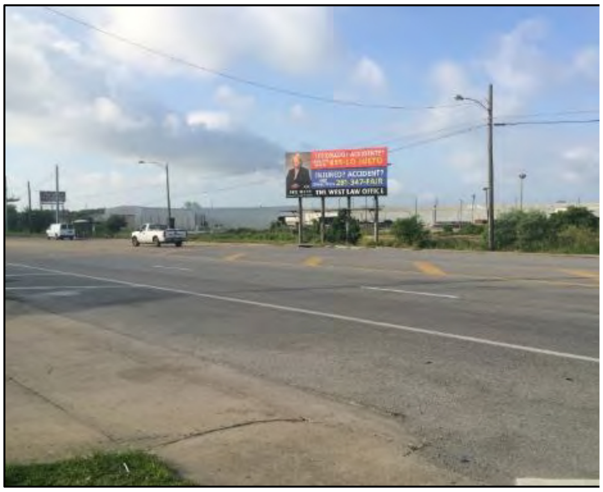


Figure 3.10-100: KVP #33 Simulated View

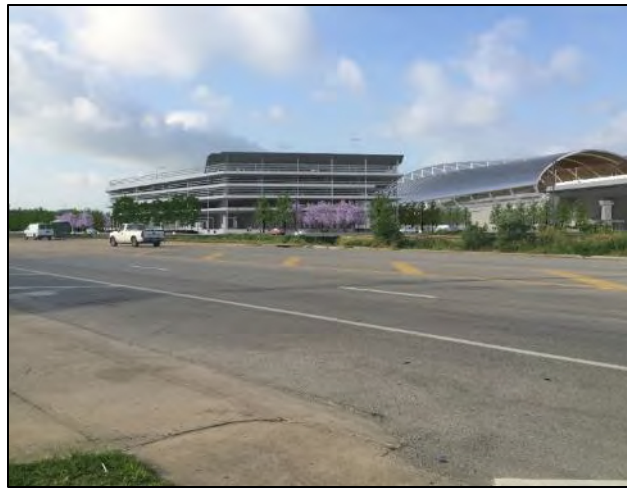


Figure 3.10-101: KVP #34 Existing

Figure 3.10-102: KVP #34 Simulated View

Figure 3.10-103: KVP #35 Existing

Figure 3.10-104: KVP #35 Simulated View

Figure 3.10-105: KVP #36 Existing

Figure 3.10-106: KVP #36 Simulated View

Figure 3.10-107: KVP #37 Existing

Figure 3.10-108: KVP #37 Simulated View

Figure 3.10-109: KVP #38 Existing

Figure 3.10-110: KVP #38 Simulated View

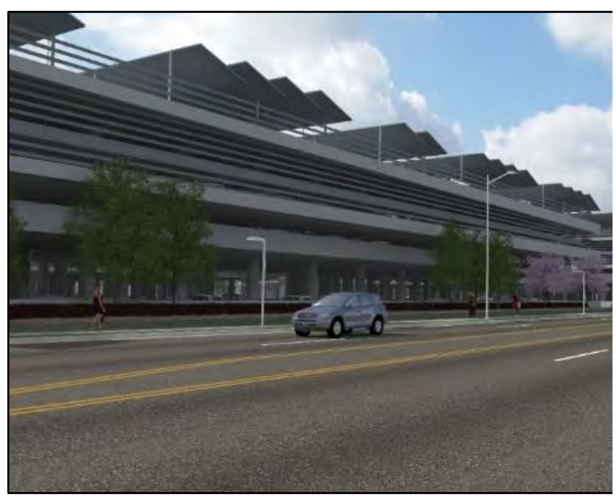


Figure 3.10-111: KVP #39 Existing

Figure 3.10-112: KVP #39 Simulated View

Source: AECOM 2019

Table 3.10-69 describes the potential visual impacts to visual resources identified in the landscape unit. More detailed descriptions of these facilities can be found in **Section 3.6, Natural Ecological Systems and Protected Species; Section 3.7, Waters of the U.S.; Section 3.11, Transportation; Section 3.13, Land Use; Section 3. 14, Socioeconomics and Community Facilities; Section 3.17, Recreational Facilities; Section 3.19, Cultural Resources;** and **Section 3.20, Soils and Geology**.

Table 3.10-69: Visual Resources – Landscape Unit #13

Build Alternative Alignment	Segment	Resource Name	Potential Visual Impacts	Distance to LOD (feet)
A, B, C, D, E, F	5	Tex-Tube	Neutral; Refer to **Section 3.10.5.2.15, Aesthetics and Scenic Resources.**	0
A, B, C, D, E, F	5	Beth Yeshurum-Post Oak	Neutral; direct view of the proposed Northwest Transit Center Station area. The Project would be compatible with the area and could enhance community character. The view from the cemetery will change the closer the viewer is to the station area. Existing trees will help limit the view, but the station will still be seen from most viewpoints in this cemetery.	10
A, B, C, D, E, F	5	Awty International School	Neutral; direct view of the proposed Northwest Transit Center Station area. The Project would be compatible with the area and could enhance community character.	988
A, B, C, D, E, F	5	Awty International School Early Learning Campus	Neutral; direct view of the proposed Northwest Transit Center Station area. The Project would be compatible with the area and could enhance community character.	0
A, B, C, D, E, F	5	HISD Delmar Sports Complex	Neutral; direct view of the proposed Northwest Mall Station area. The Project would be compatible with the area and could enhance community character.	273

Table 3.10-69: Visual Resources – Landscape Unit #13				
Build Alternative Alignment	**Segment**	**Resource Name**	**Potential Visual Impacts**	**Distance to LOD (feet)**
A, B, C, D, E, F	5	HISD Hattie Mae White Educational Support Center	Neutral; direct view of the proposed Northwest Mall Station area. The Project would be compatible with the area and could enhance community character.	186

Source: AECOM 2019

Visual Impact Assessment for Landscape Unit #13

Viewer Response: Moderate + Visual Change: Moderate = Visual Impacts: Moderate (beneficial)

The amenities around the Houston Industrial Site Terminal Station Option (i.e., sidewalks, landscaping and lighting) would enhance the visual character of the area. The degree of visual impact would be moderate and beneficial due to the presence of a new transit station and the improved viewer experience by replacing an industrial site with a new urban place designed for the area.

The amenities surrounding the Houston Northwest Mall Terminal Station Option (i.e., sidewalks, landscaping and lighting) would enhance the visual character of the area. Additionally, an abandoned mall would be removed and replaced with the Houston Northwest Mall Terminal Station Option. The degree of visual impact would be moderate and beneficial due to the presence of a new transit station and the improved viewer experience from the station area enhancements and presence of the station. The Houston Northwest Mall Terminal Station Option has been identified by FRA as the Preferred Alternative.

The amenities around the Houston Northwest Transit Center Terminal Station Option (i.e., sidewalks, landscaping and lighting) would enhance the visual character of the area. Visual quality would have a slight improvement from moderate to moderately high. The degree of visual impact would be moderate and beneficial due to the presence of a new transit station and the improved viewer experience from the station area enhancements and presence of the station.

3.10.6 Avoidance, Minimization and Mitigation

In developing the Build Alternatives, TCRR identified co-location opportunities with transportation and utility corridors to maximize compatibility with existing aesthetics and scenic views. Within the Build Alternatives, 48 percent of the LOD, on average, would be located adjacent to existing road, rail or utility infrastructure in order to minimize visual quality impacts. TCRR also identified relatively flat, open spaces to minimize impacts to tree cover during construction and operational activities. TCRR identified Houston Terminal Station options within areas of similar aesthetic quality to the proposed terminal developments. Station design was developed to be compatible with the surrounding natural and cultural environment in order to minimize visual impacts.

TCRR incorporated an LID design approach for the Project, as detailed in **Appendix F: TCRR Final Conceptual Engineering Design and Constructability Reports, Section 3.14**. The principles of the LID approach would address minimizing and mitigating visual quality impacts. Although LID was created for stormwater management, the approach applies to visual and aesthetics because the principles target preservation, protection and mitigation of natural resources, which contribute to visual quality. The TCRR HSR design approach would result in a project that:

- Complies with federal, state and local regulations
- Minimizes the environmental footprint of the Project
- Minimizes impacts to wetlands, waterbodies and natural streams
- Uses construction techniques that minimize impacts to properties
- Restores disturbed land to the original condition
- Protects natural and cultural resources
- Mitigates impacts

The Project design LID approach would, when possible, protect, preserve and enhance properties and host communities along the proposed HSR corridor (from Dallas to Houston). Several standards and rating systems provide LID guidance. TCRR will use the Institute of Sustainable Infrastructure system to implement LID, as described in **AS-MM#4: Low Impact Development.**

3.10.6.1 Compliance Measures

TCRR would be required to adhere to development codes, ordinances and other types of regulations. A list of these codes, ordinances and regulations can be found in **Table 3.10-1**. Refer to **NV-CM#1: Compliance with Local Regulations,** and **NV-MM#3: Operational Noise Mitigation and Monitoring**, in **Section 3.4.6, Noise and Vibration. Refer to LU-CM#5: Adhere to Development Regulations,** in **Section 3.13.6, Land Use.**

3.10.6.2 Mitigation Measures

TCRR would be required to implement the following Mitigation Measures (MM):

AS-MM#1: Visual Screening. As part of the LID approach, TCRR shall incorporate context-sensitive design solutions that complement the character of the surrounding communities. TCRR shall screen the Project from neighborhoods, businesses or other entities with an unrestricted view of the Project, where practicable, through visual barriers such as vegetation (including trees and shrubs), walls, berms or natural looking constructed landforms (**Figure 3.10-113**), recognizing that elements of the Project may remain visible with screening (i.e., viaduct and berms). The shape and height of constructed landforms must be adapted to the surrounding landscape and must consider the distance and viewing angle to ensure that the earthworks would be visually unobtrusive. If chain-link or cyclone fence is used, it shall include slats in the fencing. TCRR shall coordinate with local jurisdictions to identify additional pertinent visual screening criteria. TCRR shall include visual mitigation measures in the Landscaping Plan (**AS-MM#5: Landscaping Plan**). Screening shall comply with mitigation requirements related to vegetation and landscaping as summarized in the Landscaping Plan (**AS-MM#5: Landscaping Plan**).

TCRR shall present (through email, meetings or other means as outlined in the Public Involvement Plan, **AS-MM#9: Public Involvement Plan**) the concept design for the Project and proposed visual impact mitigation to the public. TCRR shall advertise the availability of the design and visual mitigation measures on TCRR's Project website[5] and through other public notification methods outlined in the Public Involvement Plan (**AS-MM#9: Public Involvement Plan**). Additionally, TCRR shall issue a public notice in newspapers. TCRR shall send a specific notification to the adversely impacted visual resources listed below.

- Guiberson Corp. Machine Shop
- Guiberson Corp Residence

[5] As of January 2020, TCRR is hosting their Project website at https://www.texascentral.com/

- Honey Springs (Bulova Homecoming Cemetery)
- Smith Family Cemetery
- Nettles
- Randolph
- Ten Mile
- Pankey – Shiloh
- Shiloh Church
- Ratliff
- Science of the Soul Study Center
- Christian Family Church

TCRR is not required to send notifications to owners of parcels that are being acquired for the Project. TCRR shall document public feedback and take reasonable measures to incorporate public feedback into the final design. The Le May and Le Forge community is not included in this mitigation measure because TCRR shall make offers to acquire each property and relocate each resident in the neighborhood per **EJ-MM-1: Le May and Le Forge Neighborhood Mitigation**.

AS-MM#2: Design Stations to Adapt to Local Context. TCRR shall coordinate with the cities of Dallas and Houston and Grimes County to design stations to visually integrate into and complement the character of the surrounding area. Design solutions include:

- Designing HSR stations and associated structures such as elevators, escalators and walkways to be attractive architectural elements or features that add visual interest to the streetscapes near them
- Designing HSR station parking structures and adjacent facilities to integrate visually into the surrounding area
- Integrating trees and landscaping into the station streetscape where practicable to soften and buffer the appearance of guideways, columns and elevated stations

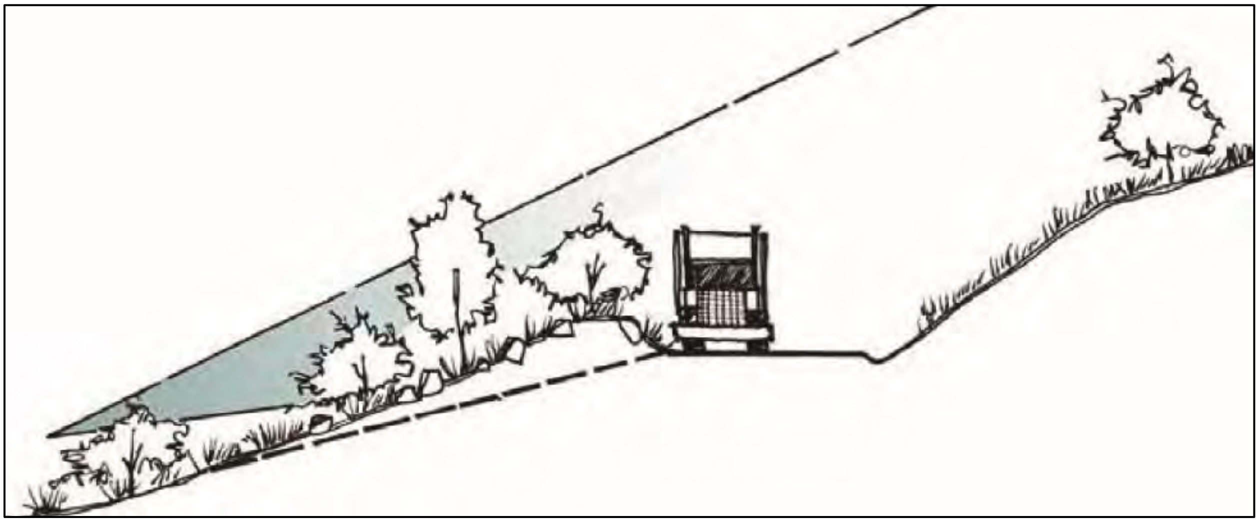
AS-MM#3: Preserve Existing Vegetation and Feather Edges. During construction, in areas that require clearing for temporary or permanent use, TCRR shall minimize the clearing of vegetation and shall only partially clear the ROW where feasible. Vegetation should be beat down, mowed or covered with protective surface matting rather than removed. When areas do not have to be contoured, the crowns and roots from cut vegetation should be left undisturbed in order to allow for re-sprouting. Trees that would not present a safety or engineering hazard or otherwise interfere with operations should be left in the ROW. When technical and safety concerns do not require complete removal of vegetation, trees shall be trimmed or topped instead of removed. TCRR shall feather edges (i.e., the progressive and selective thinning of trees) and vary tree heights to create an irregular vegetation outline and more natural appearance.

AS-MM#4: Low Impact Development (LID). TCRR will use the Institute of Sustainable Infrastructure's Envision® Rating System (also referred to as Envision®) to guide evaluation efforts to incorporate LID into the planning and design of the Project. TCRR will use the Leadership in Energy and Environmental Design (LEED) rating system to guide evaluation efforts to incorporate LID into the planning and design of ancillary and support facilities.

AS-MM#5: Landscaping Plan. During final design, TCRR shall prepare a landscaping plan that describes how TCRR will comply with mitigation measures related to landscaping, visual mitigation, and vegetation, including but not limited to **AS-MM#1: Visual Screening; AS-MM#2: Design Stations to Adapt to Local Context; AS-MM#3: Preserve Existing Vegetation and Feather Edges; WQ-MM#3: Site**

Restoration and Revegetation; and **EU-MM#8: Vegetation to Minimize Water Use and Avoid Interference with Electric Utility Lines.** Feedback obtained from public input associated with **AS-MM#9: Public Involvement Plan,** will be incorporated into **AS-MM#5: Landscaping Plan**.

Figure 3.10-113: Use of Constructed Landforms with Vegetative Screening



Source: Bureau of Land Management, *Best Management Practices for Reducing Visual Impacts of Renewable Energy Facilities on BLM-Administered Lands*, 2013

AS-MM#6: Construction Lighting Plan. Prior to construction TCRR shall develop a lighting plan that complies with applicable requirements of the local jurisdiction's regulations. TCRR shall submit the final plan to FRA and make available to local jurisdictions upon request. The plan shall define daytime and nighttime construction activities and shall stipulate techniques such as shielding and directional lighting to limit exposure. If nighttime construction activities are performed, lighting shall be limited to the lowest safe level. TCRR shall include this plan in the **Construction Management Plan (SC-MM#1)**.

AS-MM#7: Operational Lighting Plan. Prior to operations, TCRR shall develop an operational lighting plan that outlines nighttime lighting required to safely operate the system in compliance with applicable regulations. The plan shall include lighting BMPs that would focus the lighting on the rail line directly ahead and shield the surrounding communities from excess light during operation. Ancillary facility lighting, particularly in the rural communities, shall use sensors and shielding to limit light exposure at night.

TCRR's LID approach shall incorporate comfortable and energy efficient lighting optimized through architectural design that encourages natural sunlight and an adaptable, controllable systems for lighting.

AS-MM#8: Aesthetic and Visual Guidelines for Construction Security Fencing. Prior to construction, TCRR shall develop aesthetic and visual guidelines for security fencing, including signage and material shrouds. TCRR shall coordinate with local jurisdictions to identify applicable aesthetic and visual guidelines. TCRR shall install construction security fencing that complies with the guidelines. TCRR shall submit the guidelines to FRA prior to the start of construction and make them available to the local jurisdictions upon request.

AS-MM#9: Public Involvement Plan. TCRR prepared a Public Involvement Plan, provided in **Appendix I**: **TCRR Plans and Public Outreach.** TCRR shall implement the public involvement program outlined in the plan The goal of the public involvement program is to:

- Facilitate two-way communication between TCRR and the public on final design and construction activities to achieve the least possible disruption the public
- Facilitate this two-way communication on mitigation measures specifically called for in the Final EIS and for issues that may arise during the final design process or construction, such as dust control, construction vehicle routing, road closures or detours, construction noise, livestock management issues, visual impact mitigation and operational noise mitigation

The plan:

- Inventories and specifically describes how TCRR will implement mitigation measures that require public engagement
- Identifies specific customer groups (such as traveling public, neighboring residents, adjacent businesses, emergency providers, schools, local governments and environmental justice communities)
- Identifies methods for engaging customer groups and documenting feedback
- Identifies methods for informing the public of construction activities including road detours and closures

3.10.7 Build Alternatives Comparison

All Build Alternatives would have the same number of beneficial (two) and adverse (two) impacts. Beneficial impacts would occur in the landscape units (Landscape Units #1 and #13) with stations in Dallas and Houston, as shown in **Table 3.10-70**. There is negligible difference between the impacts of the three options in Houston. All three Houston Terminal Station options would replace under-utilized or industrial land uses with a modern station and station area improvements. Adverse impacts would occur as a result of the Brazos Valley Intermediate Station in Landscape Unit #8, which is common to all of the Build Alternatives. The other adverse impact would occur in Landscape Unit #10, as a result of the MOW facility, TPSS, and the HSR system degrading visual quality for a number of residents in areas where these facilities and rail system are not compatible.

Table 3.10-70: Alternatives Comparison

Landscape Unit	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F
Landscape Unit #1	Moderate/ Beneficial	Moderate/ Beneficial	Moderate/ Beneficial	Moderate/ Beneficial	Moderate/ Beneficial	Moderate/ Beneficial
Landscape Unit #2	Low/ Neutral	Low/ Neutral	Low/ Neutral	Low/ Neutral	Low/ Neutral	Low/ Neutral
Landscape Unit #3	Low/ Neutral	Low/ Neutral	Low/ Neutral	Low/ Neutral	Low/ Neutral	Low/ Neutral
Landscape Unit #4	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral
Landscape Unit #5	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral
Landscape Unit #6	-	-	Moderate/ Neutral	-	-	Moderate/ Neutral
Landscape Unit #7	Moderate/ Neutral	Moderate/ Neutral	-	Moderate/ Neutral	Moderate/ Neutral	-
Landscape Unit #8	High/ Adverse	High/ Adverse	High/ Adverse	High/ Adverse	High/ Adverse	High/ Adverse
Landscape Unit #9	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral
Landscape Unit #10	Moderate/ Adverse	Moderate/ Adverse	Moderate/ Adverse	Moderate/ Adverse	Moderate/ Adverse	Moderate/ Adverse

Table 3.10-70: Alternatives Comparison						
Landscape Unit	**ALT A**	**ALT B**	**ALT C**	**ALT D**	**ALT E**	**ALT F**
Landscape Unit #11	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral
Landscape Unit #12	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral	Moderate/ Neutral
Landscape Unit #13	Moderate/ Beneficial	Moderate/ Beneficial	Moderate/ Beneficial	Moderate/ Beneficial	Moderate/ Beneficial	Moderate/ Beneficial
Total Number of Beneficial	2	2	2	2	2	2
Total Number of Neutral	8	8	8	8	8	8
Total Number of Adverse	2	2	2	2	2	2
Total Number of Adverse Visual Resource Impacts	11	11	10	11	11	10

Source: AECOM 2019

- = Project does not cross the particular landscape unit.

Note: Visual impacts are assessed for visual resources and KVPs and an overall visual impact is determined for each landscape unit. For each landscape unit, visual impacts are first assigned a degree of impact from low, moderate, or high and project impacts can be beneficial, neutral or adverse