Dallas-Fort Worth Core Express Service

Alternatives Analysis Final Report

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Federal Railroad Administration

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Table of Contents

List of Tables

List of Figures

List of Appendices

List of Acronyms

ARRA	American Recovery and Reinvestment Act of 2009
BNSF	Burlington Northern Santa Fe Railway
DAL	Dallas Love Field
DART	Dallas Area Rapid Transit
DFW	Dallas – Fort Worth International Airport
DFX	Expanded Travel Demand Model
EIS	Environmental Impact Statement
FRA	Federal Railroad Administration
GDP	Gross Domestic Product
HSR	High Speed Rail
I	Interstate Highway
ITC	Fort Worth Intermodal Transportation Center
mph	Miles Per Hour
NCTCOG	North Central Texas Council of Governments
NEPA	National Environmental Policy Act
SAM	Texas Statewide Analysis Model
SH	State Highway
TCR	Texas Central High Speed Railway (Dallas to Houston High-Speed Rail Project)
TOPRS	Texas-Oklahoma Passenger Rail Study
T&P	Fort Worth Texas & Pacific Station
TRE	Trinity Railway Express
TxDOT	Texas Department of Transportation
UPRR	Union Pacific Railroad

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Executive Summary

Analysis Process, Purpose and Need

The Texas Department of Transportation (TxDOT), in coordination with the Federal Railroad Administration (FRA) and other stakeholders, initiated the preparation of a project-level (Tier 2) Environmental Impact Statement (EIS) pursuant to the National Environmental Policy Act (NEPA) (42 United States Code. § 4321 et seq.) and other federal, state and local laws, regulations, policies, and guidelines, for the Dallas – Fort Worth Core Express Service Project (Project). This alternatives analysis represents a key step in the NEPA process, progressing service-level findings from the Oklahoma City – South Texas Corridor Investment Plan (TOPRS) project described further in Section 1.2.1. TOPRS is examining opportunities for creating a connected and modern intercity passenger rail system for the State of Texas that will extend through Fort Worth from Oklahoma City, south to Laredo and the Rio Grande Valley, with a connection through Dallas that may be co-located with a high-speed rail service between Dallas and Houston. This project-level effort examines the service from Dallas to Fort Worth, connecting to the proposed TOPRS project.

The alternatives analysis process objectively defines those opportunities or alternatives that are anticipated for subsequent evaluation in the project-level EIS which will follow. Thus, the alternatives analysis serves as an evaluation tool that develops the information and technical analyses needed to inform decision-makers and the public on the costs, benefits and impacts associated with each alternative under consideration. This alternatives analysis synthesizes a great deal of information, far greater than a typical alternatives analysis, regarding the description of alternatives and their evaluation. This was done in order for the differences among the alternatives to be clearly understood and to inform the analysis of costs, benefits, and impacts; this information is intended for future use in the project-level EIS. The Project alternatives, including corridors, alignments and stations have been identified and shaped through extensive outreach and coordination with cooperating agencies, Project stakeholders and resource agencies, including the North Central Texas Council of Governments (NCTCOG), and the public.

TxDOT is the recipient of a $15 million grant under the American Recovery and Reinvestment Act of 2009. An amount of $8 million from that grant has been dedicated to conduct the project-level EIS. The FRA is the lead federal agency providing oversight and having responsibility for the final decision on the alternative(s) recommended for further development and is leading the preparation of the alternatives analysis in close coordination with TxDOT.

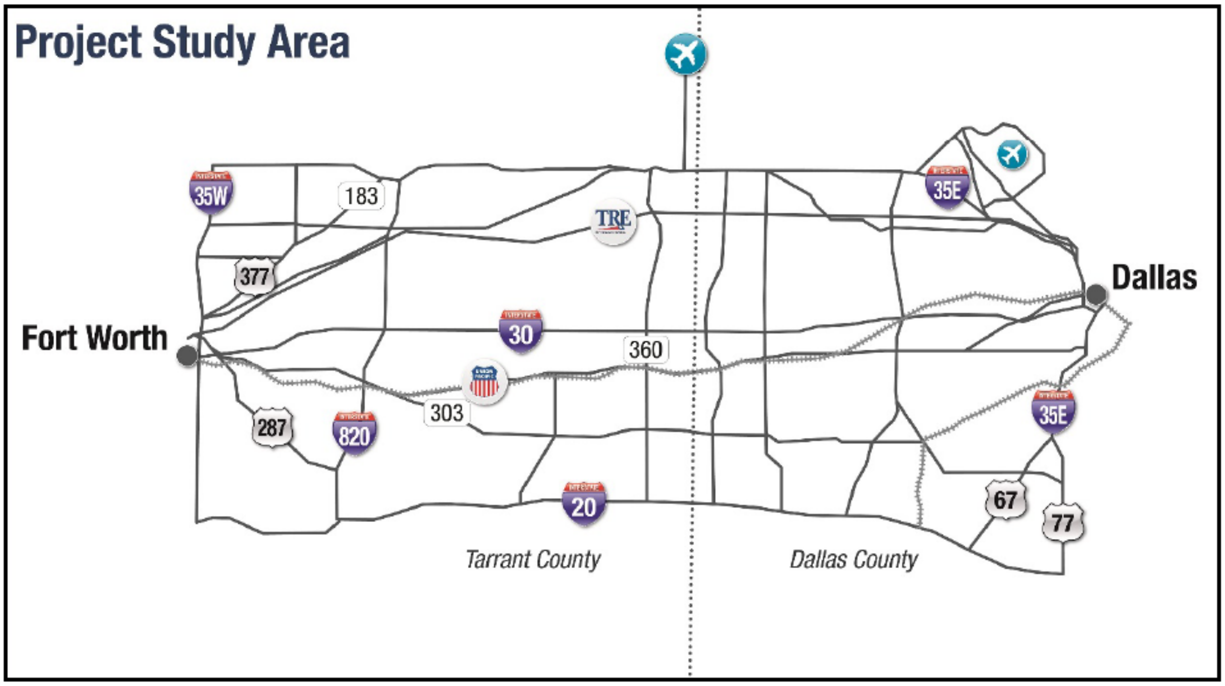
Project Background

The Project is a direct outcome of a number of key State and regional planning efforts. These efforts demonstrate the state's and region's goals to provide improved intercity travel time and efficient connections to other transportation providers with modern trainsets and facilities, and include:

- Texas Oklahoma Passenger Rail Study (TOPRS);
- Texas Rail Plans (2010, 2011, 2016);
- Adopted Regional Transportation Plan (Mobility 2040, March 2016); and
- Dallas to Houston High-Speed Rail Project (Texas Central Railway).

Project Study Area

Shown below is the Project's immediate study area, bounded to the east by the City of Dallas, and to the west by the City of Fort Worth, extending through both Dallas and Tarrant Counties. The Dallas - Fort Worth Metropolitan Statistical Area (MSA) is the official title assigned to the project area by the United States Office of Management and Budget and the project area falls completely within the MSA. The study area is also known as the Dallas – Fort Worth Metroplex, or the Metroplex. The Metroplex is rich in roadway infrastructure and is served by both freight and passenger operators.



Source: WSP/Parsons Brinckerhoff Inc. 2015

Project Purpose and Need – Problem Definition and Challenges

The Purpose and Need Statement prepared for the Project defined its need and established the fundamental framework for evaluating alternatives in order to inform decision-makers, stakeholders and the public in ultimately selecting a Preferred Alternative at the conclusion of the EIS.

The genesis for the Project reflects the robust growth of population and employment throughout the region, which has outgrown the existing transportation network. This has resulted in increased travel times for the movement of people and freight, decreased reliability and safety, and in some cases, reduced air quality. By the year 2040, the Dallas - Fort Worth region is forecast to grow from 6.3 million (2010) to 10.7 million residents, further taxing the existing transportation network. The Project presents an innovative opportunity for the State of Texas to implement the vision of an interconnected, multimodal, statewide and interstate transportation system.

Project Purpose

The overall purpose of the Project is to enhance inter- and intra-city mobility by providing a financially viable, safe, reliable and environmentally sustainable transportation alternative connecting Dallas and Fort Worth that could also provide a key link between existing and potential Texas high-performance passenger rail systems and other regional transit service.

Project Need

The overall need for the Project results from capacity constraints and lack of mobility alternatives in the existing passenger rail and roadway transportation systems, which fail to meet current and future needs. If nothing is done to remedy these issues, the region will continue to experience greater levels of traffic congestion and long trip times for travellers to, from and within the Dallas – Fort Worth Metroplex.

Alternatives Considered

A number of alternative corridors connecting Dallas and Fort Worth are considered in this alternatives analysis, in addition to the No Build Alternative, as described below.

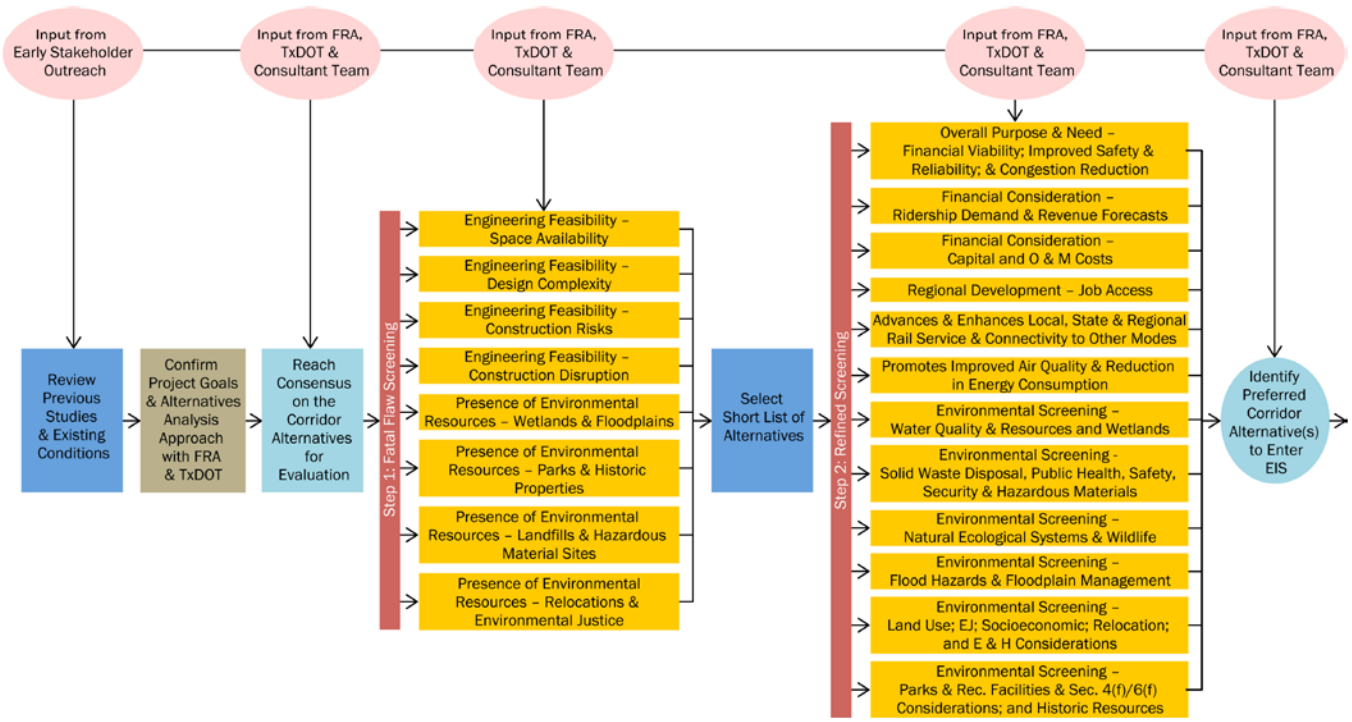
Study Corridors

The TOPRS identified three potential existing transportation corridors for implementing improved passenger service between Fort Worth and Dallas: Union Pacific (UP), I-30, and TRE (Study Corridors). The UP corridor was dropped from consideration after UP indicated it would not consider adding passenger trains in its corridor, potential serious environmental impacts were identified and the need for property acquisition was considered. The two remaining corridors, I-30 and TRE, as well as an alternative corridor consisting of a combination of the west end of the I-30 corridor and the east end of the TRE corridor connected by the state route 360 (SH360) corridor, are shown in the figure on the next page.

Within the three Study Corridors that were evaluated, there are various options for specific alignments associated with three operating speeds (90 mph, 125 mph and 220 mph), various land use and physical constraints, the potential for one or more intermediate stations between Fort Worth and Dallas, and options for entry to and from station locations in Fort Worth and Dallas; the detailed description of each of the three alternatives is provided in Chapter 3. In addition, a No Build Alternative was considered, assuming the implementation of all projects identified in the Metropolitan Transportation Plan, Mobility 2040, except for the Project (refer to Table 3-1). The No Build Alternative provides a baseline against which other alternatives will be compared in the EIS.

Screening Methodology and Results

The two-step screening process developed for the alternatives analysis includes the purpose and need criteria developed early in the study outreach efforts, the engineering feasibility criteria for the speed and alignment options within each Study Corridor and the environmental considerations identified in the alternatives analysis. This process is illustrated in the flow diagram below.



Step 1 provides the Project's fatal flaw review of the three initial Study Corridor alternatives, including an examination of the overall purpose and need, engineering feasibility and environmental considerations of the speed and alignment options. The engineering criteria include measures of alignment space, complexity and risk. Environmental considerations focus on the potential for significant impacts and/or require measurable mitigation efforts. Step 2 of the process examines the alternatives that passed the fatal flaw analysis from Step 1 and employs a greater degree of quantitative and qualitative analysis to measure their effectiveness in fulfilling the regional priorities for high speed rail service.

The presentation of results for the evaluation of alternatives used both qualitative and quantitative values, presented in a graphical format referred to as Consumer Reports' product review charts, or "Harvey Balls." This presentation format provides a clear structure to highlight the comparative benefits of alternatives for each evaluation measure, as shown below.

○	Little or no contribution
◔	0-25% are the first quadrant
◑	25-50% the half full quadrant
◕	50-75% the three quarters full
●	75-100% full circle

Summary of Evaluation Results and Recommendations

The results from the analysis of the three study corridors evaluated in the Step 1 Fatal Flaw Review show that the I-30 Corridor possesses considerable obstacles to implementation, including having the greatest engineering challenges, the highest design and construction complexity and construction risks, and the highest capital cost. For these reasons, the I-30 Corridor was dropped from further consideration and did not proceed into the Step 2 Refined Screening.

The evaluation results of the two alternatives (TRE and Hybrid corridors) that progressed from the Step 1 to Step 2 evaluation are summarized in Table ES-1 on the next page. Table ES-1 shows that both the TRE and Hybrid corridors are viable at the 90 mph and 125 mph operating scenarios. Operation in either corridor at 220 mph is not considered to be viable due to higher costs, corridor lengths and physical constraints and safety requirements for passenger equipment (rolling stock) that have not been issued by the FRA.

The Step 2 results show that the Hybrid Corridor performs slightly better, mainly due to higher ridership from the ability to serve the Arlington Station connection with TOPRS service and lower overall environmental impacts. However, the TRE Corridor offers the best financial viability, with the lower capital costs. It is therefore recommended that both corridors proceed into the EIS process. In addition to the traditional analysis of environmental impact areas included in the EIS process, there are a number of topics that will need future consideration, as discussed in Chapter 6.

Table ES-1: Summary Step 2 Evaluation Results

Identity	Objectives	Criterion	Measure	Quantity	Source	220	125E	125D	90D	220	125E	125D	90D
	ial/ Economic Considerations												

Notes to table: "DFWCES" refers to the alternatives analysis study team evaluation results. "D" refers to diesel locomotive power. "E" refers to electric locomotive power.

DRAFT
Dallas – Fort Worth New Core Express
Alternatives Analysis Report

1.0 Introduction

1.1 Overview of Alternatives Analysis Process

The Texas Department of Transportation (TxDOT), in coordination with the Federal Railroad Administration (FRA) and other stakeholders, initiated the preparation of a project level (Tier 2) Environmental Impact Statement (EIS) pursuant to the National Environmental Policy Act (NEPA) (42 United States Code. § 4321 et seq.) and other federal, state and local laws, regulations, policies, and guidelines, for the Dallas – Fort Worth Core Express Service Project (Project). This alternatives analysis represents a key step in the NEPA process, progressing service-level findings from the Oklahoma City – South Texas Corridor Investment Plan (TOPRS) project described further in Section 1.2.1. TOPRS examines opportunities for creating a connected and modern intercity passenger rail system for the State of Texas that will extend through Fort Worth from Oklahoma City, south to Laredo and the Rio Grande Valley, with a connection through Dallas that may be co-located with a high-speed rail service between Dallas and Houston. This project-level effort examines the service from Dallas to Fort Worth, connecting to the proposed TOPRS project.

The alternatives analysis process objectively defines those opportunities or alternatives that are anticipated for subsequent evaluation in the project-level EIS which will follow. Thus, the alternatives analysis serves as an evaluation tool that develops the information and technical analyses needed to inform decision-makers and the public on the costs, benefits and impacts associated with each alternative under consideration. This alternatives analysis synthesizes a great deal of information, far greater than a typical alternatives analysis, regarding the description of alternatives and their evaluation; this information is intended for future use in the project-level EIS. This was done in order for the differences among the alternatives to be clearly understood and to inform the analysis of costs, benefits, and impacts. The document focuses on NEPA's intent to ensure that environmental factors are considered equally when compared to other factors (i.e., capital costs, development benefits, etc.) and that this consideration is applied equally and uniformly across all alternatives under consideration.

The identification of the Project alternatives, including corridors, alignments and stations have been shaped through outreach and coordination with cooperating agencies, project stakeholders and resource agencies, including the North Central Texas Council of Governments (NCTCOG), and the public. This is documented in the Project's Scoping Summary Report (June 2015) and the definition of the Project's Purpose and Need (Appendix A). They have also been shaped by other studies and regional and state-wide priorities and initiatives, discussed further, below.

TxDOT is the recipient of a $15 million grant under the American Recovery and Reinvestment Act of 2009 (ARRA) to conduct this work. An amount of $8 million from this grant has been dedicated to conduct the project-level EIS. The FRA is the lead federal agency providing oversight and having responsibility for the final decision on the alternative(s) recommended for further development and is leading the preparation of the alternatives analysis in close coordination with TxDOT.

1.2 Project Background

The Project is a direct outcome of a number of key State and regional planning efforts described below. These efforts demonstrate the State's and region's goals to provide improved intercity travel time and efficient connections to other transportation providers with modern trainsets and facilities.

1.2.1 Texas Oklahoma Passenger Rail Study (TOPRS)

As previously noted, TOPRS is the effort that has influenced the Project most directly since it identified corridor alternatives between Dallas and Fort Worth, as well as potential station locations. FRA, in coordination with TxDOT, issued the Record of Decision (ROD) for the TOPRS service-level (Tier 1) EIS, studying new and/or higher-speed intercity passenger rail services along an 850-mile corridor extending from Oklahoma City to the Fort Worth area (with the connecting corridor to Dallas) and further south to Laredo and the Rio Grande Valley. In addition to the service-level EIS, TOPRS includes a service development plan for the overall length of the corridor to guide further development and capital investment in passenger rail improvements. The EIS identifies the service type of passenger rail service within the overall length of the corridor including higher speed rail service (speeds of 125+ miles per hour [mph] or higher) between Fort Worth and Laredo and the Rio Grande Valley and traditional intercity passenger rail service (speeds of 90 mph or lower) between Oklahoma City and Fort Worth.

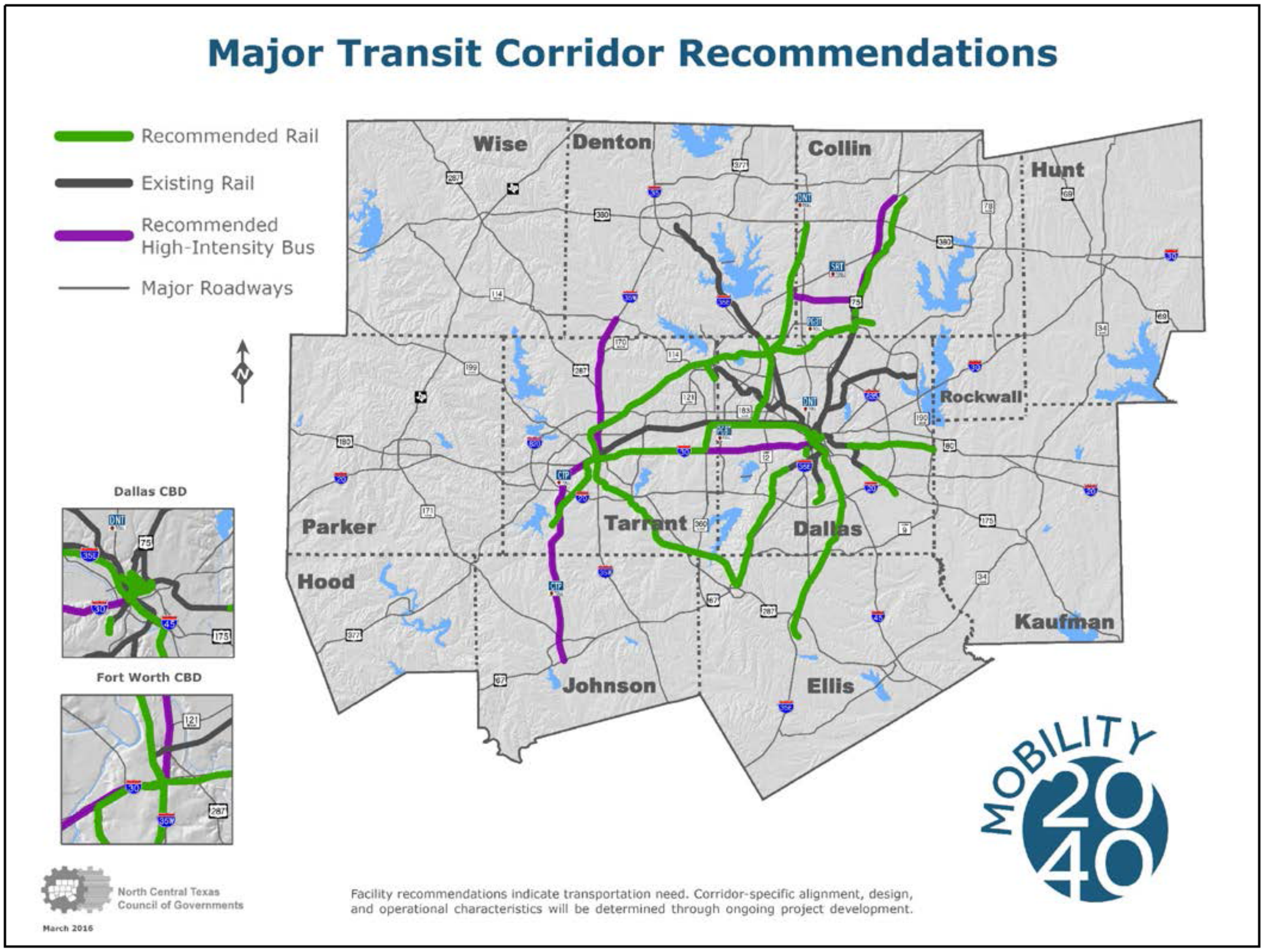
1.2.2 Texas Rail Plans

In 2016, TxDOT published the Texas Rail Plan, which establishes the vision, goals, and objectives for the passenger and freight rail system in the state (TxDOT 2010). The Plan envisions "cost-effective, energy-efficient, sustainable personal mobility and goods movement that connects Texas communities and links Texas businesses with domestic and international markets, minimizing environmental impacts, reducing road congestion, improving air quality, and promoting economic growth" (TxDOT 2010). In 2011, TxDOT published the Statewide Long-Range Transportation Plan, which emphasizes delivering a modern, interconnected, and multimodal transportation system in the state.

1.2.3 Adopted Regional Transportation Plan

The North Central Texas Council of Governments (NCTCOG), the metropolitan planning organization for the Dallas-Fort Worth Region, adopted its long-range regional transportation plan (Mobility 2040) in March 2016. The development of Mobility 2040 reflects detailed analysis and extensive coordination conducted by NCTCOG, and includes both freight and passenger transportation improvements. More specifically, the plan identifies the major transit corridor projects identified for the region, as shown on Figure 1-1 below. Germaine to this alternatives analysis, Mobility 2040 identifies a potential high-speed rail line connecting Dallas and Fort Worth, though the plan does not specify an exact route.

Figure 1-1: Mobility 2040 Major Transit Corridor Projects

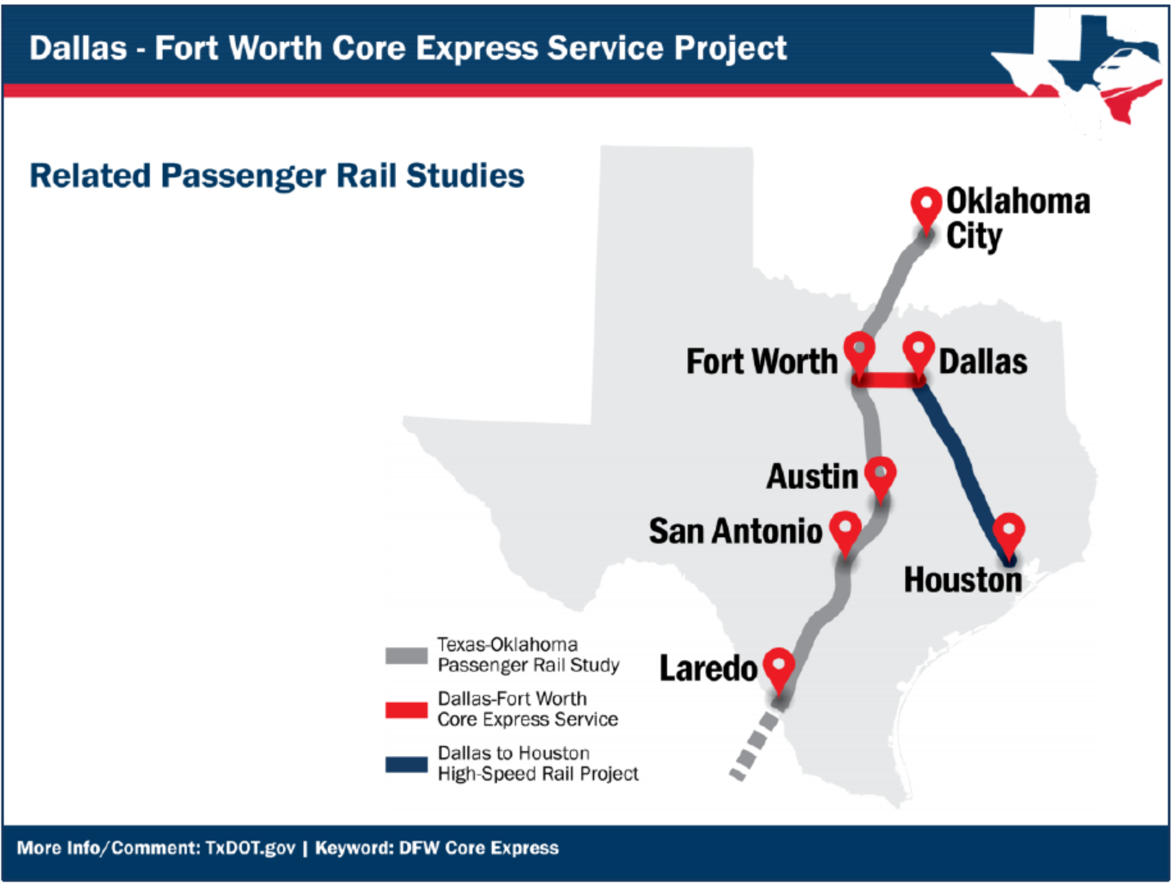


1.2.4 Dallas to Houston High-Speed Rail Project

FRA initiated a NEPA evaluation of the proposal by a private enterprise, the Texas Central Railway (TCR) to construct and operate a private, for profit, high-speed passenger rail system connecting Dallas and Houston with dedicated alignment and stations, thus providing the ability to coordinate service in a potential shared Dallas terminus of the Project. TCR proposes to use Japanese N700-1 Tokaido Shinkansen high-speed rail technology along the approximately 240-mile long corridor between the two cities. TCR's proposed high-speed rail system requires a fully sealed corridor with grade separated crossings and dedicated right-of-way that is approximately 125-feet wide in order to accommodate a two-track railroad and an access road. It requires a "closed system," meaning that the train must run on dedicated, high-speed rail tracks for passenger rail service only and cannot travel on existing or planned freight rail lines or share tracks with any other passenger rail service.

In summary, Figure 1-2 below shows a map that identifies the related passenger rail studies that influenced the Project and were discussed above.

Figure 1-2: Related Passenger Rail Studies



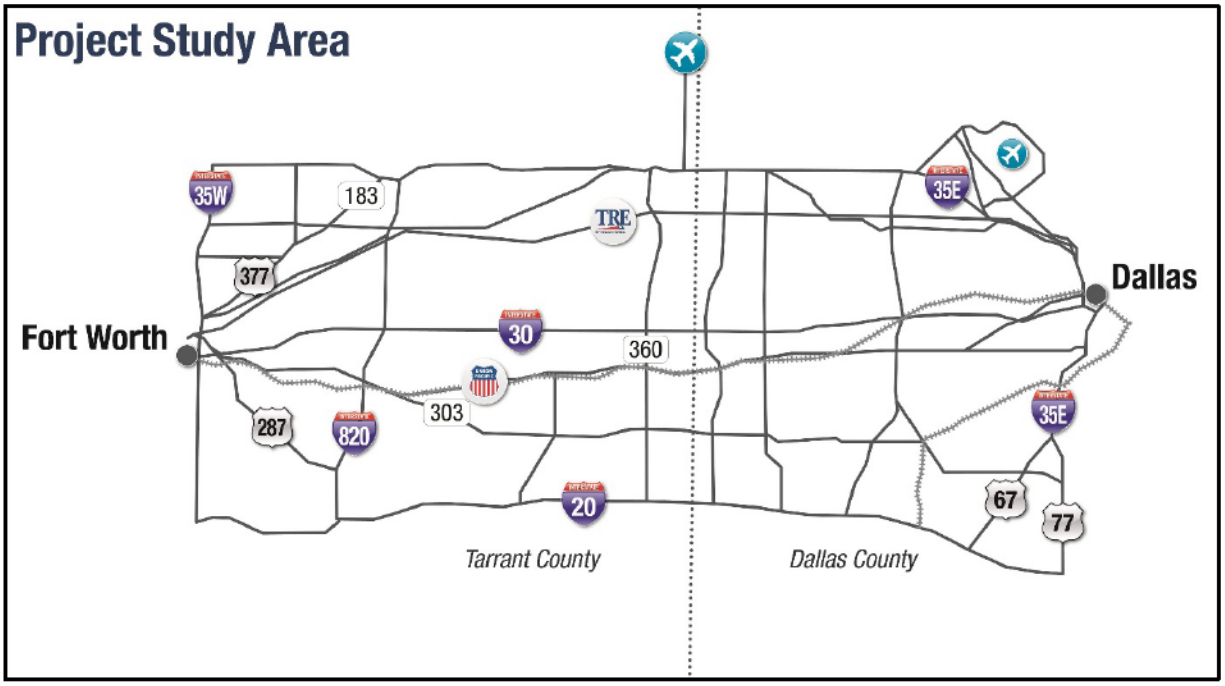
Source: WSP/Parsons Brinckerhoff 2015

1.3 *Project Study Area*

Figure 1-3 illustrates the Project's immediate study area, bounded to the east by the City of Dallas, and to the west by the City of Fort Worth, extending through both Dallas and Tarrant Counties. The Dallas - Fort Worth Metropolitan Statistical Area (MSA) is the official title assigned to the project area by the United States Office of Management and Budget, and the project area falls completely within the MSA. The study area is also known as the Dallas – Fort Worth Metroplex, or the Metroplex, which also serves as an economic and cultural hub. However, as noted in Sections 1.2.1 and 1.2.4, the provision of passenger rail service through the study area extends well beyond its immediate borders to Oklahoma City to the north and to Laredo and points south; the proposed TCR service to the study area would also provide a connection to Houston. Thus, the study area's geographic location serves as an important connection to a much broader passenger rail network envisioned for the State of Texas and beyond.

The study area is rich in roadway infrastructure, served by Interstate roadways, as well as a number of state highways. TxDOT is currently or has planned to invest significant resources to improve and expand the roadway network, including major interchanges in the City of Dallas. The Project study area is also presently served by both freight and passenger rail operators. The Class 1 freight operators include the BNSF Railway and the Union Pacific Railroad (UP). The Trinity Railway Express (TRE) provides daily commuter rail service in the study area, serving both Dallas and Fort Worth and connecting to 10 local stations. The Dallas Union Station is also served by Amtrak's Texas Eagle trains.

Figure 1-3: Project Study Area



Source: WSP/Parsons Brinckerhoff Inc. 2015

2.0 Project Purpose and Need – Problem Definition and Challenges

2.1 Overview

The Purpose and Need Statement prepared for the Project established the fundamental framework for evaluating alternatives in order to inform decision-makers, stakeholders and the public in ultimately selecting a Preferred Alternative at the conclusion of the EIS.

The genesis for the Project reflects the robust growth of population and employment throughout the Dallas – Fort Worth Metroplex, which has outgrown the existing transportation network. This has resulted in increased travel times for the movement of people and freight, decreased reliability and safety, and reduced air quality. Furthermore, recently constructed and planned roadway and transit improvements may be insufficient to meet current and projected demand. In addition, other planned high speed rail service(s) will further impact the transportation system, and will require enhanced regional connectivity to fully leverage the multi-billion dollar investments.

By the year 2040, the Dallas – Fort Worth region is forecast to grow from approximately 7 million (2016) to 10.7 million residents, an increase of more than 65 percent. This continued rapid growth will further increase traffic congestion and may impact air quality, depending on the pollutant. A high speed, reliable passenger transportation option is needed that will both improve local mobility and provide connections to alternative modes for traveling between major cities in Texas and surrounding states. The Project presents an innovative opportunity for the State of Texas to implement the vision of an interconnected, multimodal, statewide and interstate transportation system.

2.2 Project Purpose

As stated in the August 2015 Project Purpose and Need, the TOPRS EIS defined the purpose of the Project as introducing a new, limited service transportation option in the Metroplex. The Project will increase intercity mobility to, from, and within the Metroplex by providing enhanced passenger rail service as a transportation option that is competitive with automobile, bus, and other travel modes. The Metroplex is an integral part of the larger Northern and Central Sections evaluated in the TOPRS EIS. The connection to other high- performance intercity passenger rail services in Texas, as well as regional transit service is critical to facilitate improved travel to, from, and within the Metroplex.

Building upon the TOPRS program rationale, the purpose of the Project is to enhance inter- and intra-city mobility by providing a financially viable, safe, reliable and environmentally sustainable transportation alternative connecting Dallas and Fort Worth that could also provide a key link between existing and potential Texas high-performance passenger rail systems and other regional transit service. The overall Project purpose can be more specifically defined to:

- P-1 Advance the local, state and regional high-performance rail network in accordance with the State Rail Plan described in Section 1.2.2;

- P-2 Enhance connectivity to existing and planned passenger rail services, airports, roadways, bicycle and pedestrian facilities, and be competitive with private automobile and air travel;
- P-3 Promote improved air quality and reduced energy consumption; coordinate with and do not negatively affect freight rail operations or facilities; and
- P-4 Augment economic development opportunities and enhance environmental sustainability, while facilitating regional land use and transit-oriented development plans, within the Metroplex by providing improved access to employment, entertainment, recreation, health and shopping opportunities for existing and future residents and visitors in the study area.

2.3 Project Need

The need for the Project results from capacity constraints in the existing transportation system. If nothing is done to address these constraints, the region will experience greater levels of traffic congestion and travelers to and from the Metroplex will continue to have limited mobility options. Expected growth in both population and economic development opportunities will further strain the congested transportation system.

2.3.1 Population and Economy

The Dallas-Fort Worth Metroplex is one of the fastest growing urban areas within the state. The Metroplex has continued to sustain an unprecedented level of population and economic growth as a result of factors such as a favorable business climate, attractive tax policies and an abundance of available land (TxDOT 2014). In 2016, the Metroplex had a population of approximately 7 million. As noted above, by the year 2040, NCTCOG forecasts that the Metroplex will grow to 10.7 million residents, an increase of almost 4 million people. This growth represents a 53 percent increase in the population of North Central Texas. The Metroplex is the second fastest growing area in the US (behind Houston). The Metroplex is also the most populous area in the State and the 4th most populous in the US. Growth trends are forecast to continue through 2040.

According to the NCTCOG, "The transportation system is central to this growth because it allows for the efficient movement of people and goods. Understanding not only population but also employment growth is critical to the transportation planning process and to providing the best system to move people to and from jobs."

North Central Texas is responsible for 30 percent of the State's Gross Domestic Product (GDP), is home to 18 Fortune 500 companies, and is the 12th largest metropolitan economy in the world. According to the Dallas Chamber of Commerce, the Metroplex is the Number 1 visitor and leisure destination in the State of Texas, attracting over 44 million visitors annually. Activity centers/employment areas are seeing strong employment demand, including downtown Dallas, the Southwestern Medical District, Stemmons Corridor, Las Colinas, Galleria/Tollway Corridor, DFW

Airport, the Telecom Corridor and Legacy. Additionally, NCTCOG is projecting continued high employment growth in the Beach Street, North Richland Hills-Iron Horse, North Richland Hills-Smithfield, and Summer Creek areas (TEX Rail 2014). The dispersal of employment and entertainment centers results in complex travel patterns in the Metroplex that affect residents, business travelers and tourists.

In addition to being the Number 1 visitor and leisure destination in the State, the Metroplex is a major economic, social and political center which supports a diverse economy. Jobs within the Metroplex are projected to increase 46 percent from 4,584,235 in 2017 to 6,691,459 in 2040. According to NCTCOG's 2040 Demographic forecasts, the highest increase in the number of jobs is projected to occur in Dallas County at 1,312,672, a growth rate of 70 percent. Dallas County is followed by Tarrant County, which is expected to have 702,772 additional jobs or a 68 percent increase.

An increase in freight volumes also contributes to rising congestion on the transportation system within the Metroplex and statewide. According to the Texas Transportation Plan 2040, Texas truck tonnage is expected to increase by 78% between 2011 and 2040. Furthermore, the Texas Freight Mobility Plan notes that between 2014 and 2040, total freight tonnage (truck and rail) moved in Texas is projected to increase by 88%. Both congestion and the intensity of freight movement affect travel times and safety to, from and within the Metroplex.

2.3.2 Traffic Congestion

The Metroplex has the second largest number of freeway miles per capita in the nation, behind only the Kansas City Metropolitan area. Yet, due primarily to the enormous growth of area suburbs, the region experiences an ever-increasing problem with traffic congestion. The adopted Metropolitan Transportation Plan for North Texas, Mobility 2040 Plan notes that the Metroplex's population is expected to grow by more than 50 percent in size over the next 25 years, and that the region faces a tremendous challenge to provide a roadway system that meets the future needs and travel demands of its residents.

Daily commuting patterns have historically been characterized by suburb-to-central business district trips, with the average commute in the Dallas – Fort Worth area being 20 miles. Recently however, daily trip patterns have become increasingly more complex. The growth of employment centers outside of the central cities—the Alliance area for example—has become more common and has led to increased congestion along multiple travel corridors. This situation is further complicated by pass-through traffic using the Metroplex's interstate highway system.

The demand for truck freight services in the region has created additional congestion problems on the roadway network. Vehicular mobility is also reduced at highway-rail grade crossings that experience long blockage times as a result of increasing train frequencies and lengths, and congestion-induced reduction in train speeds. The total vehicle delay in the Study Area described in

Section 1.3 is projected to significantly increase by 2040. The Federal Highway Administration defines Vehicle Delay as the time difference between ideal travel time and actual travel time.

2.3.3 Air Quality

Dallas and Tarrant counties do not currently meet the federal air quality standard for ozone. Under the most recent Environmental Protection Agency (EPA) Ozone Standard, ten of the twelve Metroplex counties are classified as moderate nonattainment for the 2008 8-hour ozone standard (0.070 parts per million (ppm) averaged over 8 hours). In addition, vehicle miles traveled are expected to increase from 206 million miles annually in 2017 to 320 million miles annually by 2040. As congestion levels rise, air quality in the region can decline, although there have been recent improvements to air quality in the Metroplex. Meeting regional air quality standards should be considered while continuing to secure future federal highway funding, as well as in promoting future economic growth.

Thus, the needs and corresponding issues to be addressed by the Project include:

- N-1 Planning for rapid population and economic growth between now and 2040 that will generate increased travel demand, additional congestion and reduce automobile and public transportation reliability;
- N-2 Enhancing transportation connectivity to, from and within the Metroplex;
- N-3 Facing access constraints to the DFW Airport and other major activity centers.; and
- N-4 Continuing to improve air quality within the Metroplex while also mitigating the effects that increased truck and rail freight traffic have on the transportation system.

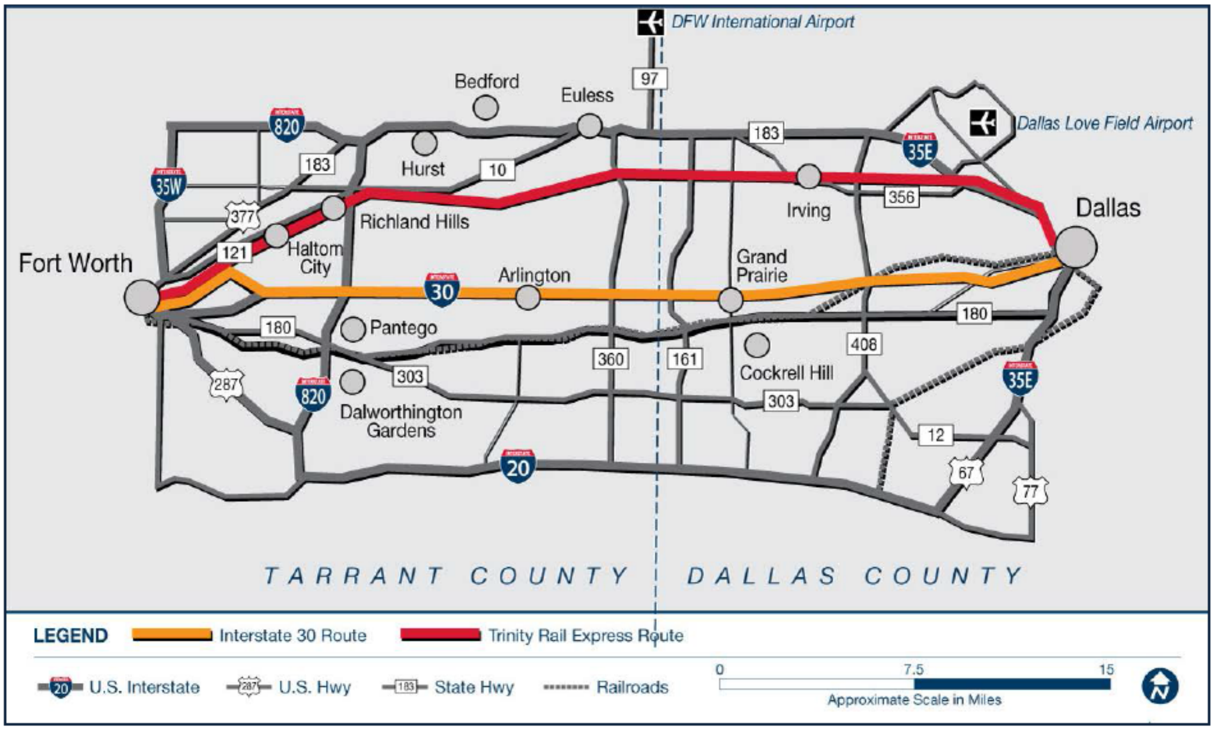
3.0 Definition of Alternatives

This section defines the key physical characteristics, service attributes and operating plans for the alternative corridors connecting Dallas and Fort Worth considered in TOPRS (I-30 and Trinity Railway Express (TRE)) and the combination I-30/SH 360/TRE (Hybrid) Corridor, in addition to the No Build Alternative. Detailed descriptions of each of the three corridors, their attributes and travel demand are provided below.

3.1 Study Corridors

The TOPRS identified three potential existing transportation corridors for implementing improved passenger service between Fort Worth and Dallas: Union Pacific (UP), I-30, and TRE. The UP corridor was dropped from consideration early in the alternatives analysis after UP indicated it would not consider adding passenger trains in its corridor, potential serious environmental impacts were identified and the need for property acquisition was considered. The two remaining corridors, I-30 and TRE are shown in Figure 3-1 below.

Figure 3-1: Potential Corridors Defined in TOPRS Study



Source: WSP/Parsons Brinckerhoff 2015

As a result of the Project's ongoing public outreach and stakeholder and agency coordination, an alternative corridor consisting of a combination of the west end of the I-30 Corridor, the east end of the TRE Corridor, and the State Route 360 (SH360) corridor connecting the approximate midpoints was added for consideration. These three corridors are the subject of this alternatives analysis, and are shown in Figure 3-2.

Figure 3-2: Corridors Considered in Alternatives Analysis

Within the three study corridors (I-30, TRE and I-30/SH 360/TRE (Hybrid)) there are various options for specific alignments associated with the maximum operating speeds, various land use and physical constraints, the potential for one or more intermediate stations between Fort Worth and Dallas, and options for entry to and from station locations in Fort Worth and Dallas. In the TRE corridor, sharing of TRE track could only be an option for the lower speed service alternatives.

As described in Chapter 4, an initial "fatal flaw" screening has been applied to each of the corridors to identify obstacles or constraints that would prevent an alternative from serving the Project's purpose and need, or would entail extraordinary, impractical and/or unacceptable measures, impacts, and costs to overcome. Following the initial screening, subsequent levels of more detailed analysis have been applied to a short list of alternatives. The analysis also includes a No Build Alternative throughout the evaluation as a baseline for comparison of the build alternatives. Under the No Build Alternative, high-performance intercity passenger rail service between Dallas and Fort Worth would not be constructed or implemented.

3.1.1 No Build Alternative

The No Build Alternative assumes the implementation of all projects in the Metropolitan Transportation Plan, Mobility 2040, except for the Project. The No Build Alternative provides a baseline against which other alternatives will be compared in the EIS. It assumes implementation of infrastructure, transit facilities and passenger rail projects identified on the following table, with the exception of the Project, which is identified as project Number 20, the West/East Line.

Table 3-1: Transit Project Listings – NCTCOG Draft Mobility 2040 Plan

Corridor ID	Corridor	From	To	Estimated Length (miles)	Region	Agency	Mode	Status	Conformity Range	Recommendation	Project Type	Segment ID	Capital Cost ($M) (YOE)
1	Blue Line – UNT Extension	Ledbetter	UNT South Campus	3	East	DART	Light Rail	Under Construction	Present - 2017	DART 2030 System Plan	Extension of Line	TR1- 10303.2	$266
2	Cotton Belt	DFWIA Terminal A/B	Shiloh	28	East	DART	Regional Rail	Programmed	2018 - 2027	DART 2030 System Plan	New Corridor	TR1- 10314.0	$2,900
3	Downtown Dallas 2nd Alignment (D2)	Victory Station	Deep Ellum	2.4	East	DART	Light Rail	Programmed	2018 - 2027	DART	New Corridor	TR1- 10333.0	$650
3	Downtown Dallas 2nd Alignment (D2) - Convention Center Extension	Metro Center Station	Dallas Convention Center	0.5	East	DART	Light Rail	Future	2018 - 2027	DART	New Corridor	TR1- 10333.1	$349
4	Dallas Streetcar (Central Link)	Urban Circulator/McKinney Avenue Trolley	Union Station	1.5	East	East-Other	Streetcar	Programmed	2018 - 2027	DART	New Corridor	TR1- 10351.2	$92
4	Dallas Streetcar	Oak Cliff	Bishop Arts	1	East	East-Other	Streetcar	Under Construction	Present - 2017	City of Dallas	New Corridor	TR1- 10351.1	$26
5	A-train	Trinity Mills	Belt Line (Carrollton)	2	East	DCTA	Regional Rail	Future	2028 - 2037	DCTA	Extension of Line	TR1- 10306.2	$96
6	Frisco Line	South Irving Transit Center	Frisco	29	East	East-Other	Regional Rail	Future	2028 - 2037	RRCS	New Corridor	TR1- 10318.0	$1,392
7	Mansfield Line	Midlothian	Fort Worth ITC	30	West	West-Other	Regional Rail	Future	2028 - 2037	NCTCOG	New Corridor	TR1- 10328.0	$1,440
8	McKinney Line	Parker Road Station (Plano)	McKinney North	18	East	East-Other	Regional Rail	Future	2028 - 2037	RRCS	New Corridor	TR1- 10300.2	$864
9	Midlothian Line	Westmoreland	Midlothian Central	18	East	East-Other	Regional Rail	Future	2028 - 2037	RRCS	New Corridor	TR1- 10336.0	$864
10	Green Line – Southeast Extension	Buckner Blvd.	South Belt Line Road	6	East	East-Other	Regional Rail	Future	2028 - 2037	NCTCOG	Extension of Line	TR1- 10302.2	$288
11	TEX Rail	T&P Terminal	DFWIA Terminal A/B	27	West	FWTA	Regional Rail	Programmed	2018 - 2027	FWTA	New Corridor	TR1- 10315.1	$996
12	Southwest TEX Rail	Sycamore School Road/McPhearson	T&P Terminal	11	West	FWTA	Regional Rail	Future	2028 - 2037	FWTA	Extension of Line		$528

Corridor ID	Corridor	From	To	Estimated Length (miles)	Region	Agency	Mode	Status	Conformity Range	Recommendation	Project Type	Segment ID	Capital Cost ($M) (YOE)
13	Scyene Line	Lawnview	Masters	4	East	East-Other	Regional Rail	Future	2028 - 2037	NCTCOG	New Corridor	TR1- 10345.1	$192
13	Scyene Line	Masters	Lawson Road	8	East	East-Other	Regional Rail	Future	2028 - 2037	NCTCOG	New Corridor	TR1- 10345.2	$384
14	Waxahachie Line	Downtown Dallas	City of Waxahachie	31	East	East-Other	Regional Rail	Future	2028 - 2037	RRCS	New Corridor	TR1- 10335.0	$1,488
15	IH 35W Express	T&P Terminal	TX 114	21	West	West-Other	High- Intensity Bus	Future	2018 -2027	NCTCOG	New Corridor		$10
16	Chisholm Trail Express	Fort Worth ITC	Cleburne Amtrak Station	33	West	West-Other	High- Intensity Bus	Future	2018 -2027	NCTCOG	New Corridor		$18
17	US 75 Express	Parker Road Station (Plano)	North McKinney	13	East	East-Other	High- Intensity Bus	Future	2018 - 2027	NCTCOG	New Corridor		$10
18	IH 30 Express East	Managed Lane Western Terminus	Downtown Dallas East Transfer Center	21	West/East	Other	High- Intensity Bus	Programmed	Present - 2017	NCTCOG	New Corridor		$11
19	Spring Creek Parkway Express	Sam Rayburn Tollway	US 75	15	East	East-Other	High- Intensity Bus	Future	2018 - 2027	NCTCOG	New Corridor		$16
20	West/East Line*	Downtown Fort Worth	Downtown Dallas	32	West/East	Other	High-Speed Rail	Future	2018 – 2027	FRA/TxDOT	New Corridor		$2,900

Source: Draft Appendix E: Mobility Options, The Metropolitan Transportation Plan for North Texas, Mobility 2040, NCTCOG, http://www.nctcog.org/trans/mtp/2040/documents/EMobilityOptions.pdf

*Project 20, West/East Line is the Dallas – Fort Worth Core Express Service; it is excluded from the No-Build Alternative.

3.2 Build Alternatives

This section describes the conceptual alignments that were identified within each of the three corridors, shown in Figure 3-2. These descriptions represent concept-level engineering and field verification that has been performed. The descriptions present substantial detail in excess of what is typically included in an alternatives analysis. This was done in order for the differences among the alternatives to be clearly understood and to inform the analysis of costs, benefits, and impacts. As noted, each alignment is based on engineering factors and reducing or eliminating impacts to existing land uses, and includes curves with noted speed limitations. Where speed limitations are not noted, the alignment is suitable to accommodate maximum speeds up to 220 mph. However, the defined maximum speeds for the various alternatives of 90 mph, 125mph, and 220 mph are nominal. The actual maximum speeds that would be reached for each of those alternatives may be limited by the capabilities of the defined rolling stock for each maximum speed category operating within the limitations posed by the noted speed restricted curves of the selected alignment and station stops.

Although the FRA permits highway grade crossings with specified protections up to 125 mph, the TxDOT administration has established safety parameters and long range planning goals to avoid highway grade crossings where train speeds exceed 79 mph. In addition, the introduction of new grade crossings with frequent train movements at less than 79 mph will introduce traffic impacts and safety concerns, with the potential for accidents and service disruptions. Thus the conceptual alignment assumes full grade separation for the 125 mph and 220 mph alternatives, including in areas of speed-restricted curves, but does include some grade crossings for the 90 mph alternative in segments where an at-grade alignment was selected for 90 mph to reduce capital costs.

The figures in the following alignment descriptions are derived from the graphics that were initially prepared by the firms of HNTB and WSP/Parsons Brinckerhoff Inc., and subsequently modified by the FRA's Monitoring and Technical Assistance Contractor (MTAC), Urban Engineers, Inc.

3.2.1 The I-30 Corridor

The I-30 corridor runs for approximately 30 miles between Fort Worth and Dallas, and is a primary route for commuters and interstate travellers between these two metropolitan areas. Daily traffic levels average between 122,000 and 130,000 vehicles. The corridor runs through a heavily urbanized area with dense development adjacent to the existing interstate right-of-way, severely limiting further expansion of the highway and necessitating the use of multi-level interchanges to provide capacity and access.

TXDOT has invested more than $1 billion in recent improvements to I-30, nearly all of it (approximately $919 million) east of SH 360 between Arlington and Dallas. The Fort Worth District of TXDOT is in the early planning stages of developing projects to improve travel conditions in the western portion of the corridor between Fort Worth and Arlington, allowing opportunity for coordination with design of a new rail line in that portion of the corridor.

Construction investments scheduled or completed between Arlington and Dallas include three major interchanges with I-30:

- SH 360
- SH 161 (President George Bush Turnpike)
- I-35E (located in the City of Dallas)

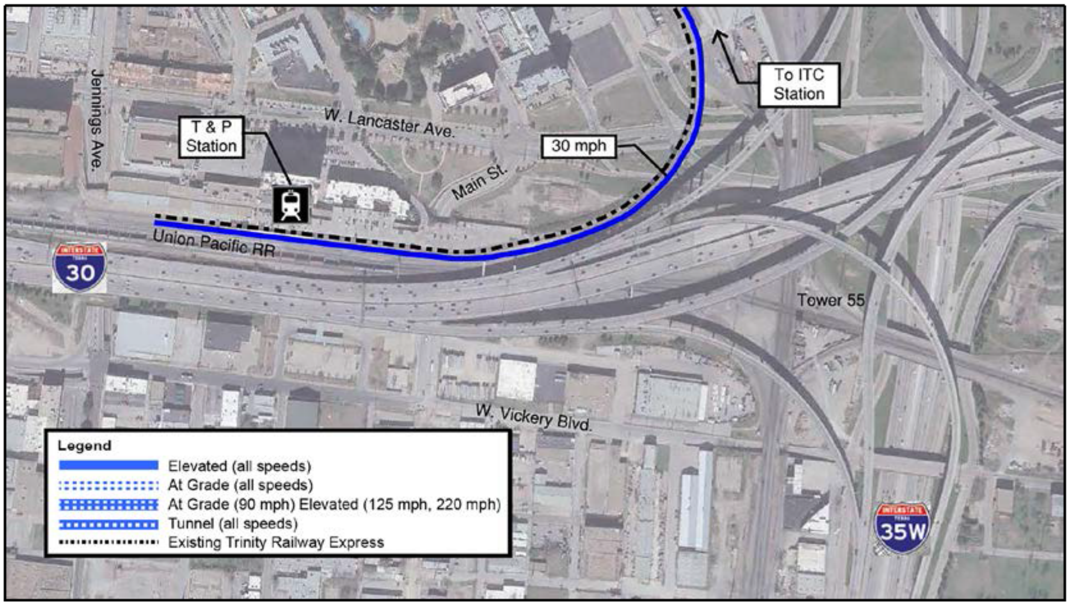
These are complex multi-level interchanges that are major obstacles for a new rail alignment.

As described below, the discussion of the alignment has been divided into segments due to the complexity of the entire route.

Downtown Fort Worth

Station options in Fort Worth include the former T&P station, served by the TRE, and the Fort Worth Intermodal Transportation Center (ITC), served by TRE, Amtrak, and local bus routes. The T&P Station lies immediately west of the Tower 55 railroad junction and the multi-level I-30/I-35W interchange above the junction. Local streets pass beneath the railroad. The very heavy freight traffic through the junction precludes an at-grade route for a new passenger rail line, and the complex ramps and structures of the interchange and the streets below render both a viaduct and a tunnel unfeasible. The conceptual alignment beginning at the T&P station, shown in Figure 3-3 would parallel the existing TRE alignment leading to the ITC. The alignment would be on viaduct to avoid interference with TRE, Amtrak, and freight operations.

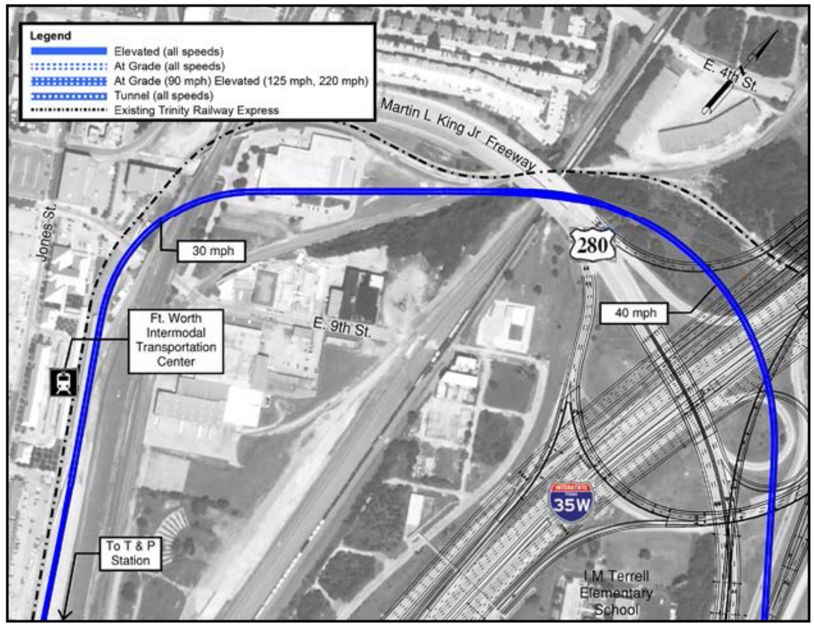
Figure 3-3: Fort Worth T&P Station



A route that bypasses Tower 55 and the I30/I35W interchange to the north would follow the existing TRE track passing adjacent to or through the ITC. Thus the ITC could serve as a terminal station, or an additional station if the proposed passenger service were to continue and terminate at the T&P station. Because of the need for a viaduct for the route between the station and the I-30 corridor, the new tracks would need to be elevated in the station area, which would also avoid conflicts with TRE, Amtrak, future TEX Rail commuter rail service, and freight movements.

The proposed conceptual alignment through the ITC in downtown Fort Worth is shown in Figure 3-4.

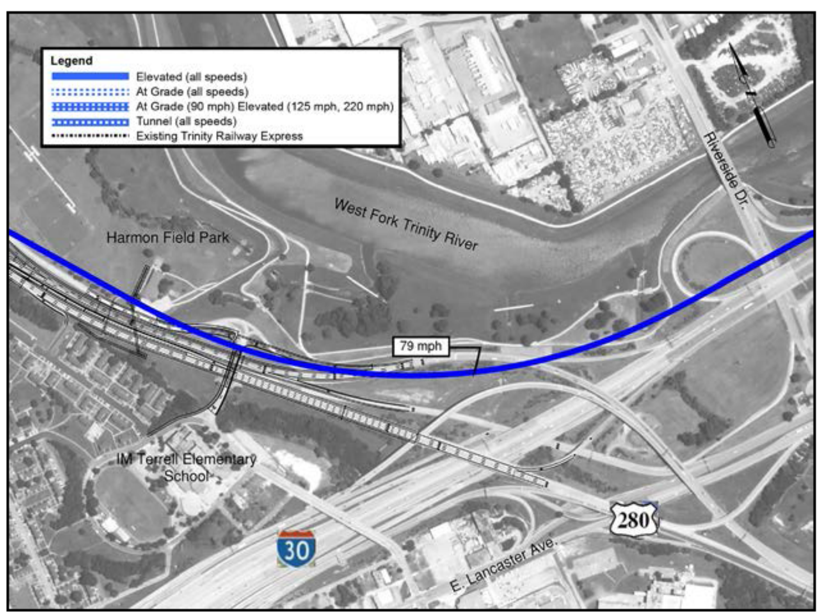
Figure 3-4: Conceptual Alignment in Downtown Fort Worth



Fort Worth to SH360

Leaving Downtown Fort Worth, the elevated alignment crosses above three rail lines and Martin Luther King Jr. Freeway. It then follows the east side of US 280 to avoid impacts to the Butler Learning Center and residential development as well as the IM Terrell Elementary School (on the southwest side of US 280), while also avoiding the US 280/I-30 interchange. The I-30 Conceptual Alignment curve in the northeast corner of the US 280/ I-30 interchange, as shown in Figure 3-5, intrudes into the west side of the Harmon Field Park, but is elevated to avoid direct impact to the park and the Fort Worth Branch trail (part of the Trinity Trail System).

Figure 3-5: Conceptual Alignment Adjacent to Harmon Field Park



The conceptual alignment connects to the I-30 corridor at the US 280 interchange and remains on the north side of I-30 (to avoid crossing I-30), where it continues to encroach slightly into the edge of the park and trail system.

In the section between Beach Street and Oakland Boulevard, as shown in Figure 3-6 and Figure 3-7, the alignment is located to minimize proximity to the West Fork Trinity River and the Trinity Trail System while avoiding a crossing of I-30. The maximum speed would be 90 mph.

Figure 3-6: Curve East of Beach St.

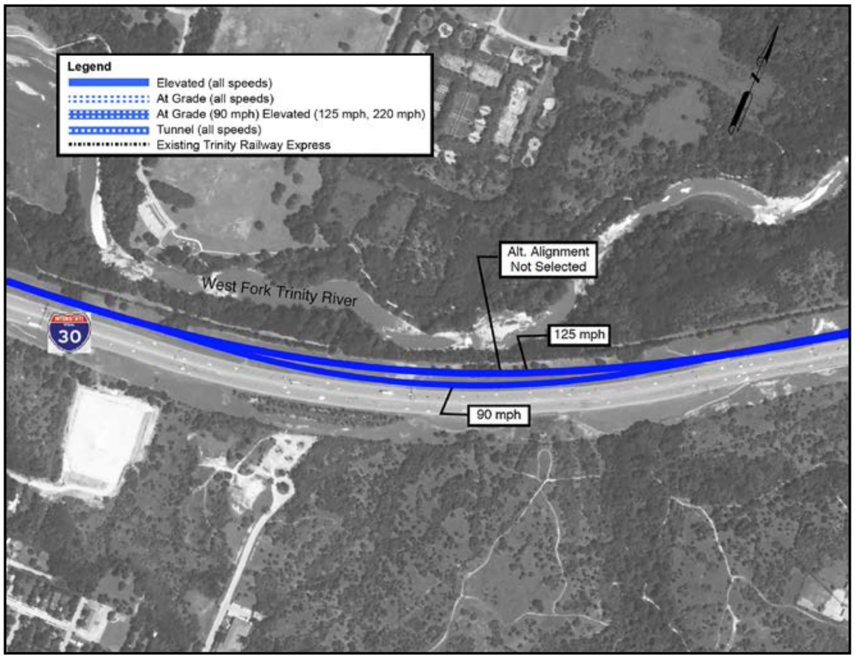
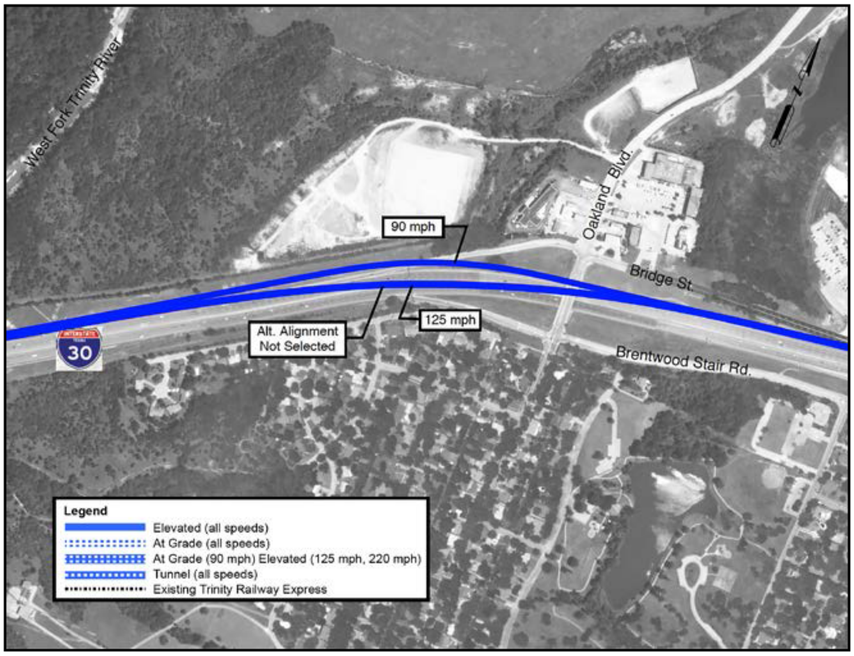


Figure 3-7: Curve at Oakland Blvd.



The conceptual alignment continues on the north side of I-30 and crosses above the I-820 interchange to avoid impacts to residential communities on the south side of I-30 as shown in Figure 3-8.

The conceptual alignment remains within the existing interstate right-of-way on the north side of I-30 and is elevated above crossing roadways and freeway ramps until it crosses to the south side of I-30 at N. Davis Drive, as shown in Figure 3-9. The conceptual alignment shifts to the south side of I-30 due to right-of-way restrictions on the north side, approaching Cooper Street.

Crossing I-30 requires straddle bents to span the I-30 lanes or reconstruction of I-30 in this area to provide for column locations for this alignment. The conceptual alignment on the south side of I-30 requires columns to be located between the main lanes and the frontage road between Cooper Street and SH 360 in Arlington. The conceptual alignment provides a tangent alignment to allow for a potential station location in Arlington.

Figure 3-8: Conceptual Alignment at I-820

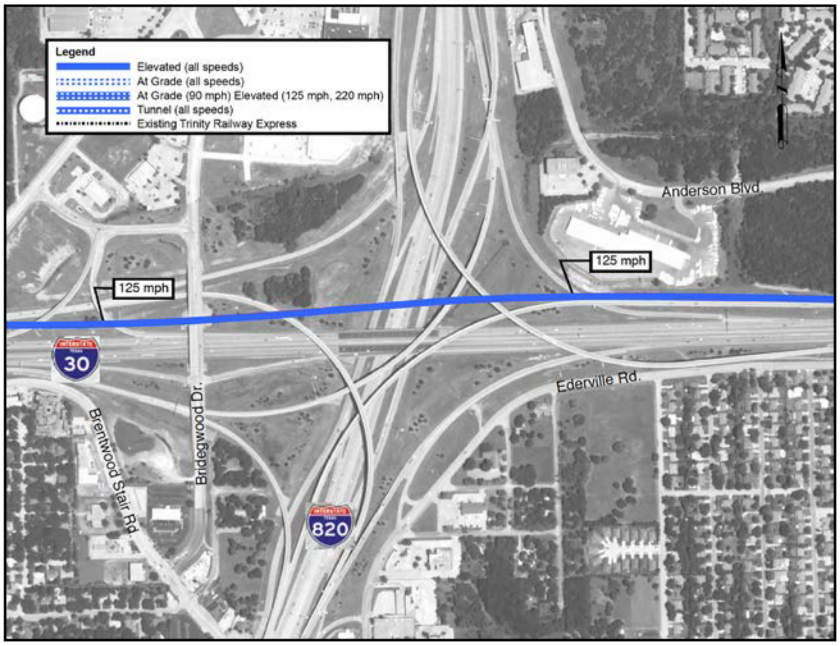
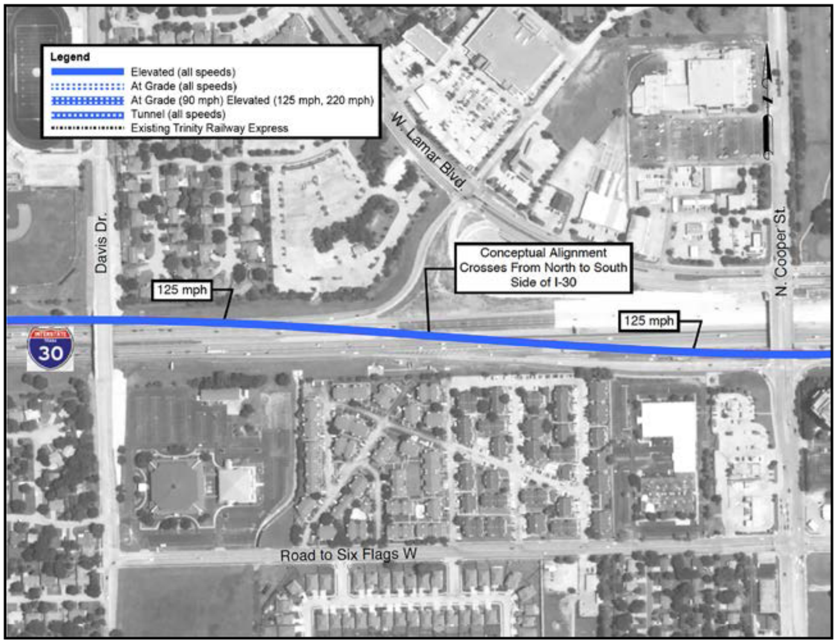


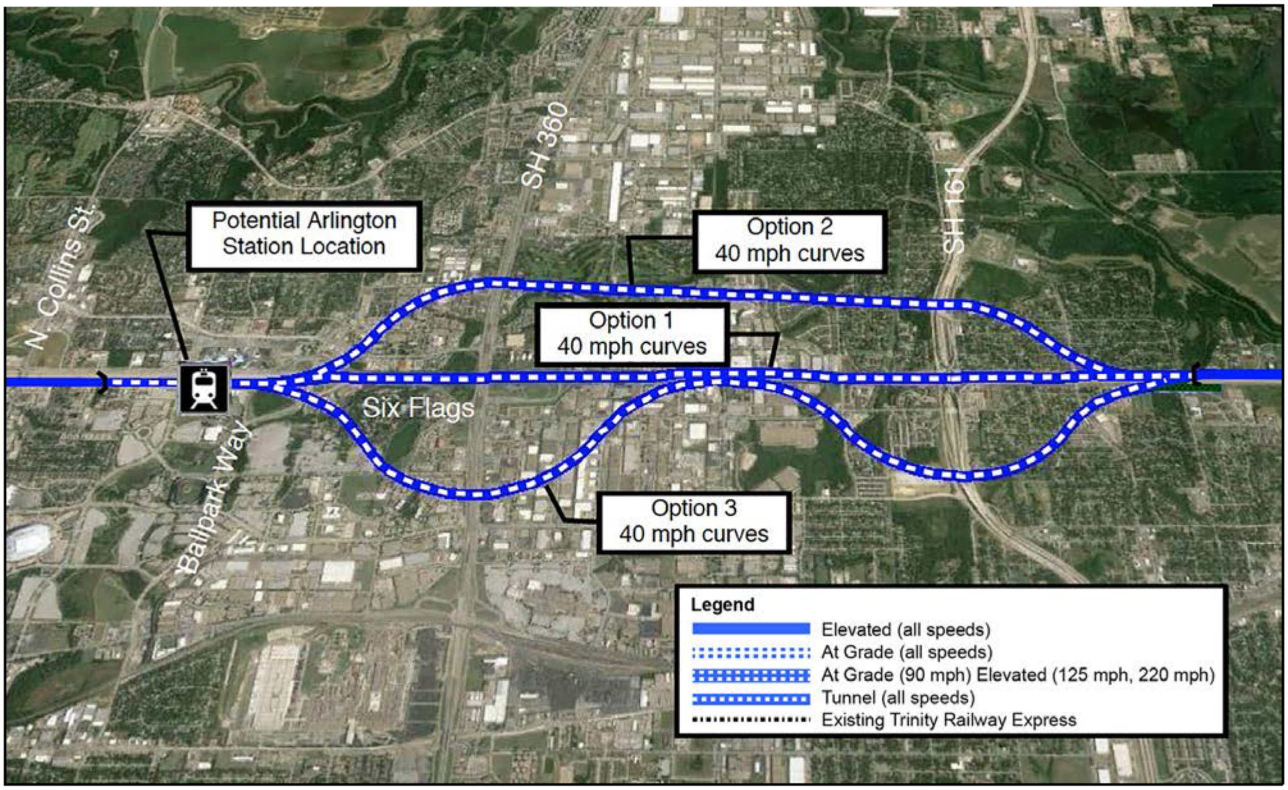
Figure 3-9: Conceptual Alignment at Davis Drive



Arlington

In Arlington the SH 161 interchange opened to traffic in 2009, and reconstruction of the SH 360 interchange got underway in March, 2016. When completed in 2020, the SH 360 interchange, similar to the SH 161 interchange, will be a large, multi-tiered junction with ramps on several levels. The current design for the SH 360 interchange does not provide the provision to accommodate rail service. Thus, the options at SH 360 include an alignment through the interchange, or more likely, a bypass alignment around the interchange since its current design does not accommodate a high-speed rail line. The alignment options are shown in Figure 3-10. Because the two interchanges are only about two miles apart, a combined or common solution is appropriate for both locations. Option 1 represents an alignment through the interchange. Options 2 and 3 represent bypass alignments to the north and south of the interchanges respectively.

Figure 3-10: Conceptual Alignments at Arlington



Option 1:
Due to the multi-level roadways within the SH 360 interchange, a viaduct would have to be more than 100 feet tall, and due to the long approaches, could impact the options at the nearby SH 161 interchange approximately two miles away. A viaduct of that height and scale would be a very high cost element with long approaches and significant visual impact. It would negatively impact the ability to place an intermediate station near the entertainment district in Arlington with the alignment on a very high structure at that location.

Tunnel construction methods include cut and cover or boring/mining and would have to occur beneath the main roadways to avoid the large number of ramp overpass foundations. Cut and cover construction would have severe impacts to the traveling public including lane closures and reduced speeds to accommodate excavation, support of existing foundations and earth, construction of an overhead causeway for construction traffic and material delivery, and protection for construction workers. The disruption to traffic could extend from one and one-half to two years. A bored tunnel method of construction could reduce, but not eliminate, the disruption to traffic. It would present significant engineering challenges and risks due to the nature of the subsurface geological conditions. The tunnel would penetrate alluvial soil near the surface and the Eagle Ford Shale formation as it goes deeper. The formation varies both vertically and laterally and is known for its methane gas production, in-situ clay, water content, and physical traits of becoming unstable after drying due to its pervasive clay/bentonite content. Potential settlement of structures immediately above the tunnel would be a major concern. The transition from tunnel to viaduct, depending on the specific alignment, could have significant traffic impacts. Both tunnel construction methods would be very costly. A station in Arlington near the entertainment district would need to be below ground.

Options 2 and 3:

A deviation that would swing around the interchanges with sweeping curves would be substantial due to the size of the interchanges and would vary in extent depending on the maximum design speed of 90, 125, or 125+ mph. The higher design speeds would require the greatest deviation unless permanent speed reductions were in effect. A deviation to either the north or south side of I-30 would take the alignment outside of the corridor and have major impacts due to the extensive commercial and residential development in the area. Figure 3-10 shows Option 2 on the north side of I-30 as a single bypass for both interchanges while Option 3 on the south side shows separate bypasses for each interchange. Either solution or a bypass alignment falling between the two shown could be implemented on either the north or south side of I-30 depending on detailed analysis to minimize impacts. Because of the extensive development on both sides of I-30, both a viaduct and surface alignment would have severe impacts. A surface deviation would have the greatest number of impacts due to the need to take many homes and businesses and the introduction of numerous grade crossings or street/road closures. Both a viaduct and a cut and cover tunnel would eliminate the need for permanent street closures or grade crossings, but would still require the taking of many homes and businesses. A deep bored tunnel would entail the fewest impacts, but would present similar engineering challenges and risks as noted in the Option 1 discussion above. A station near the entertainment district would have to be either elevated on viaduct or in tunnel below grade.

For the conceptual alignment, a tunnel and 40 mph curves as shown in Figure 3-10 are assumed for all of the Arlington options to minimize potential impacts through this area.

Arlington to Dallas

Continuing east from Arlington, the conceptual alignment would be elevated on the north side of I-30. At S. MacArthur Blvd., shown in Figure 3-11, a series of curves ranging from 90 to 160 mph would be required to minimize impacts.

After a 160 mph maximum curve west of Loop 12, the elevated alignment passes over Loop 12 and then transitions to tunnel east of Chalk Hill Rd. to minimize impacts to dense development along I-30. Curves could permit a maximum operating speed up to 160 mph in the tunnel alignment. The alignment at this location is shown in Figure 3-12.

Figure 3-11: Alignment at S. MacArthur Blvd.

Figure 3-12: Transition to Tunnel at Chalk Hill Rd

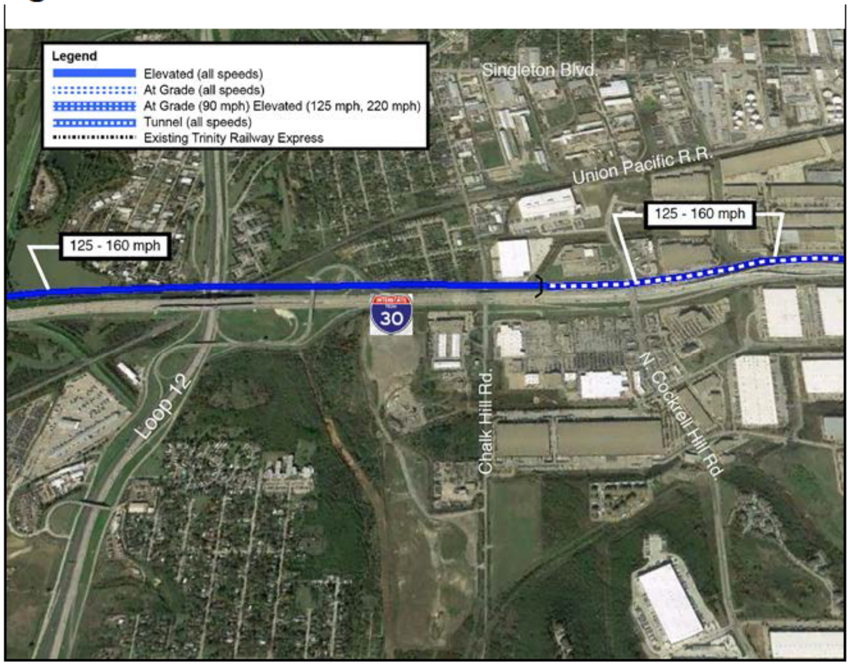
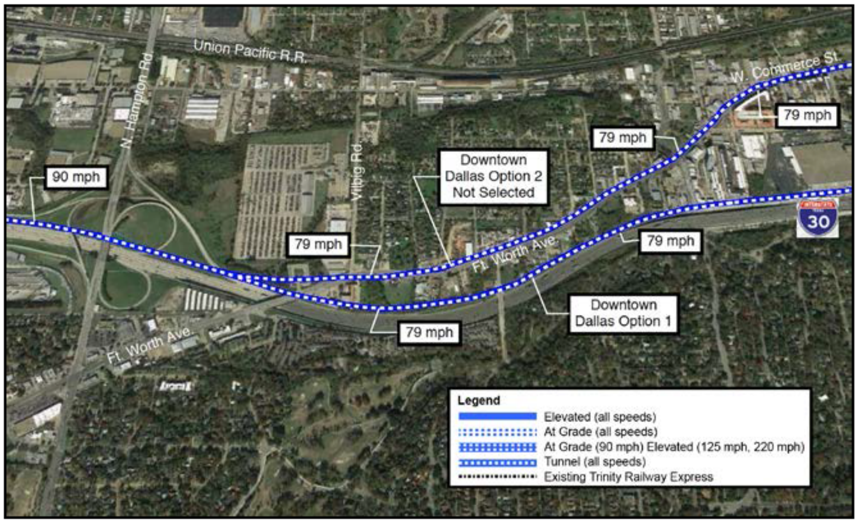


Figure 3-13: Alternative Options Approaching Downtown Dallas

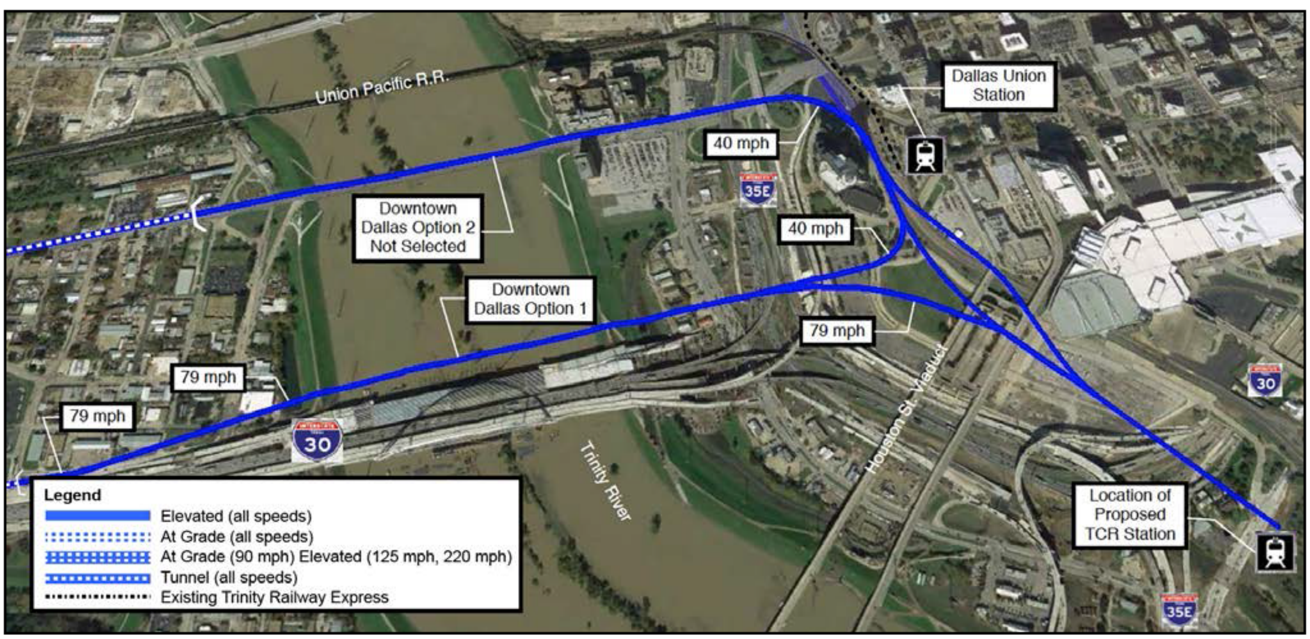


The tunnel alignment continues along the north side of I-30, passing beneath the N. Hampton Rd. interchange. Starting just west of Fort Worth Ave. two alternative alignments to reach downtown Dallas are considered. Option 1 remains on the north side of I-30, and Option 2 follows Fort Worth Ave. and, further east, W. Commerce St. Both options, as shown in Figure 3-13, remain in tunnel and entail 79 mph curves.

Downtown Dallas

Figure 3-14 shows the two optional alignments entering downtown Dallas. Both options emerge from tunnel to cross the Trinity River on viaduct and continue elevated to either of the proposed Dallas termini.

Figure 3-14: Downtown Dallas Alignments



Option 1 passes adjacent to and through portions of the I-30/I-35E interchange adjacent to downtown Dallas. This is a complex intersection with ongoing major roadway reconstruction projects including expansion and addition of several new bridges and roadways as well as the construction of a new signature bridge over the Trinity River. The number of support columns for ramps and limited vertical clearances preclude threading a surface rail alignment through the interchange into downtown Dallas. The only feasible options are a viaduct or a tunnel, both of which have significant challenges due to the density of highway structures and cost. A viaduct would have to be approximately 100 feet high, and finding room to place viaduct supports may prove to be impossible. A tunnel would face challenges due to subsurface conditions and the need to avoid or reliably underpin the dense array of highway structure foundations.

Figure 3-15, looking west toward Fort Worth, shows the interchange with some of the new bridge piers under construction.

Immediately beyond the interchange area, the alignment sharply turns either northward to serve Dallas Union Station or southward to serve the proposed TCR Station. Serving both would require a backup movement.

Figure 3-15: Reconstruction of I-30/I-35E Interchange

Option 2 avoids most of the I-30/I-35W interchange and offers the potential advantage of serving both Union Station and the proposed TCR station without the need for a backup move. However, Option 2 includes substantial subway tunnel construction beneath major urban streets west of the Trinity River.

Both options include 40 mph curves. They are both shown as elevated in Figure 3-14 although detailed engineering would be required to determine whether a viaduct or tunnel would be feasible and which would be more cost effective. For purposes of the Alternatives Analysis, Option 1 is selected as it would avoid tunneling under Ft. Worth Avenue and West Commerce Street, which are more densely developed than the north side of I-30.

3.2.2 The Trinity Railway Express (TRE) Corridor

The TRE is a railway line extending approximately 34 miles between the T&P Station or the ITC in downtown Fort Worth to Union Station in downtown Dallas. The line is served by the TRE commuter rail service, a daily Amtrak train in each direction, and freight service. Located primarily at grade, the line is a mix of single and double track. Full double tracking and the addition of a future third track are under consideration.

Most of the TRE corridor consists of long stretches of tangent track connected by a few isolated curves making it possible, with the exception of the curves, for 90 mph, 125 mph, or 125+ mph maximum speed alignments to stay within or closely parallel to the existing corridor right-of-way. The existing corridor includes numerous highway grade crossings, industrial sidings, and TRE rail stations. The alignment for the three maximum speed alternatives is the same; however, the profile for the 90 mph alternative includes more at-grade segments than the 125 mph and 220 mph alternatives.

Downtown Fort Worth

Either the T&P, the ITC, or both would be viable stations in Fort Worth as they are currently connected to the TRE corridor. The conceptual alignment beginning at the T&P station is shown in Figure 3-16. An elevated alignment and platform would be required due to expected capacity limitations at the station hosting existing and planned additional TRE service.

The alignment continues elevated through the ITC to avoid conflicts with existing and future TRE service as well as Amtrak and future TEX Rail service. From the Fort Worth ITC, the alignment continues east on elevated structure south of the existing TRE tracks to cross above freight lines, US 280, and the West Fork Trinity River. The alignment requires a slight shift away from the existing TRE tracks to minimize impacts to adjacent properties, although the alignment would impact a large wholesale distributor warehouse to the south

Figure 3-16: Fort Worth T&P Station

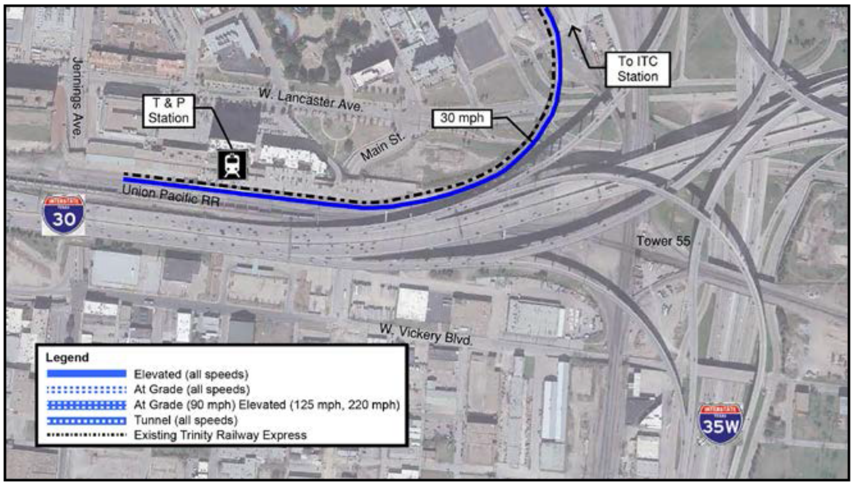
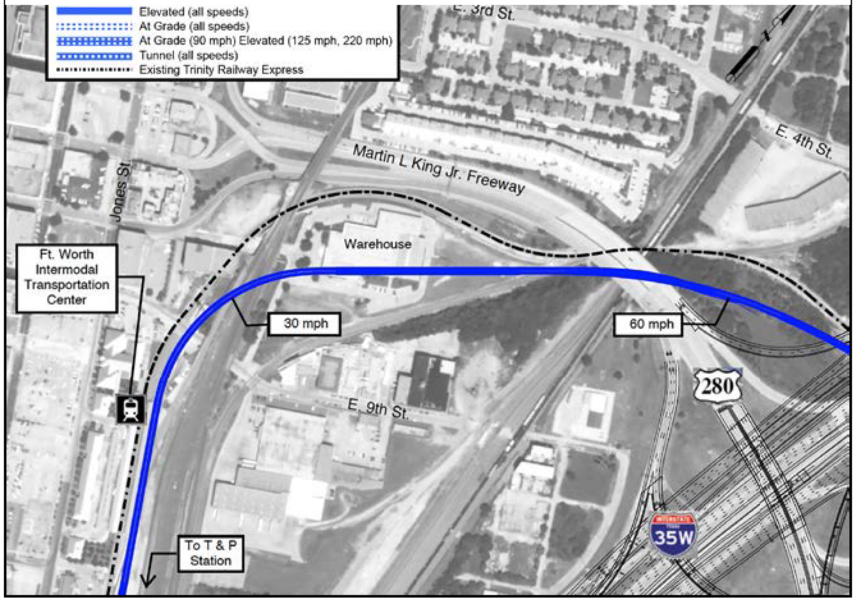


Figure 3-17: TRE Conceptual Alignment in Downtown Fort Worth

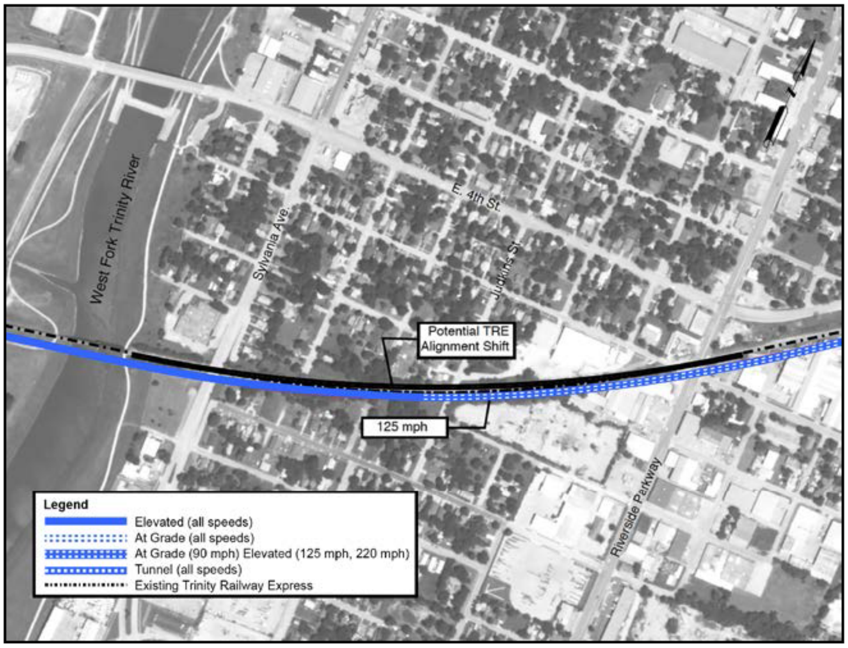


of the TRE line. The alignment is shown in Figure 3-17.

Fort Worth to TRE CentrePort Station

East of the West Fork Trinity River the alignment continues on the south side of the TRE tracks, on elevated structure for the 125 mph and 220 mph alternatives to avoid grade crossings of the numerous streets and roads, and at-grade for the 90 mph alternative. The curve immediately east of the West Fork Trinity River, shown in Figure 3-18, may require some shifting to accommodate higher speeds depending on what speeds could be realized given the need to accelerate from and brake for the speed restricted curves entering downtown Fort Worth.

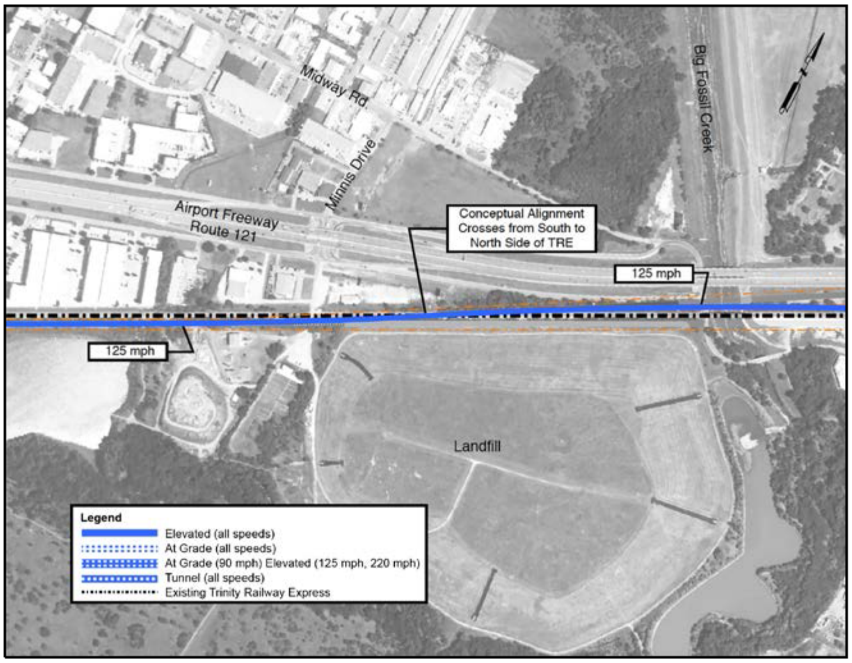
Figure 3-18: Curve East of West Fork Trinity River



The TRE alignment continues eastward south of the existing TRE track on elevated structure for the 125 mph and 220 mph alternatives to remain grade separated from the many roadway crossings, and at-grade as far as Elliot Reeder Rd. for the 90 mph alternative.

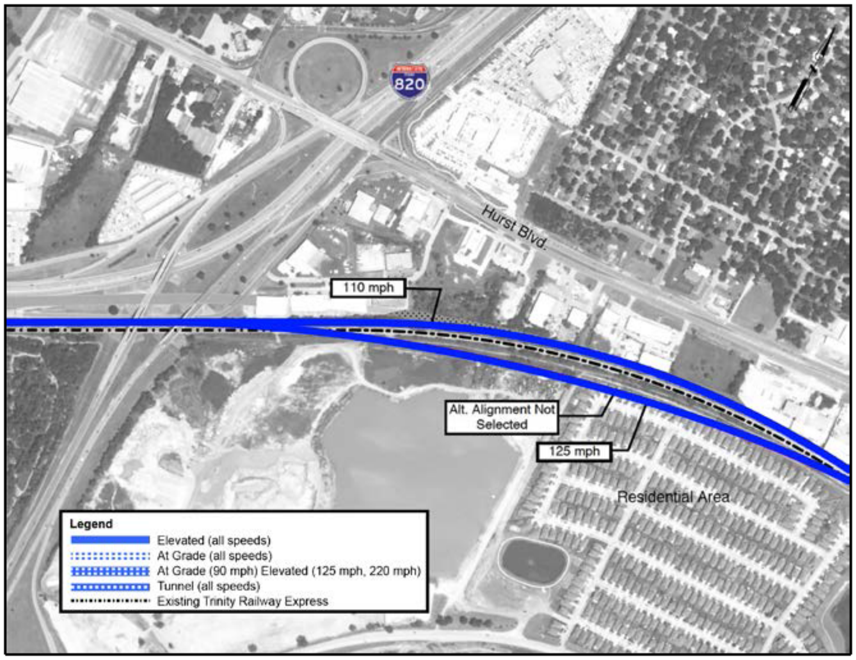
The segment from Minnis Drive, where the alignment crosses from the south to the north side of the TRE track, to Bell Helicopter includes a major curve, a landfill and residential area on the south side of the TRE track, and a crossing of I-820, for which improvements are planned on the north side of the TRE track. Transitioning to the north side of the TRE track at Minnis Drive would avoid impacts to the landfill, shown in Figure 3-19, and the residential area on the south side east of I-820, shown in Figure 3-20. This would entail a maximum

Figure 3-19: Conceptual Alignment at Minnis Drive



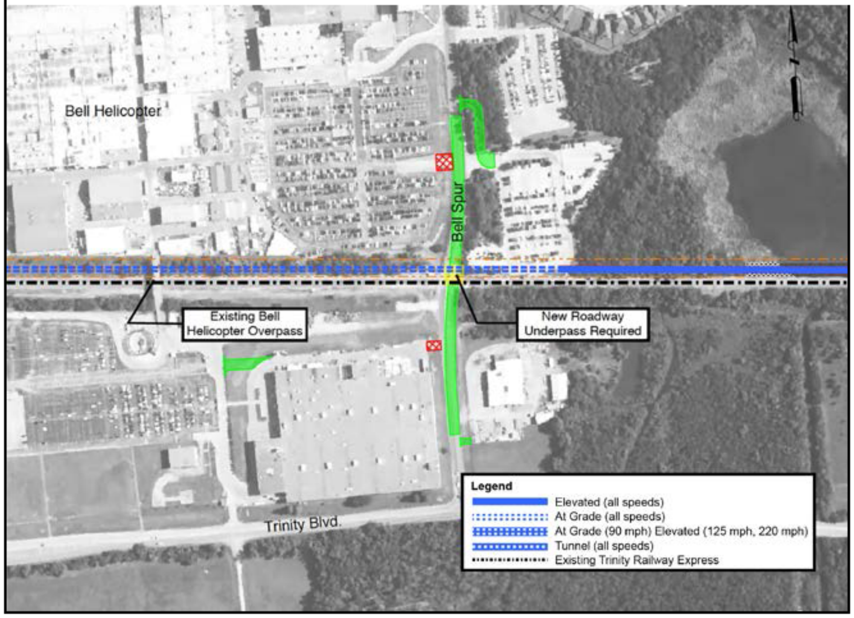
speed of 125 mph on the curves at the transition location. A 110 mph alignment at the curve east of I-820 would minimize impacts, while a 125 mph curve would require transitioning back to the south side of the TRE track and the taking of 20 homes in the northwest portion of the residential development, and then transitioning back to the north side. An alignment for speeds higher than 125 mph would have significantly more impact and the taking of additional homes. The 110 mph and 125 mph curves are shown in Figure 3-20, and it is assumed that the more conservative (110 mph) curve speed would be utilized.

Figure 3-20: Curve at I-820



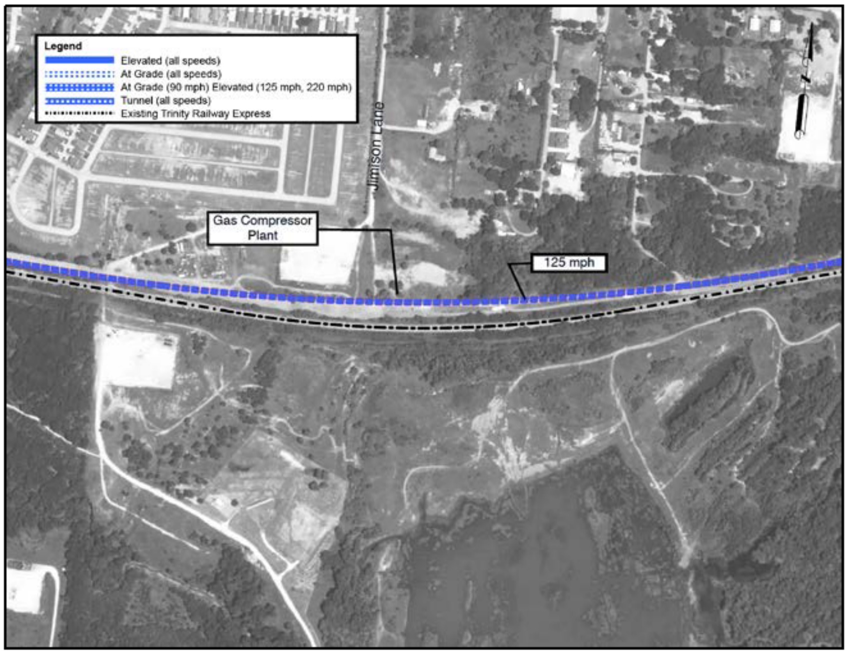
After the curve, the alignment continues east on the north side of the TRE on elevated structure except for two short at-grade segments for the 90 mph alternative, and transitions from elevated structure to at-grade just west of the Bell Helicopter property to avoid conflicts with helicopter flight and landing areas on the north side of the tracks. The alignment passes under the existing Bell Helicopter overpass and requires a grade separated roadway underpass at Bell Spur as shown in Figure 3-21.

Figure 3-21: Conceptual Alignment at Bell Helicopter



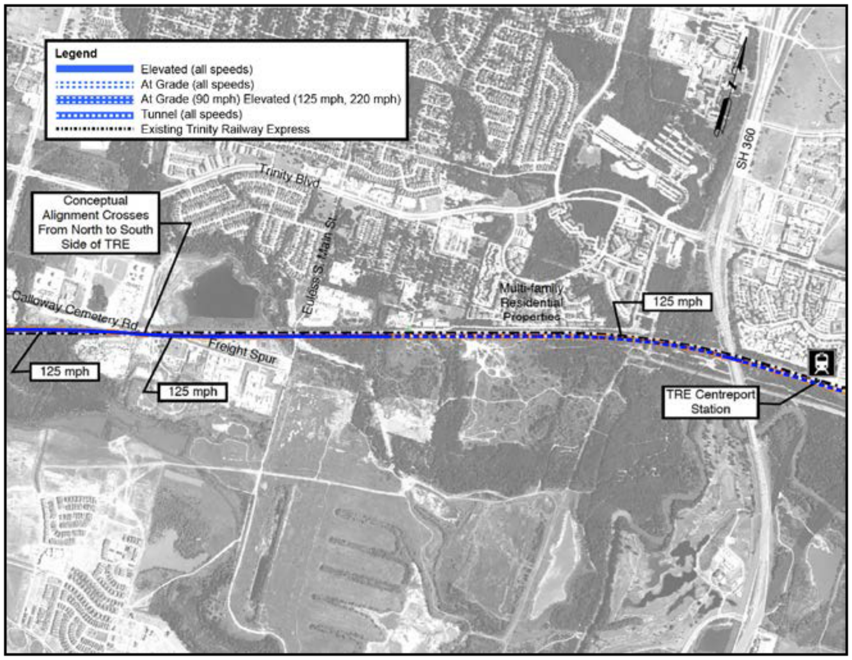
The conceptual alignment continues east mostly at grade on the north side of the TRE tracks, passing under Trinity Blvd., where the highway profile and bridge may require adjustment to provide adequate clearance to the rail line below. East of the Trinity Blvd. overpass, there is a major curve. Maintaining a 125 mph curve would impact a gas compressor plant on the north side of the TRE. The curve and plant are shown in Figure 3-22. Being on the north side, the alignment avoids a large landfill and quarry operation on the south side. The alignment requires a grade separated roadway overpass at Mosier Valley Road and a rail bridge above the depressed Hwy 157 (N. Collins Street).

Figure 3-22: Curve East of Trinity Blvd.



Farther east near Calloway Cemetery Road, the alignment includes a rail overpass to cross from the north to the south side of the TRE tracks and above a freight spur track on the south side. This avoids impacts on the north side of the TRE tracks such as the multi-family residential properties west and east of SH 360 on the north side and the TRE CentrePort Station on the north side east of SH 360. After the overpass the alignment continues at grade. The alignment in this area is shown in Figure 3-23.

Figure 3-23: Alignment at Calloway Cemetery Rd.



The alignment is grade separated on a rail bridge generally following existing ground elevations across the depressed SH 360 lanes.

TRE Proposed CentrePort Station to Dallas

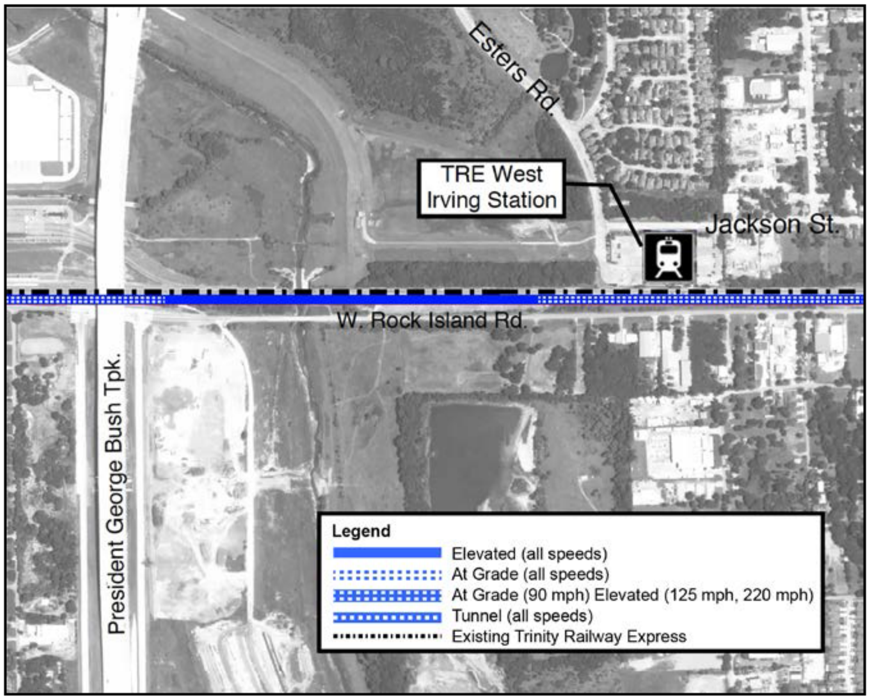
The TRE alignment continues east at grade and requires reconstruction of the existing Trinity Boulevard overpass east of CentrePort Station to maintain required vertical clearance above the alignment.

The alignment transitions to elevated structure again just west of Roy Orr Blvd. and continues on the south side of the TRE to avoid impacts to the TRE maintenance facility and storage tracks on the north side as shown in Figure 3-24. While the alignment for the 125 mph and 220 mph alternatives remains on elevated structure, the alignment for the 90 mph alternative returns to and remains at-grade after crossing Roy Orr Blvd.

Figure 3-24: Trinity Blvd. to President George Bush Tpk.

After passing over the President George Bush Tpk., the alignment continues on the south side of the TRE, passing the TRE West Irving Station located on the north side of the TRE as shown in Figure 3-25.

Figure 3-25: Alignment at Proposed TRE West Irving Station

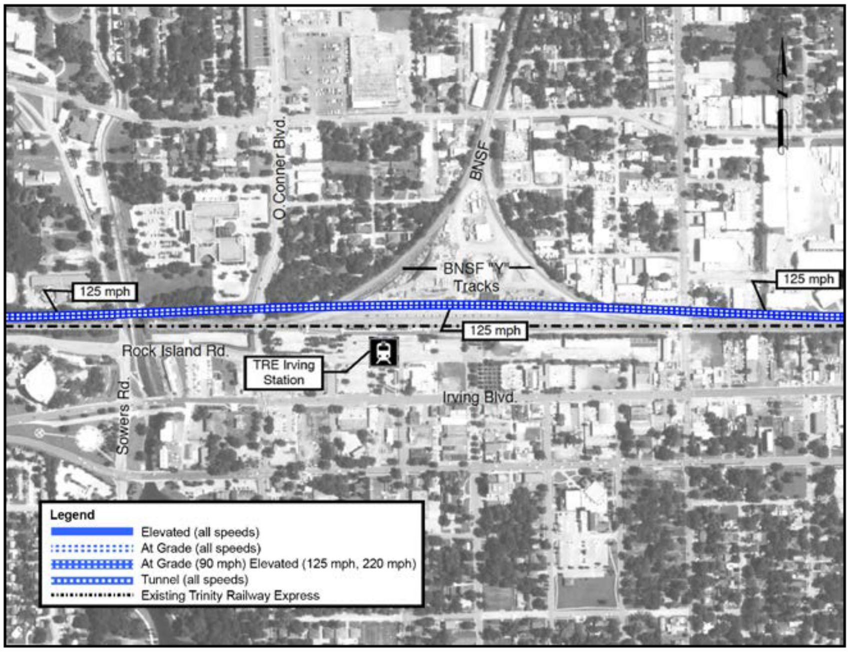


The TRE alignment continues eastward on elevated structure for the 125 mph and 220 mph alternatives and at grade for the 90 mph alternative to Belt Line Rd. where, for all alternatives, as shown in Figure 3-26, the alignment shifts on elevated structure from the south side to the north side of the TRE due to the proximity of Rock Island Road on the south side of the TRE tracks. An alignment remaining on the south side of the TRE utilizing straddle bents across Rock Island Road would have numerous direct and indirect impacts to the residential properties east of S. Briery Road.

Figure 3-26: Alignment at Belt Line Rd.

The TRE alignment continues on the north side of the TRE, on elevated structure for the 125 mph and 220 mph alternatives but transitioning west of Irving Blvd./Hwy 356 to at-grade for the 90 mph alternative. The 125 mph and 220 mph alternatives cross above the BNSF "wye" tracks near the TRE Irving Station while the 90 mph alternative crosses the "wye" tracks at grade, as shown in Figure 3-27. The alignment employs 125 mph curves to avoid impacting several side tracks parallel to the TRE within the "wye".

Figure 3-27: Alignment at Proposed West Irving TRE Station

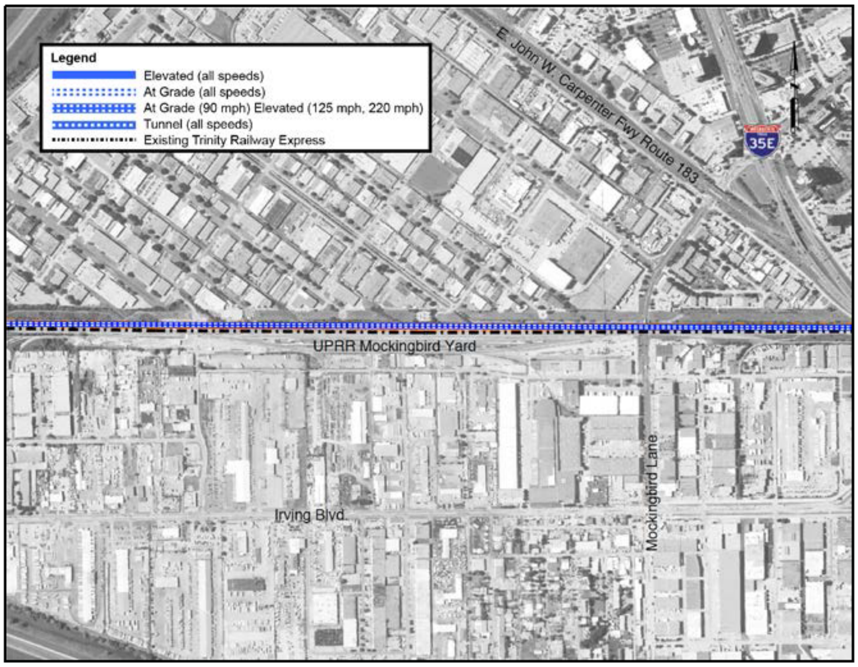


As shown in Figure 3-28 the alignment at Loop 12 employs 125 mph reverse curves to minimize impacts to the Loop 12 bridge structure. East of Loop 12 the 90 mph alternative transitions to elevated structure, but returns to at-grade after crossing the Elm Fork of the Trinity River.

Figure 3-28: Alignment at Loop 12

The alignment, elevated for the 125 mph and 220 mph alternatives and at-grade for the 90 mph alternative, remains on the north side of the TRE to I-35E to avoid the UPRR Mockingbird freight yard on the south side, though it does impact some businesses on the north side. The conceptual alignment at Mockingbird Yard is shown in Figure 3-29.

Figure 3-29: Alignment at Mockingbird Yard

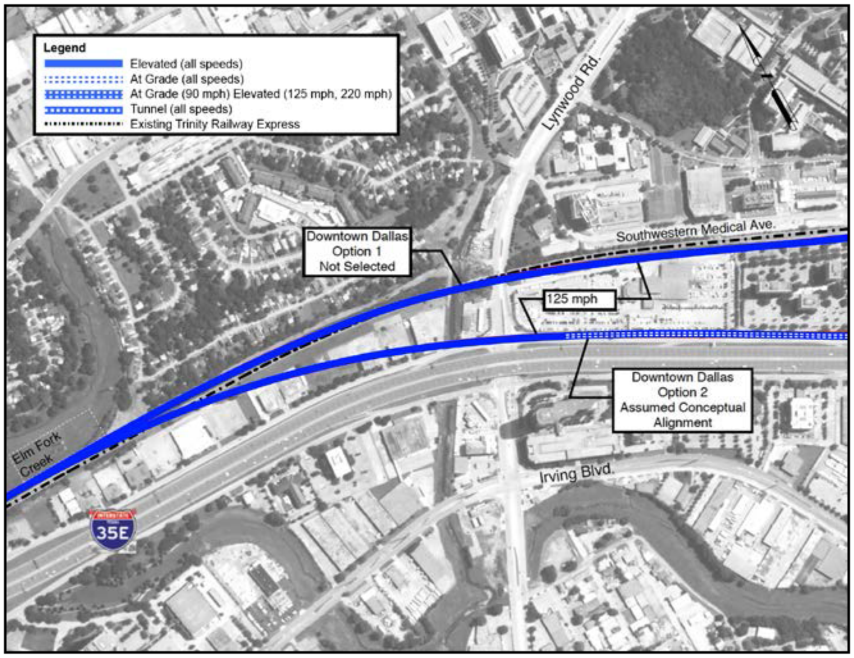


Downtown Dallas

Two potential alignment options between I-35E/North Stemmons Freeway and the Dallas North Tollway were considered: the TRE Downtown Dallas Option 1 and TRE Downtown Dallas Option 2 with reduced speed curves, as shown in Figure 3-30 through Figure 3-32. All 3 speed alternatives are elevated as they approach downtown.

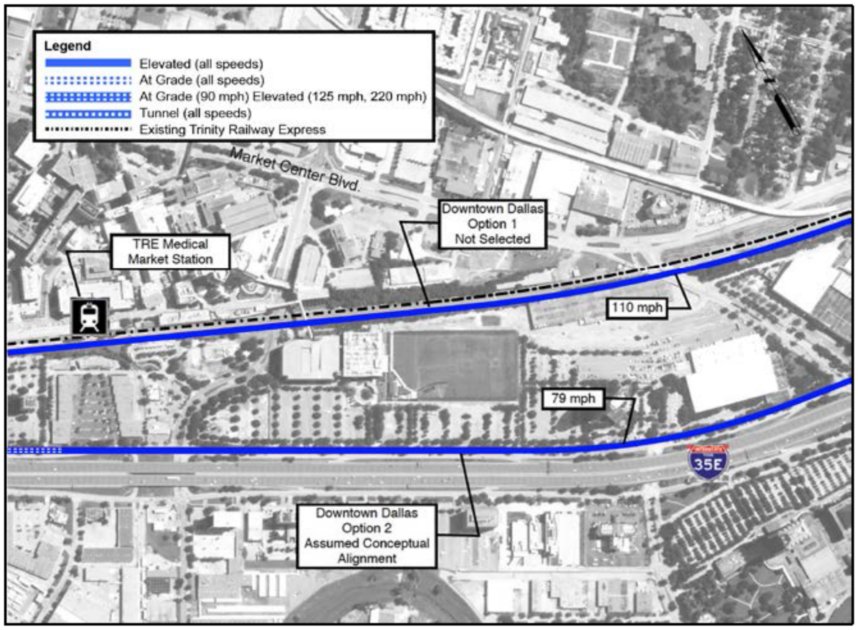
As shown in Figure 3-30, Option 1 transitions from the north to the south side of the TRE at Lynwood Road and remains elevated to avoid grade crossings. Option 2 transitions from the north to the south side of the TRE west of Lynwood Road and shifts away from the TRE to parallel the north/east side of the I-35E frontage road and, to avoid grade crossings, remains elevated except for a short segment immediately east of Lynwood Rd. that is at-grade for the 90 mph alternative.

Figure 3-30: Downtown Dallas Option 1 & 2 Near Lynwood Rd.



Both options have curves with reduced design speeds ranging from 60 mph to 110 mph due to the right-of-way and geometry restrictions through downtown Dallas. Option 1 affects more acres of commercial properties than Option 2 (12 and seven acres, respectively). Option 2 has more property access impacts to commercial properties located between the TRE and I-35E, since these commercial establishments face the frontage road rather than the TRE tracks at the rear of the property; however, the access impacts may be mitigated by careful placement of piers to retain ingress/egress and visibility for the properties. Because of its fewer impacts to commercial acreage and the ability to mitigate frontage road access impacts, Option 2 is assumed for the alignment.

Figure 3-31: Downtown Dallas Options 1 & 2 Near Market Center Blvd.



Southeast of Oak Lawn Ave. the alignment is elevated over the Dallas North Tollway direct connectors and stays on the south side of the TRE to avoid impacts to the DART/TRE Victory Station. The alignment would require relocating existing electrical transmission lines underground to accommodate I-35E interstate improvements and to provide structural touchdowns for the viaduct that would be required. The alignment is also elevated over the Woodall Rodgers Freeway interchange and the UPRR "wye" tracks as

Figure 3-32: Downtown Dallas Options 1 & 2 Near Oak Lawn Ave.

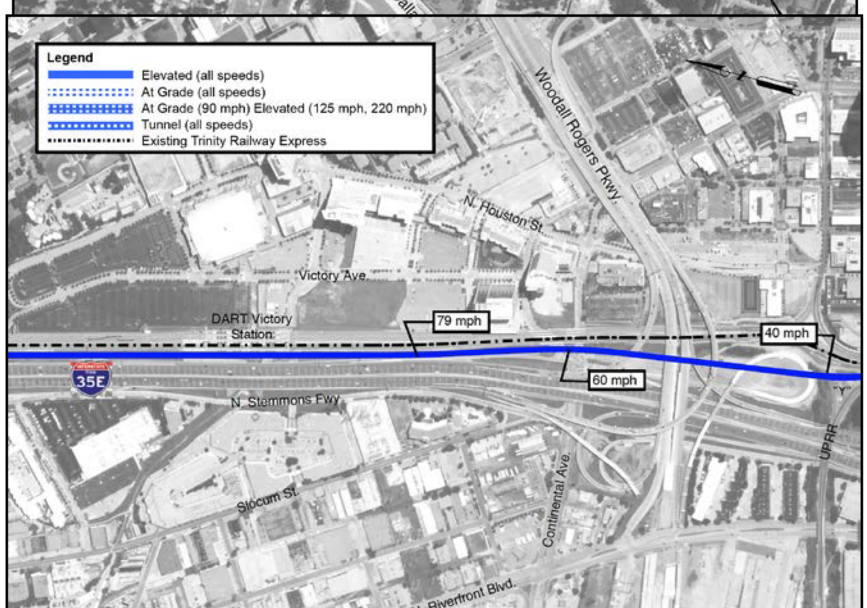
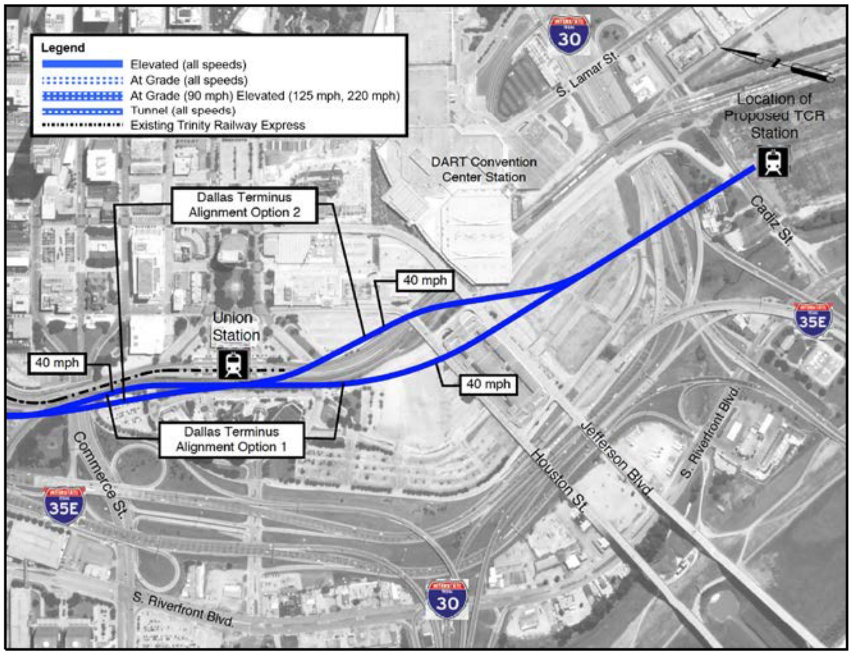


Figure 3-33: Alignment at Woodall Rogers Fwy. & UPRR

shown in Figure 3-33, with reduced design speeds due to curvature along areas of restricted right-of-way.

Figure 3-34: Dallas Terminus Alignment Options



The alignment at Union Station would likely need to be elevated to minimize impacts to UPRR tracks and existing station tracks and platforms. If the service terminates at Union Station, a tangent alignment parallel to the existing station tracks is optimal. For the service to extend to and terminate at the proposed TCR station on the east side of I-30, two options were considered as shown in Figure 3-34.

Option 1 would be tangent and parallel to the existing tracks and platforms at Union Station. Option 2 would be curved and at an angle to the Union Station tracks and platforms. Both options would entail 40 mph curves and be elevated to cross streets and I-30, and remain elevated east of I-30 as the proposed TCR station would also be elevated.

Option 1 -Tangent alignment at Dallas Union Station impacts the DART Convention Center parking garage, one park, two National Register Historic Districts, and 3.4 commercial acres.

Option 2 – Curved and angled alignment at Union Station Impacts UPRR and DART tracks, two parks, two National Register Historic Districts, and 3.7 commercial acres.

If the proposed service were to serve both Union Station and the TCR Station, Option 1 would provide a better alignment at Union Station as it would be parallel to the existing station tracks and platform layout rather than crossing at an angle, which would likely require more complicated structures and platform access.

3.2.3 *I-30/SH 360/TRE Corridor*

This Corridor, also referred to throughout this document as the Hybrid Corridor, combines the west end of the I-30 Corridor and the east end of the TRE corridor by using the SH 360 Corridor as a connecting link between them.

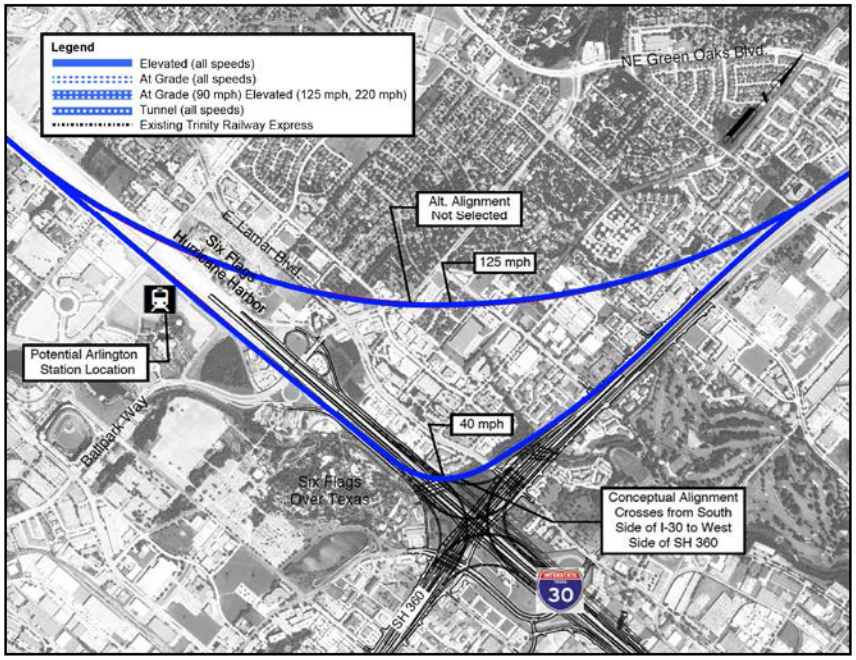
<u>Fort Worth to SH 360</u>

The conceptual alignment between Fort Worth and SH360 would be the same as described in the I-30 Corridor option. Approaching the I-30/SH360 interchange from the west, the alignment would be elevated on the south side of I-30. This option takes advantage of the less densely developed portion of the I-30 corridor west of SH 360 and the ability to coordinate rail planning with proposed I-30 improvements west of SH 360, which are currently in the planning stage. It also avoids the high costs, engineering challenges and impacts presented by the I-30 interchanges at SH360, SH161, and I-35E.

I-30 Corridor to SH360 Corridor Connection

Two alignment options for transitioning from the I-30 corridor to the SH 360 corridor were evaluated: a 125 mph design speed option and a 40 mph design speed option, both shown in Figure 3-35. Both options stay on the west side of the I-30/SH 360 interchange taking into account the current reconstruction, which is scheduled for completion in 2020.The 125 mph design speed option results in about 15 acres of right-of-way impacts, including residential and commercial properties. This option bisects the Six Flags Hurricane Harbor Waterpark and affects one acre of wetlands. It also traverses several neighborhoods, resulting in three single-family relocations and 123 multifamily unit relocations.

Figure 3-35: I-30 to SH 360 Corridor Connection



The 40 mph design speed option hugs the west side of the interchange and has right-of-way impacts to two acres of commercial properties and four acres of residential properties, but results in no residential relocations. The 40 mph option also affects five acres of floodplains.

Both options are on viaduct to cross over from the south side of I-30 and to cross over the numerous streets, frontage roads, and access ramps.

Based on the issues described above, the 40 mph design speed option was found to be more desirable to minimize property impacts to the waterpark and residences.

SH 360 Corridor

The conceptual alignment remains on viaduct on the west side of SH 360 within the right-of-way between the roadway and frontage roads until it reaches Post and Paddock Street, thus minimizing property impacts.

SH 360 Corridor to TRE Corridor Connection

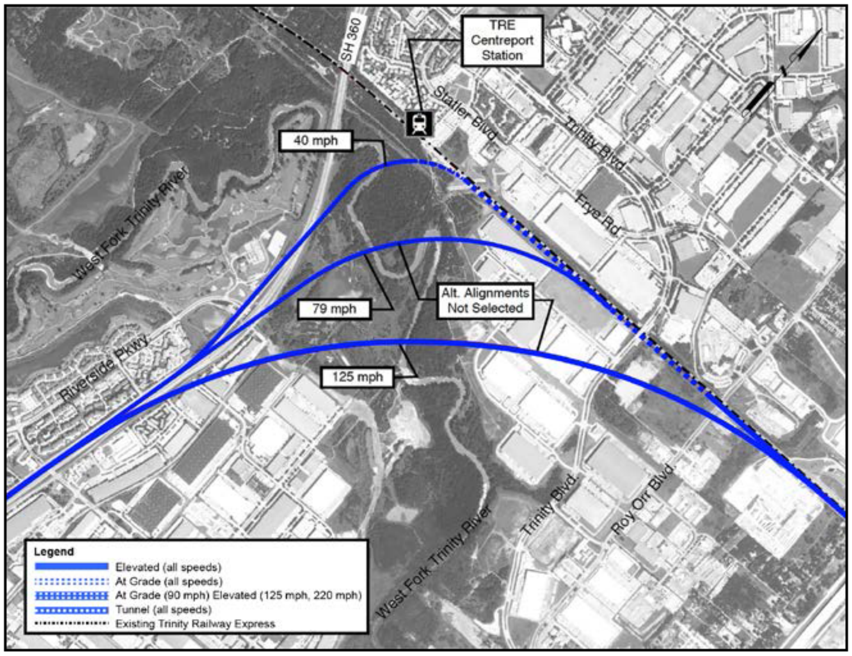
For a transition from the SH 360 Corridor to the TRE Corridor, multiple alignment options with design speeds ranging from 40 mph to 125 mph as shown in Figure 3-36 were considered.

Each option requires a new crossing of the West Fork Trinity River, and has floodplain and wetland impacts.

The 125 mph design speed option requires the largest radius curve and impacts at least eight warehouses along the curve (11 acres of commercial/industrial property), six acres of residential property (no relocations) and six acres of floodplains.

The 79 mph design speed option impacts one warehouse property (two acres of commercial land), seven acres of residential property (no relocations), and nine acres of floodplains.

Figure 3-36: SH 360 to TRE Corridor Connection



The 40 mph design speed option has the smallest radius curve, impacts two acres of commercial land including right-of-way of a private golf course west of SH 360, six acres of residential property (no relocations), and 10 acres of floodplains.

Based on the discussion above, the alignment incorporates the 40 mph design speed option to minimize property impacts. The 40 mph option also merges with the TRE alignment closest to the TRE CentrePort station allowing the possibility of an expanded station serving both rail services.

SH 360 to Dallas

East of SH 360 the alignment is the same as described in the TRE Corridor Description in Section 3.2.2.

3.3 Stations

Seven station locations were evaluated, two each in downtown Fort Worth and downtown Dallas, and in three intermediate locations approximately half way between Fort Worth and Dallas. These station locations are shown in Figure 3-2. In Fort Worth and Dallas the stations could be served by all three of the corridor alignments. Intermediate stations that could be served depend on the particular corridor.

Fort Worth

There are two existing stations in Fort Worth, the T&P and the ITC. Both stations are served by the TRE and will also be served by the planned TexRail commuter service. The ITC, served by Amtrak, is a hub for local bus routes, and is considered a potential station location by the TOPRS. The two stations are less than one mile apart.

The T&P is the westernmost station. The Project's proposed service could stop at the ITC and then continue to the T&P, terminating at that station, or it could terminate at the ITC with no service to the T&P.

The three corridor alignments are the same for both stations and would need to be elevated to avoid conflicts with TRE, Amtrak, and future TexRail trains as well as the heavy freight traffic that moves through the area.

Dallas

There is one existing station in downtown Dallas, Union Station, which is the eastern terminal for TRE service and is also served by Amtrak and by DART light rail trains. A new station to serve the proposed TCR high speed service between Dallas and Houston is anticipated to be constructed on the south edge of downtown, approximately ¾ miles from Union Station.

The proposed service on the TRE and Hybrid corridor alignments could terminate at Union Station, or could stop at Union Station and then continue to a terminal at the TCR location. Because the I-30 corridor alignment enters downtown Dallas between the two station locations, the proposed service could turn north to terminate at Union Station or south to terminate at the TCR station. To serve both stations it would need to directly proceed to one and then reverse direction to terminate at the other.

The selected alignment for all three corridors in downtown Dallas would need to be elevated to avoid conflicts with TRE, DART light rail, and freight trains as well as numerous city streets, and interstate highways and ramps.

Arlington

An intermediate station located in the entertainment district at Arlington could serve the proposed service on either the I-30 or the Hybrid corridor alignments. The station would be located on the west side of the I-30/SHA 360 interchange. For the I-30 corridor alignment, it is anticipated that the station would be below grade to enable the alignment to tunnel through the interchange area. For the Hybrid alignment the station would be elevated to allow the alignment to turn northward and cross over I-30.

CentrePort

The CenterPort station is an existing TRE station and could serve as an intermediate stop for Project trains operating on the TRE corridor alignment. By modifying and expanding the station it could also serve the selected Hybrid alignment, which would join the TRE corridor at the east end of the station. The CentrePort station could provide for transfers between the existing TRE commuter rail service and the proposed Project service.

County Line

A new intermediate station was considered near the Tarrant/Dallas County line at a location approximately one mile east of the CentrePort Station. Although trains on the TRE corridor alignment could serve this station, it was primarily useful to be served by trains on a higher speed Hybrid alignment, which would join the TRE corridor east of the CentrePort Station. Since a slower 40 mph connecting alignment was selected for the Hybrid alignment allowing service to an expanded CentrePort station, a County Line station was dropped from further consideration.

3.4 Maintenance Facilities

Seven potential locations for a maintenance facility were identified. The locations are shown in Figure 3-2. All seven locations are located along the existing TRE alignment, three in the western half of the corridor and four in the eastern half. For the I-30 corridor option, trains would need to travel without passengers (deadhead) over the TRE from Dallas or Fort Worth to reach any of the seven locations. For the Hybrid corridor option, deadhead movements over the TRE would be required for access to any of the three locations in the western half of the existing TRE corridor. All of the locations would have impacts on primarily commercial and industrial properties, most likely requiring displacement depending on the design of the maintenance facility.

Location M-FW1

This location in the western half of the TRE corridor is on the south side of the existing TRE tracks immediately west of the TRE Richland Hills station and Handley Ederville Rd. The site is occupied by a mix of one story commercial and light industrial facilities; up to 14 properties would be impacted.

Location M-FW2

Also in the western half of the TRE corridor, this location is on the north side of the TRE track, between the track and W. Hurst Blvd. The site is occupied by two commercial and three industrial properties that would be impacted.

Location M-FW3

Less than ½ mile further east of the M-FW2 site, this location is also on the north side of the TRE corridor between the track and W. Hurst Blvd. The western portion of the site is undeveloped; the eastern portion is occupied by three commercial and one industrial properties, which would be impacted.

Location M-DAL1

Located in the eastern half of the TRE corridor, this site is less than a mile east of the TRE Irving Station near S. Britain Rd. on the north side of the TRE tracks. The site is occupied by one residential, one commercial, and one industrial property, which would be impacted.

Location M-DAL2

This site is located on the west side of Dallas on the north side of the TRE tracks. It is near the west end of the Mockingbird freight yard. The site centers on the alignment of a removed rail spur surrounded by commercial and industrial properties. Three industrial and 25 commercial properties would be impacted.

Location M-DAL3

This site is immediately east of and adjacent to M-DAL2 on the north side of the TRE tracks. One industrial property and up to 34 commercial properties would be impacted.

Location M-DAL4

Located about 1/2 mile east of M-DAL3, this site is also located on the north side of the TRE tracks and near the east end of the Mockingbird freight yard. Similar to M-DAL 2, the site centers on the alignment of a removed rail spur with commercial and industrial properties on each side. One industrial and up to 26 commercial properties would be impacted.

3.5 Alternative Speed Considerations

Three operating speeds, consistent with the TOPRS, were considered for each of the corridor alternatives described in Section 3.3. The three operating speeds are: 90 mph; 125 mph; and 220 mph. The corridor alignment design concepts described in Section 3.3 reflect the alignment requirements for each of these speed categories.

3.5.1 90 mph Operation

In order to operate at 90 mph, the alignments would require separation of freight service from the passenger service. In addition, a number of other improvements would be required, including: implementation of curvature and profile improvements; modification of the train control system; and procurement of diesel powered train sets that meet the 90 mph speed requirements. These rolling stock improvements focus on the acceleration/deceleration rates and maximum operating speed, plus premium passenger accommodations to meet the comfort and technology expectations of today's intercity rail passengers.

3.5.2 125 mph Operation

Operation at 125 mph can be accomplished with the use of either diesel or electric locomotives, although the latter provides faster acceleration and deceleration characteristics. It is assumed that the service would be fully grade-separated with no shared track with freight or commuter rail service, and no at-grade crossings with roadways.

The track alignments would be designed for a maximum allowable speed of at least 125 mph and up to 160 mph (Class 7 track according to the FRA's Track Safety Standards in 49 CFR Part 213, Subpart G). Curves would be designed to the highest speeds possible based on design criteria, train performance models, and local conditions and are not typically held to the maximum allowable operating speeds. In some locations the minimum allowable speed of 125 mph may not be feasible due to constraints related to the urban environment of the Metroplex; in these areas the speeds may be reduced to less than 125 mph as detailed in the screening and reflected in the travel times and ridership estimates.

3.5.3 220 mph Operation

The 220 mph operating speed, as defined by TOPRS, represents an electrified system that is fully grade-separated. This service type could only reach its maximum speeds of 220+ mph outside of existing transportation corridors because existing railroad alignments are not compatible with the speeds and they do not have the required room for separation of freight and high-speed rail. In areas where this service type is within existing transportation corridors or within constrained right-of-way that may impede the design, it would operate at lower speeds and be reflected in the travel times and ridership estimates.

3.6 Initial Corridor Service and Operating Characteristics

The operating plan elements for this evaluation include travel time, frequency of service, span of service and how the proposed service would be integrated with other passenger and freight services.

Travel Time – An operating simulation was completed for the operation of the 90 mph, 125 mph and 220 mph services along each of the corridors. The simulation established the optimum travel times for the corridors and the shortest travel times achievable for the alternatives. This maximum speed provided the shortest express service travel time achievable along the corridors as 35 minutes. In contrast, the current TRE one-way travel time of 55 minutes includes some limited mixed operation with freight services entering each downtown area of Dallas and Fort Worth, plus several station stops along the way.

Frequency of Service – The frequency of service was initially defined to reflect the travel demand expectations for each corridor, plus the incremental opportunities to add in-line stations at large activity centers, as appropriate. This definition of initial frequencies first examined the current levels of service operated along the TRE. TRE operates a generalized 30-minute headway or average time between trains in the weekday peak travel periods of 7-9am and 4-6pm, and 60-minute headways during most of the remaining weekday span of service and the full duration on weekends and holidays. This was an iterative process that was considered as part of the ridership demand methodology described in Section 4.4.3.

Span of Service - The service plan includes a span of service that reflects the travel demand profile of the corridors. The travel demand market within the corridors connecting Fort Worth and Dallas reflect a 24-hour daily travel pattern as evidenced by the hourly vehicle counts along I-30. It was assumed that the proposed alternatives would be limited by the span of service on the connecting services and the demand profile for the more centralized activity centers each will serve. As such, the span of service would be closer to 14-16 hours per day and would apply uniformly across all alternatives.

Service Integration – This aspect of the operating plan focuses on the integration or separation of the proposed new alternatives with existing TRE/Amtrak services and/or freight or full dedicated alignment that is clear of any service delays from other services. Another aspect of service integration is the separation for grade crossings with vehicular traffic. This similarly adds delay to travel time, plus safety considerations with the number and design of the crossings.

3.6.1 Summary of Service and Operating Characteristics

Sections 3.5 and 3.6 defined the speed categories and operating characteristics that would inform the definition of each corridor alternative and be employed in their evaluation. In order to evaluate each of the alternatives at the three operating speed categories described above, their service and operations characteristics provided key input to the development of ridership demand forecasts. In addition to the operating speed and other service and operational considerations, other factors were also considered. These include:

- potential station locations that could be served – these include options for terminal stations in both Dallas and Fort Worth, as well as intermediate station locations, specific to each alternative;
- trainset characteristics – consideration was given to the use of diesel-hauled and electric trainsets;
- the potential for a future one-seat ride between Dallas and Houston; and
- trip time – based on the items described above, Train Performance Calculations (TPCs) were assessed in order to identify the corresponding trip time for each alternative.

4.0 Screening Methodology

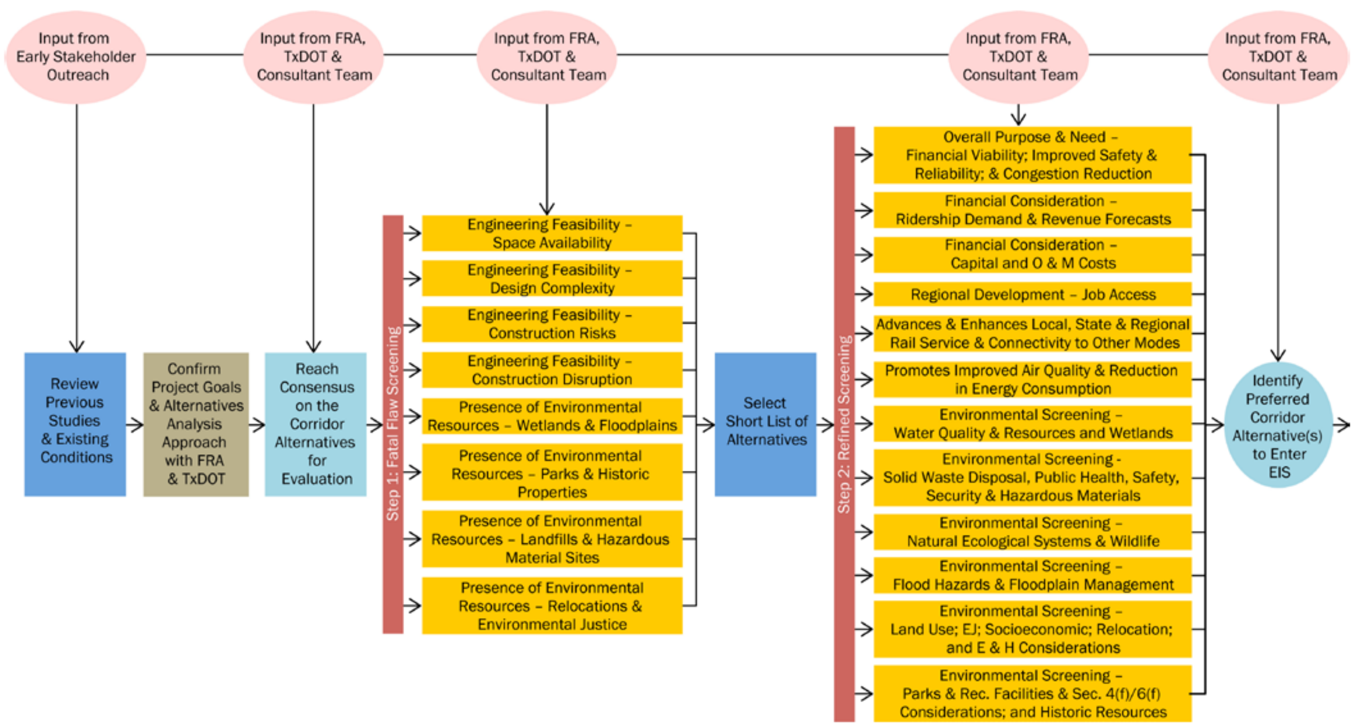
4.1 Overview of Screening Approach

This chapter presents the screening process used to evaluate the corridor alternatives described in Chapter 3. The process includes the screening methodology comprised of two-steps, beginning with a fatal flaw analysis of the critical aspects of each corridor alternative and then a more detailed Step 2 refined screening of the most viable remaining corridor alternatives. The analytical results from applying this methodology are included to present the quantitative inputs to the evaluation process. The findings and evaluation are provided in Chapter 5.

4.2 Screening Process

The two-step screening process developed for the alternatives analysis includes the purpose and need criteria developed early in the study outreach efforts, the engineering feasibility criteria for the speed and alignment options within each corridor and the environmental considerations identified in the alternatives analysis. This process is illustrated in Figure 4-1 below.

Figure 4-1: Two-step Screening Process



Step 1 provides the Project's fatal flaw review of the three initial corridor alternatives, including an assessment of the study purpose and need elements, an examination of the engineering feasibility and environmental considerations of the speed options within each corridor. The engineering criteria include measures of alignment space, complexity and risk. Environmental considerations focus on the potential for significant impacts and/or measurable mitigation efforts.

Step 2 of the process examines the corridor alternatives that passed the fatal flaw review from Step 1 and employs a greater degree of quantitative and qualitative analysis to measure their effectiveness in fulfilling the regional priorities for high speed rail service in the corridor between Dallas and Fort Worth.

4.3 Step 1 – Fatal Flaw Review

As noted above, the Fatal Flaw Review evaluates the corridor alternatives defined in Section 3.3 on their ability to address the Purpose and Need of the project as outlined in Chapter 2, and evaluates each alternative corridor for engineering feasibility and potential environmental concerns. This step is intended to eliminate those alternatives that do not meet the Project's Purpose and Need, cannot reasonably overcome overly complex engineering challenges, or may result in significant environmental impacts. Each of the evaluation criteria is further described below.

4.3.1 Overall Purpose and Need

The overall purpose for the Project is to create a financially viable, safe, reliable and environmentally sustainable passenger rail service. The overall need for the Project is to decrease regional capacity constraints in the transportation system. The overall purpose and need measures were established through the initial study outreach efforts, as the priority objectives for the study alternatives evaluation process. To evaluate the ability of the corridor alternatives to meet the project's purpose and need, a series of criteria and corresponding measures were evaluated. The objectives and evaluation criteria shown in Table 4-1 were applied in the analysis of each alternative.

Table 4-1: Overall Purpose and Need Measures

Identity	Objective	Criterion	Measure	Quantity	Source
Overall Purpose	Create a financially viable, safe, reliable, and environmentally sustainable intercity passenger rail service	Financially Viable	Additional Funding Requirement	$ Subsidy	NCTCOG Mobility 2040 Plan
		Safety	Regional Traffic Accident Rate	per Million Vehicle Miles	NCTCOG Mobility 2040 Plan
			At-grade Crossings	Eliminations	DFWCES
		Reliability	Proportion of Grade Separated Alignment	% of Alignment	DFWCES
Overall Need	Need to ameliorate capacity constraints in the existing transportation system	Reduce Congestion	Increase in travel time due to congestion	Regional Travel Time	NCTCOG Mobility 2040 Plan

- Extent to which each alternative creates a financially viable, safe, reliable and environmentally sustainable passenger rail service addressing:
  - Financial viability based on any additional funding requirement(s)

- Safety considerations of the regional traffic accident rate change due to reductions in vehicle miles of travel and the number of at-grade crossings included in each alternative
- Reliability of service based on the proportion of grade separation posed for each corridor and speed option

- Extent to which each alternative decreases capacity constraints in the existing transportation system –to reduce regional travel times. The Alternatives Analysis approximated this objective through the ridership estimate for each alternative.

The specific measures for the Purpose and Need elements broadly include consideration of how each alternative fulfils the study's expectations.

4.3.2 Engineering Feasibility

As shown in Table 4-2, engineering feasibility was evaluated by answering the following questions:

- Is there sufficient clearance available in the corridor for the implementation of each alternative?
- Are there overwhelming problematic or complex challenges that would make certain corridors or portions there of difficult or excessively expensive to construct?

Table 4-2: Fatal Flaw Review – Engineering Feasibility

Identity	Objective	Criterion	Measure	Quantity	Source
Fatal Flaw Analysis	Engineering Feasibility	Integration within existing and proposed infrastructure	Space Availability	Level of Construction Feasibility	DFWCES
			Design Complexity	Extent of Grade Separation	DFWCES
		Operational envelope clearance options within corridor	Construction Risks	Level of Construction Complexity	DFWCES
			Construction Disruption	Impact on Transportation	DFWCES

Notes to this and all other tables, as appropriate: "Source" refers to the originator of the information included in the tables; DFWCES = the Project team, including TxDOT consulting staff and FRA Monitoring & Technical Assistance Contractor staff; NCTCOG = North Central Texas Council of Governments

These engineering criteria were used to gauge the feasibility of developing an alternative within each corridor and to include measures of the magnitude of engineering challenges. These measures reflect the spatial ability to fit alignments into the corridors; a measure of the design complexity based on the extent of grade separation required – especially below grade portions; the measure of construction risks due to the constraints of the construction envelope available in each corridor; and the impact on other existing transportation services already operating within each corridor. The data sources for these evaluation criteria include this alternatives analysis and the results of the regional long range plan – The Metropolitan Transportation Plan for North Central Texas Council of Governments Year 2040 Regional Mobility Plan (NCTCOG Mobility 2040 Plan).

4.3.3 Environmental Screening

The environmental fatal flaw screening assessed significant environmental effects for each corridor alternative. The presence of a number of environmental resources was evaluated, based on a Geographic Information Systems (GIS) analysis and desktop level research. The air quality improvement potential noted in the Project's Purpose and Need was not considered in the Step 1 analysis.

Although environmental resources are present within each of the three study corridors, there are opportunities to elevate, tunnel, or shift the alternative alignments within each corridor from one side of the existing infrastructure to the other at various locations to avoid or minimize effects to these and other environmental resources and established land uses. Since the environmental resources evaluated as part of this Step 1 environmental screening are present within all three of the corridor alternatives and since there are opportunities to refine alternatives within each corridor, no environmental fatal flaws were identified for the three study corridors.

The station and operations and maintenance (O&M) facility locations were selected based on the alternatives that proceeded to the Step 2 environmental constraints screening. Therefore, environmental effects associated with station and O&M facility locations were evaluated as part of the Step 2 Refined Environmental Screening.

4.4 Step 2 – Refined Screening Process

The alternatives that met the Step 1 evaluation criteria and "passed" the Step 1 screening process were carried forward into the Step 2 evaluation process. Step 2 includes the estimation of quantitative aspects of each alternative corridor, including speed and technology options. In addition to the purpose and need screening aspects identified in the study outreach, there are project planning elements that are included in the Step 2 alternatives analyses to account for the specific characteristics of each alternative corridor and speed and technology option.

These measures were developed through the early study outreach process that included the more detailed purpose and need elements and the additional project planning, financial, engineering and environmental elements considered in the evaluation process. The quantitative evaluation factors include ridership, passenger revenue and the capital and operating and maintenance cost of each option, along with environmental factors. These factors were then used to comparatively measure the performance of each alternative.

While the results of Step 1 are not discussed in detail until Section 5.1, it is important to note that the I-30 Corridor was eliminated from further consideration based on the Step 1 analysis for reasons including significant design and construction feasibility and constraints and although not required for the Step 1 evaluation, the capital costs associated with the I-30 Corridor are approximately double that of the other two corridors.

4.4.1 Expanded Purpose and Need Measures

Step 2 of the screening process included more robust analysis of each corridor alternative, as shown on Table 4-3.

Table 4-3: Expanded Purpose and Need Measures

Identity	Objective	Criterion	Measure	Quantity	Source
P1	Advance the local, state and regional high-performance rail network	State Rail Plan Connections	State Rail Line Connections	Number of Rail Lines	DFWCES
P2	Enhance connectivity to existing and planned passenger rail services, airports, roadways, bicycle and pedestrian facilities, and be competitive with private automobile travel and air travel	Airports	Direct and Transfer Airport Connections	Number of Airports	DFWCES
		Station Access	Station Access Modes	Number of Modes	DFWCES
		Competitive With Auto Travel Time	Auto and Rail Travel Time	Auto - Number of Minutes	NCTCOG Mobility 2040 Plan
				Rail - Number of Minutes	NCTCOG Mobility 2040 Plan
P3	Promote improved air quality and reduced transportation energy consumption	Reduce Energy Consumption	Energy Savings	BTUs	NCTCOG Mobility 2040 Plan
			Difference in Vehicle Miles Traveled	VMT	NCTCOG Mobility 2040 Plan
P4	Augment economic development opportunities	Improve Accessibility	Difference in Vehicle hours spent in delay	Vehicle Hours	NCTCOG Mobility 2040 Plan
N1	Planning for rapid population and economic growth	High Speed Rail Ridership	Average Daily Trips	Trips	DFWCES
N2	Enhancing transportation connectivity to, from, and within the Metroplex	Improved Accessibility	Hourly Capacity	Miles	NCTCOG Mobility 2040 Plan
N3	Improving air quality within the Metroplex	Reduce Carbon Emissions	Carbon Emissions	Auto to Transit Trips	NCTCOG Mobility 2040 Plan

The features of each criterion shown in this table are described by the specific objectives, the measures used, the quantity for the measure and the source for each criterion – either the NCTCOG 2040 Mobility Plan or the DFWCES study analysis efforts. They broadly include consideration of how each alternative:

- **Advances the local, state and regional high-performance rail network through additional connections to the high speed rail network.** The State Rail Plan includes proposed corridors with high speed rail services. Achieving this objective was measured by the opportunity for direct transfers at each station that connects with the rail network including Dallas, Fort Worth and Arlington, and preference for the higher speed options in accordance with the State Rail Plan.
- **Enhances connectivity and the transportation network for the Metroplex.** This connectivity objective was measured by the three criteria: one each for the three major passenger transportation modes of airport access, rail station access and competitive auto/rail travel times.
  - Direct and transfer connections to the region
  - Competitive travel times in the region, particularly with the auto mode along the study corridors
- **Promotes improved air quality and reduced energy consumption.** Air quality improvement and reduced energy consumption are measured by the diverted travel from the auto mode to the rail alternatives. Reduced auto travel decreases energy consumption, and thereby improves air quality.
- **Augments economic development opportunities of the Metroplex.** Improved regional access is measured in the regional planning model by the vehicle hours spent in delay. In this alternatives analysis, this is approximated by the diversion of auto travellers to rail.
- **Plans for population and economic growth.** This was measured as the number of rail passenger trips estimated for each alternative.
- **Enhances transportation connectivity within the Metroplex.** This was measured by the passenger capacity of each alternative.

4.4.2 Study Planning Measures

The Step 2 alternatives analysis process includes the expanded purpose and need elements, plus those study planning measures that utilize the evaluation results of the alternatives analysis planning process. These study-planning measures were similarly developed in order to account for the specific characteristics of each corridor alternative's speed and technology option. The speed and technology options are the 220 mph operation (220), 125 mph operation with electric locomotives (125E), 125 mph operation with enhanced diesel locomotives (125D) and 90 mph operation with conventional diesel locomotives (90D). These characteristics and their quantified measures are shown in Table 4-4, below.

Table 4-4: Study Planning Measures

Identity	Objectives	Criterion	Measure	Quantity	Source	TRE				Hybrid			
						220	125E	125D	90D	220	125E	125D	90D
Q1	Engineering Characteristics	Alternative Alignment	Alignment Length	Miles	DFWCES	33.59	33.59	33.59	33.59	35.93	35.93	35.93	35.93
Q2		Travel Time	Terminal to Terminal Travel Time	Minutes	DFWCES	23.48	25.31	23.98	37.83	27.74	29.03	27.70	41.85
Q3		Alignment Grade	Above Grade Proportion	Above Grade Proportion	DFWCES	82%	82%	82%	50%	94%	94%	94%	79%
Q4	Financial / Economic Characteristics	Ridership Demand	Average Daily Ridership	Trips	DFWCES	3,374	3,344	3,344	2,718	5,425	5,430	5,430	4,894
Q5		Capital Cost	Total Capital Cost	$ Billion Capital Cost	DFWCES	$5.79	$5.65	$5.27	$3.49	$6.87	$6.73	$6.32	$5.27
Q6		Operating Cost	Total Operating Cost	$ Million Operating Cost	DFWCES	$27.9	$25.8	$29.2	$29.5	$31.0	$28.9	$32.3	$32.7
Q7		Local Funding Available	Regional Funding Estimate	$ Billion Total Revenue	Mobility 2040 Plan	$2.9	$2.9	$2.9	$2.9	$2.9	$2.9	$2.9	$2.9
Q8		Capital Cost	$ Capital Cost per Annual Passenger	$ Cap Cost / Annual Psgr	DFWCES	$4,702	$4,629	$4,318	$3,518	$3,469	$3,396	$3,189	$2,950
Q7			$ Capital Cost per Alignment Mile	$ Million Cap Cost / Mile	DFWCES	$172	$168	$157	$104	$191	$187	$176	$147
Q7		Operating Cost	$ Operating Cost per Annual Psgr	$ Ops Cost / Annual Psgr	DFWCES	$22.66	$21.14	$23.92	$29.74	$15.66	$14.58	$16.30	$18.31
Q7		Fare Revenue	Average Fare per Rider	$ Revenue	DFWCES	$8.00	$8.00	$8.00	$8.00	$8.00	$8.00	$8.00	$8.00
Q7		Fare Revenue	Total Annual Passenger Revenue	$ Million Revenue	DFWCES	$9.85	$9.76	$9.76	$7.94	$15.84	$15.86	$15.86	$14.29

Notes to this and all other tables in Chapter 5: "Source" refers to the originator of the information included in the tables; DFWCES = the Project team, including TxDOT consulting staff and FRA Monitoring & Technical Assistance Contractor staff; NCTCOG = North Central Texas Council of Governments

These study planning measures were defined to include the following:

The Engineering Characteristics were used to measure the alignment and travel time aspects of each alternative, including:

- The alignment length was used to develop cost and impact unit measures.
- The travel times were inputs to the travel demand and operating cost estimates.
- Alignment above grade proportion was used to approximate the safety contribution through a corresponding reduction in at-grade crossings.

The Financial/Economic Characteristics were calculated to measure the performance of each alternative, as described below.

- Average daily ridership is a good indicator of the market potential attractiveness of each alternative. This includes connecting riders through the proposed TCR service in Dallas and TOPRS and regional trips between Fort Worth and Dallas.
- Capital cost estimates indicate the funding level required to design and construct each alternative. The higher speed alternatives result in higher capital cost estimates.
- Operating cost estimates indicate the ongoing funding required to operate and maintain each of the alternatives.
- Local funding available for the design and construction of the recommended alternative is $2.9 Billion as included in the NCTCOG Mobility 2040 Plan. This is the funding amount included in the plan, designated as "local funds." Additional funds will be required from local, state, federal and other sources to fulfil the funding required for capital costs.
- Average fare per passenger was estimated as a constant average fare of $8.00 per trip. The actual average fare will likely vary depending upon the alternative selected for implementation.
- Total passenger revenue was calculated with ridership and average fare data to identify the level of annual funding support necessary for each alternative at this fare level.

An overview of how these key measures were defined and developed is provided in Sections 4.4.3 through 4.4.7, below.

4.4.3 Ridership Demand Estimation

This section presents a discussion on the methodology used for the travel demand modelling effort and a summary of the ridership/revenue results from the application of the model. The specific local and regional input data resources, the integration of the intra-urban, inter-city and air travel model components, and the key ridership and revenue outputs are provided.

4.4.3.1 Travel Demand Background

The purpose of the travel demand evaluation is to estimate the potential ridership that each alternative corridor and service type could attract. The ridership estimates are based primarily on alignment characteristics, travel time and station options, since a uniform baseline fare was used for all alternatives. A detailed description of the Ridership Demand Forecasting Methodology, completed by WSP/Parsons Brinckerhoff Inc., is provided in Appendix C. The key inputs to the ridership demand forecasting effort were discussed in Section 3.5, and include travel time, frequency of service, span of service, uniform fares, parking availability and cost.

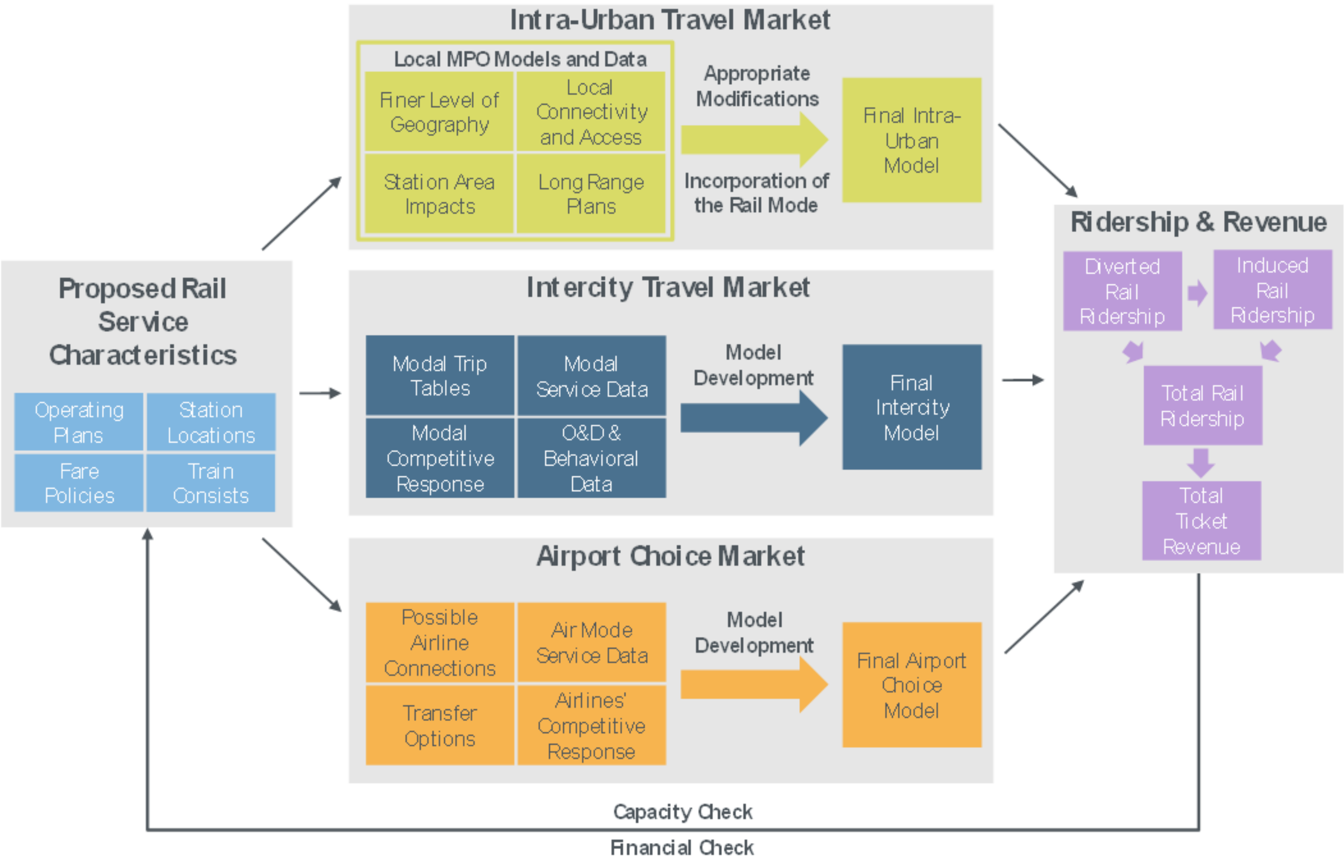
The ridership analysis included an evaluation of four different technologies: 90 mph conventional diesel powered locomotives, 125 mph enhanced diesel powered locomotives, 125 mph electric powered locomotives, and 220 mph operation for 12 different scenarios of station groupings and alignments within the corridor alternatives. The initial steps included performing a series of ridership analyses on the scenarios representative of the TRE and Hybrid corridor alignments with different technology, station combinations, and fares. These are the two corridor alignments remaining after the Step 1 screening. Results at the end of each round were analyzed to determine scenarios to be carried forward to the next round of ridership analysis. The purpose was to compare the ridership performance results by technology and fare variation and station performance through all scenarios.

4.4.3.2 Travel Demand Model Development

It should be noted that because the Project is part of a developing high-speed rail network linking two north/south high-speed rail corridors, and because there is an existing commuter rail service between Dallas and Fort Worth, all of the alternatives evaluated assume that TOPRS and TCR are operational by Year 2040. Both projects are mentioned in the North Central Texas Council of Governments' (NCTCOG) Mobility 2040 Plan (March 2016), but are not included in the Dallas-Fort Worth Expanded Travel Demand Model (DFX) for the 2040 planning horizon or on the list of fiscally constrained projects for the region.

As the Metropolitan Planning Organization for the Metroplex, NCTCOG maintains the DFX for the region. The ridership demand forecasting team worked in concert with NCTCOG and TxDOT to determine the best approach to integrating high-speed rail into the DFX model. Figure 4-2 shows the ridership demand forecasting framework which was initially employed in the TOPRS Service Development Plan and service-level EIS to address intra-urban and intercity and airport and airport travel markets. This framework has a number of unique strengths that facilitates the successful development of robust and credible ridership and revenue forecasts and guided the ridership demand forecasting for the alternatives analysis.

Figure 4-2: Ridership Demand Forecasting Methodology Framework



Source: TOPRS Service Development Plan, CH2M Hill 2016

The ridership forecasting model included the capability to forecast intra-regional high speed rail trips and their effect on destination choice, treatment of special markets unique to HSR, and the effects of inter-regional HSR trips on the transportation system within the Dallas – Fort Worth region. The work effort required integration of this enhanced modeling system with inter-regional HSR forecasts being developed separately. Thus, a number of critical model enhancements were developed to provide the necessary detail for the evaluation of changes in the overall transportation network. They include: Mode Choice Expansion; Latent and Induced Demand; Air Passenger Model; Special Events Model; Inter-regional Model Enhancements; Mode Choice Expansion; and Intercity Modeling for Dallas to Houston Corridor.

The applicable model enhancements were then integrated into the DFX and Texas Statewide Analysis Model (SAM) models. The SAM has been enhanced with an inter-regional HSR system component. The enhancements also include integration of the SAM outputs used as inputs into the enhanced DFX. The inputs to the resulting travel demand model used existing regional travel inputs from the NCTCOG model and State of Texas travel characteristics. This combination of intra-urban and inter-city travel characteristics was designed to improve its ability to estimate total travel demand on a corridor basis, and then estimate the diversion to the Dallas – Fort Worth corridor alternatives. The results of these two components were then carefully combined in a predefined process to provide total revenue and ridership for each alternative. These ridership estimates were completed for each specific corridor alternative and its individual service characteristics (speed/frequency/assumed stations/etc.).

4.4.3.3 Corridor Travel Market

The travel market for the Dallas to Fort Worth rail corridors is composed of three main submarkets—inter-city, intra-urban and air. These three submarkets are the main ridership sources for the proposed rail service, as described below.

- Inter-city travel to and from neighbouring cities that are accessible to the corridor through proposed high speed rail networks and other existing intercity modes – including auto, direct air, bus and other shuttle services
    - Intercity travel by auto: current auto trips made on the corridor which terminate in neighbouring cities outside the corridor
    - Intercity travel by air: current air trips starting or ending within the corridor and connecting to another city potentially served via the inter-city high speed rail services planned for Dallas and Fort Worth
    - Intercity travel by bus: current bus/van/shuttle trips made on the corridor that continue to a neighbouring city within the proposed high speed rail networks
    - Intercity travel by rail: Amtrak Texas Eagle (Dallas – San Antonio) and Heartland Flyer (Oklahoma – Fort Worth) services.
- Intra-urban travel within the corridor – including auto, commuter rail and other public transit between the two neighbouring cities of Dallas and Fort Worth and midline stations along the two corridors.
- The Connect Air Market (Airport Choice) is for air passengers traveling to or from a destination out of the modelling area that may use the Dallas to Fort Worth corridor to access a hub airport within the corridor. The corridor has two such hub airports, Dallas Fort Worth (DFW) and Dallas Love Field (DAL). DFW is the largest hub airport and, with improved rail access into the region, some of these passengers might divert to corridor rail alternatives.

4.4.3.4 Station Alternatives

There are two station locations within each of the terminal cities and three midline stations along the three corridors, as shown on Figure 3-2. Even though not required for Step 1 of the evaluation of alternatives, capital cost estimates (discussed in Section 4.4.4) and initial ridership demand forecasts were developed for all three corridors, including the I-30 Corridor which ultimately did not survive the Fatal Flaw evaluation in Step 1. This was done to confirm the methodology and inform the overall evaluation process. The station alternatives considered are:

- Fort Worth has two main rail stations – Texas and Pacific (T&P) and the Intermodal Transportation Center (ITC). The ITC is located within the Fort Worth central business district at the entry to the central area. The T&P is located further along the alignment into the southern portion of the central business district.
- Centreport is the existing midline station along the TRE Corridor.
- County Line is the midline option along the northern, TRE portion of the Hybrid Corridor.
- Arlington Station is the midline station along the I-30 Corridor and the Arlington segment of the Hybrid Corridor.
- Dallas has two main central Dallas Stations – Union Station and the Dallas terminal station of the proposed Texas Central Railway (TCR).

The three corridor alternatives have access to the two terminal stations in Fort Worth and Dallas.

The station stopping options are presented below in Table 4-5. These station stopping patterns were placed into eight station groupings for the ridership demand estimation. Station groupings S1 and S2 were applied in the ridership demand forecasting process to include all stations and determine their individual contributions to the ridership estimates. Fort Worth T&P is located along the end of the alignment past ITC. Station groupings S4 and S5 include only the ITC Fort Worth Station, plus only one mid-line station on each of the two corridors. Station groupings S7 and S8 are similar, but without the Dallas Texas Central Railway Station – TCR. Station groupings S10 and S11 are similar, but without the other main Dallas Union Station. These eight station stopping groups covered each of the three corridors and station options.

Table 4-5: Corridor and Station Stopping Combinations for Ridership Estimation

	Station Groups											
	TRE	*H*	*I30*	*TRE*	*H*	*I30*	*TRE*	*H*	*I30*	*TRE*	*H*	*I30*
Station	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
Fort Worth T&P	X	X	X									
Fort Worth ITC	X	X	X	X	X	X	X	X	X	X	X	X
Centreport	X			X			X			X		
County Line		X										
Arlington		X	X		X	X		X	X		X	X
Dallas Union	X	X	X	X	X	X	X	X	X			
Dallas TCR	X	X	X	X	X	X			X	X	X	X

Source: WSP/Parsons Brinckerhoff Inc. 2016

4.4.3.5 Service Alternatives

The study team defined a total of 12 corridor alternatives for the three corridors from which ridership forecasts were developed. As previously noted, the three operating speeds and four trainsets that were included in the definition of the alternatives are:

- 90 mph conventional diesel locomotive,
- 125 mph enhanced diesel locomotive,
- 125 mph electric propulsion, and
- 220 mph high speed rail technology (i.e., Shinkansen).

The ridership estimation strategy estimated ridership for the speed options and with the baseline fare level of $8.00.

4.4.4 Capital Cost Estimation

Capital costs were estimated for each of the corridor alignment alternatives; the detailed methodology is provided in Appendix C. These costs were estimated based on the alignment definitions, station options, access configurations and the speed profile options described in Chapter 3. Conceptual capital costs were estimated using basic infrastructure costing categories while applying recent and designed rail project costs. These cost estimates have reflected relevant transportation industry standard unit costs applied to the estimated quantities. The quantities shown in the estimates were extracted from the corridor alternative alignments and categorized by their speed profiles. The capital cost estimates were then used in the cost related criteria for the alternatives analysis.

The capital costing methodology provided cost estimates at a level of detail applicable to this concept-level phase of project development. Unit costs per mile were developed to compare the capital costs of alignments, facilities, and train technologies. This approach provides capital cost estimates in December 2015 dollars, then escalated to base year – 2016.

The 10 FRA Standard Cost Categories are shown in Table 4-6. Each SCC is further broken down into subcategory items that further detail the capital cost estimate of each major asset category. The capital cost estimates only include categories 10 through 90 as category 100 is finance charges. The value for category 100 will be determined in subsequent stages of project development.

The capital cost estimates apply allocated and unallocated contingencies. Allocated contingency is added to each cost category, based on an assessment of the level of available design information, means and methods, and site accessibility available for individual items of work. Unallocated contingency includes more widespread uncertainties not associated with individual construction activities. Unallocated contingency was based on a percentage of the total project cost for categories 10 through 80.

Table 4-6: Federal Railroad Administration Standard Cost Categories

Standard Cost Categories
10 Track Structures and Track
20 Stations, Terminals, Intermodal
30 Support Facilities: Yards, Shops, Administration Buildings
40 Sitework, Right-of-Way, Land, Existing Improvements
50 Communications and Signaling
60 Electric Traction
70 Vehicles
80 Professional Services
90 Unallocated Contingencies
100 Finance Charges

For the Project alternatives, the allocated contingency is 30 percent to 50 percent to mitigate the many unknowns at this level of design. Allocated contingency of 50 percent was applied to Track Structure for the last 5 mile approaches to Fort Worth and Dallas to account for the many unknowns in mitigating rail capacity issues in Fort Worth and infrastructure issues in Dallas. A 30 percent contingency was applied to all of the remaining Track Structure and associated infrastructure – Stations, Systems, Storage and Maintenance Facilities, and Land Acquisition Costs to mitigate the many unknowns at this level of design. The unallocated contingency is assumed at 15 percent for the conceptual level cost to mitigate the uncertainty in the overall implementation of the project including schedule, governance, stakeholder agreements and other issues. Project contingencies reduce in value as the design and delivery approach clarifies in line with progress and detail of the overall project development. Table 4-7 lists the assumed contingencies for capital cost estimates utilized for this project.

Table 4-7: Contingency Values for Each Standard Cost Category

Standard Cost Categories	Contingencies
10 Track Structures and Track	30 - 50%
20 Stations, Terminals, Intermodal	30%
30 Support Facilities: Yards, Shops, Administration Buildings	30%
40 Sitework, Right-of-Way, Land, Existing Improvements	30%
50 Communications and Signaling	30%
60 Electric Traction	30%
70 Vehicles	30%
80 Professional Services	30%
90 Unallocated Contingencies	15%
100 Finance Charges	0%

Source: WSP/Parsons Brinckerhoff Inc. 2016

The contingency values were included for each of the cost categories. A 30% amount was included as an allocated contingency to each of the cost categories. A range of 30 percent to 50 percent contingency was included for the track and structural components, depending upon the cost risk of escalation. The higher 50 percent contingency was assigned to the segments entering the central business districts of Dallas and Fort Worth. These segments include corridor constraints that will require further engineering efforts to determine the preferred alignment options, some of which may require higher unknown costs. An additional 15% unallocated contingency was included for the wider unknowns at this stage of study and cost development. A 0% contingency amount was included for the finance costs since these have not been defined yet.

Stations - The station cost estimates are based on improvements to and the use of existing or proposed terminal facilities in the Dallas and Fort Worth central business districts and one or two new intermediate stations along each alternative corridor. For the purposes of the estimated costs, it is assumed that the existing Fort Worth T&P or the ITC and the Dallas Union Station or the proposed TCR station would provide the station buildings for the terminal stations. Costs for platforms and accessibility to those platforms for the Project are included as part of the estimates. Intermediate station sites include potential station locations in Arlington and at the TRE CentrePort Station. A standard unit cost was used for intermediate stations treating them initially as large stations per Amtrak's Station Program and Planning Guidelines (2013). The intermediate station building costs are represented as a lump sum per station.

Support Facilities - Support facility requirements were generally determined based on the proposed operation on each of the two corridors, informed by ridership demand forecasts. Support facilities include vehicle storage and light maintenance facilities, heavy maintenance facilities, wayside maintenance facilities, and administrative facilities. These costs are lump sum costs and based on past similar project maintenance facility layouts for similar fleet sizes.

Sitework, Right of Way, Land, Existing Improvements – As the Project progresses through the design process, it will include an evaluation of right-of-way needs that may consist of up to three types of property: Urban, Suburban, and Undeveloped right-of-way acquisition. The following list provides additional definition of each type of property for estimating purposes. A minimum right-of-way width of 60 feet was assumed for the Project.

- Urban Right-of-Way - Purchase of property in the densely developed areas of downtown Dallas and Fort Worth
- Suburban Right-of-Way - Purchase of property in less densely developed areas outside of downtown Dallas and Fort Worth, but with some improvements on the purchased land
- Undeveloped Right-of-Way Purchase of property without improvements (land only)

Vehicles - Vehicle unit cost estimates include diesel electric and electric vehicle technologies satisfying operating speeds of 90mph (diesel electric), 125mph (diesel electric or electric), and 220mph (electric). Vehicle purchase costs (including design) are included in FRA standard cost category 70 on a cost-per-trainset basis. The trainset number of cars and seating capacity are based on the ridership analysis and service operating plan developed for the Project. Costs for an additional 20% of vehicles (spare cars) and replacement parts are included in the estimate. The cost of vehicles were determined from recently completed studies and vehicle purchases within the United States and publicly available data regarding recent sales of comparable equipment to other High Speed Rail projects around the world.

Professional Services - The costing approach for professional services was based on percentages of the construction cost for categories 10 through 60. Professional services costs for Cost Category 70: Vehicles was excluded because professional services for vehicle procurement, design, and manufacturing is typically included in the cost of the vehicles. These percentages are common practice percentages adjusted for the anticipated magnitude of the capital cost. The following list presents the assumed percentage values that were used.

- 80.01 Service Development/Service Environmental: Not Applicable (currently underway)
- 80.02 Preliminary Engineering/Project Environmental: 4%
- 80.03 Final Design: 7%
- 80.04 Project Management for Design and Construction: 3%
- 80.05 Construction Administration and Management: 3%
- 80.06 Professional Liability and Other Non-Construction Insurance 0%, Negligible
- 80.07 Legal; Permits; Review Fees by Other Agencies and Cities: 0%, Negligible
- 80.08 Survey, Testing, and Investigation: 1%
- 80.09 Engineering Inspection: 1%
- 80.10 Start Up: Not Applicable

Unit Costs and Units of Measure – The definition of the alternatives for each corridor included the asset categories and elements to conform to the FRA Standard Cost Categories presented in Table 4-6. The Track Structures are defined by the alignment grade and track type—ballast and non-ballast—on a route mile basis. Stations are defined by the number of terminal and midline stations. Systems are defined by the communication, power and catenary requirements on a route mile basis. Vehicle storage and maintenance facility requirements were defined for the facility, servicing and maintenance of way requirements on a per vehicle basis. Existing land use cost differential was accounted by the development intensity. Acquisition cost was defined on a per acre basis for developed and undeveloped land use and then for the density of that development use.

Unit costs were derived from multiple comparable services that have been either evaluated (such as the TOPRS, California High Speed Rail, Midwest Regional Rail Initiative, Florida High Speed Rail, High Speed Rail Feasibility studies completed by the Georgia Department of Transportation and others) as well as Amtrak Acela service currently in operation in the northwestern U.S. The unit capital costs developed from these sources were in a base year of prior value and then escalated to Year 2015 values are presented in Table 4-9. The base years of the unit cost estimate were from year 2010 to 2015. These unit costs served as the basis for estimating per mile costs for analysis of the corridor alternative alignments and technologies. The project team updated all unit costs to 2015 dollars for the design and construction of the Project. Escalating these unit costs to 2015 dollars was completed by utilizing the Engineering News Record Construction Cost Index (CCI) for Dallas – Fort Worth.

Quantities - Conceptual quantities were developed based on the engineering plans for the FRA cost categories in line with the percent complete of drawings and specifications. Capital asset quantities by FRA Standard Cost Category are presented in Table 4-10 for each corridor alternative. These initial quantities are related to structures, track roadbed (ballast and non-ballasted), rail, track materials, turnouts, stations, support facilities, right-of-way, communications and signaling, electric traction, and vehicles. These asset categories have corresponding unit costs as noted in the prior table. The alternative asset quantities are defined to be comparable with the units of measure developed for each cost category. Quantities that are specific to preliminary engineering and final design including earthwork, sitework, and utilities are estimated as part of the per mile costs for the analysis of alternatives. These undefined quantities can be significant cost drivers and thus are also addressed within the allocated and unallocated contingencies. Quantities were based on plan and profile drawings, typical sections, and sketches created during the conceptual and preliminary engineering tasks. The station cost estimates are based on improvements to and the use of existing or proposed terminal facilities in the Dallas and Fort Worth central business districts and the quantities of one or two new intermediate stations along each alternative corridor. The quantities were applied to the unit capital costs to estimate the capital costs by asset category. The resulting capital costs for each corridor alternative are presented in the following section.

Table 4-8: Unit Capital Costs for Each Asset Category

	Unit	Unit Costs - Low	Unit Costs - High	ENR Conversion Factor	Adj. Unit Costs - Low	Adj Unit Costs - Avg	Adj. Unit Costs - High
Track Structure							
Tunnel	Route Mile	$ 247,438,514	$ 427,438,514	1.15	$ 285,000,000	$ 389,000,000	$ 492,000,000
Trench	Route Mile	$ 29,630,871	$ 88,188,514	1.15	$ 34,100,000	$ 67,800,000	$ 101,500,000
At Grade Non-Ballasted	Route Mile	$ 8,438,514	$ 17,438,514	1.15	$ 9,720,000	$ 14,900,000	$ 20,080,000
At Grade Ballasted	Route Mile	$ 7,172,737	$ 14,822,737	1.15	$ 8,260,000	$ 12,670,000	$ 17,070,000
Embankment	Route Mile	$ 19,188,514		1.15	$ 19,900,000	$ 22,100,000	$ 24,300,000
Low Aerial	Route Mile	$ 61,395,173		1.15	$ 63,600,000	$ 70,700,000	$ 77,800,000
High Aerial	Route Mile	$ 81,834,181		1.15	$ 84,800,000	$ 94,200,000	$ 103,600,000
Stations							
Terminal	Each	$ 197,363,075	$ 300,000,000	1.15	$ 227,000,000	$ 286,000,000	$ 345,000,000
Mid Line	Each	$ 43,092,730	$ 81,662,741	1.15	$ 49,600,000	$ 71,800,000	$ 94,000,000
Systems							
Communication and Signaling	Route Mile	$ 3,700,000		1.03	$ 3,440,000	$ 3,820,000	$ 4,200,000
Electric Traction	Route Mile	$ 3,750,000		1.03	$ 3,480,000	$ 3,870,000	$ 4,260,000
Catenary and Pole	Route Mile	$ 3,220,000		1.03	$ 2,990,000	$ 3,320,000	$ 3,650,000
		$ 10,670,000		*0.90*			
Storage And Maintenance Facilities							
Major Maintenance Facility	Each	$ 131,000,000	$ 239,000,000	1.15	$ 151,000,000	$ 213,000,000	$ 275,000,000
S&I Facility	Each	$ 32,750,000	$ 59,750,000	1.15	$ 38,000,000	$ 54,000,000	$ 69,000,000
MOW Facility	Each	$ 4,830,000		1.03	$ 4,480,000	$ 4,980,000	$ 5,480,000
Land Acquisition Costs							
Non-Developed	per acre	$ 4,000	$ 30,000	1.03	$ 4,130	$ 17,550	$ 30,960
Developed, Open Space	per acre	$ 435,600	$ 871,200	1.03	$ 449,000	$ 674,000	$ 899,000
Developed, Low Intensity	per acre	$ 2,178,000	$ 4,356,000	1.03	$ 2,250,000	$ 3,370,000	$ 4,490,000
Developed, Medium Intensity	per acre	$ 5,445,000	$ 10,890,000	1.03	$ 5,620,000	$ 8,430,000	$ 11,240,000
Developed, High Intensity	per acre	$ 10,890,000	$ 21,780,000	1.03	$ 11,200,000	$ 16,900,000	$ 22,500,000
Rolling Stock							
220 HSR Train Sets	Each	$ 29,000,000	$ 47,000,000	1.15	$ 33,400,000	$ 43,800,000	$ 54,100,000
125 Electric Loco	Each	$ 7,000,000	$ 10,000,000	1	$ 7,000,000	$ 8,500,000	$ 10,000,000
125 Desiel	Each	$ 6,000,000	$ 10,000,000	1	$ 6,000,000	$ 8,000,000	$ 10,000,000
90 Deisel	Each	$ 3,000,000	$ 6,000,000	1	$ 3,000,000	$ 4,500,000	$ 6,000,000
Coach	Each	$ 1,000,000	$ 2,000,000	1	$ 1,000,000	$ 1,500,000	$ 2,000,000

ENR Conversion - Engineering News Record Construction Cost Index (CCI) for Dallas – Fort Worth.

Source: WSP/Parsons Brinckerhoff Inc. 2016

Table 4-9: Capital Asset Quantities by Category for Each Alternative

	Unit	TRE - 220	TRE - 125E	TRE - 125D	TRE - 90D	I-30 - 220	I-30 - 125E	I-30 - 125D	I-30 - 90D	I-30/SH 360/TRE - 220	I-30/SH 360/TRE - 125E	I-30/SH 360/TRE - 125D	I-30/SH 360/TRE - 90D
Track Structure		3	5	7	9	11	13	15	17	19	21	23	25
Tunnel	Route Mile					10	10	10	10				
Trench	Route Mile												
At Grade Non-Ballasted	Route Mile												
At Grade Ballasted	Route Mile	5.15	5.15	5.15	15.81					0.97	0.97	0.97	7.7
Embankment	Route Mile												
Low Aerial	Route Mile	2.67	2.67	2.67	12.27	1	1	1	1	1.57	1.57	1.57	5.95
High Aerial	Route Mile	25.48	25.48	25.48	5.22	21.5	21.5	21.5	21.5	33.39	33.39	33.39	22.28
Stations													
Terminal	Each	0	0	0	0	0	0	0	0	0	0	0	0
Mid Line	Each	3	3	3	3	3	3	3	3	3	3	3	3
Systems													
Communication and Signaling	Route Mile	33.3	33.3	33.3	33.3	32.5	32.5	32.5	32.5	35.9	35.9	35.9	35.9
Electric Traction	Route Mile	33.3	33.3			32.5	32.5			35.9	35.9		
Catenary and Pole	Route Mile	33.3	33.3			32.5	32.5			35.9	35.9		
Storage And Maintenance Facilities													
Major Maintenance Facility	Each	1	1	1	1	1	1	1	1	1	1	1	1
S&I Facility	Each												
MOW Facility	Each												
Land Acquisition													
Non-Developed	Acres	0	0	0	0	0	0	0	0	0	0	0	0
Developed, Open Space	Acres	0	0	0	0	0	0	0	0	0	0	0	0
Developed, Low Intensity	Acres	0	0	0	0	0	0	0	0	0	0	0	0
Developed, Medium Intensity	Acres	0	0	0	0	0	0	0	0	0	0	0	0
Developed, High Intensity	Acres	0	0	0	0	0	0	0	0	0	0	0	0
Rolling Stock													
220 HSR Train Sets	Each	6				6				6			
125 Electric Loco	Each		6				6				6		
125 Desiel	Each			6				6				6	
90 Deisel	Each				8				8				8
Coach	Each		48	48	64		48	48	64		48	48	64

Source: WSP/Parsons Brinckerhoff Inc. 2016

4.4.5 *Operations and Maintenance Cost Estimation*

The Operations and Maintenance (O&M) Cost Estimation Methodology provided in Appendix D assures that the project O&M cost estimates were prepared in a consistent and uniform manner, organized and standardized in methods, and formatted to facilitate reviews and reporting for the evaluation of each corridor alternative. Operating cost estimates were prepared for both the TRE and Hybrid Corridors.

The O&M cost estimates are represented by key inputs of system capacity, service options and operating plans. Service options include ridership, route miles, annual operating days, annual trips, annual train miles, average ridership per train, cars per train, annual car miles, and stations. The speed and technology options are identical to those employed in the ridership demand forecasting effort, described in Section 4.4.1.

Parametric cost information from existing passenger rail operations and recently completed studies were used to develop the O&M cost estimates. Parametric costs were identified for the following overall O&M Cost Categories:

- **Maintenance of Way** – Cost of maintaining the track, signals, buildings, structures, bridges, etc.
- **Maintenance of Equipment** – Cost of layover and turnover servicing and preventive maintenance, wreck and accidents, and contractor maintenance.
- **Transportation (train movement)** – Operating cost of train crew, bus connections, train fuel, propulsion power, and railroad access.
- **Sales and Marketing** – Operating cost of advertising, marketing, and reservations.
- **Station** – Operating cost of station staff (ticketing, baggage etc.), building rent, utilities, and security and station maintenance costs—cleaning, trash pickup, lighting, fire, emergency egress, communication systems, and connecting bus/shuttle service.
- **General / Administrative Expenses**

4.4.6 *Fare Revenue Estimation*

The estimation of passenger revenue started with the existing commuter rail fares and then adapted to a market-based fare structure for the premium status of the higher speed rail service options in this alternatives analysis study. The initial effort was oriented to a calculation of the average fare rate for the TRE that connects Fort Worth and Dallas with a commuter rail service. This was than increased to rates that reflect the premium value of higher speed rail alternatives. All fares reflect one-way, 2015 prices.

The passenger fare assumptions are based upon subsidized precedents and without the benefit of detailed surveys reflecting unique Metroplex characteristics. Thus these fares are not expected to yield an operating profit/net revenue, in the way that an unsubsidized concessionaire or private operator would require.

Average fares make allowances for concessions and advance purchase discounts. In addition, the fare assumptions show no difference in fares charged from/to Dallas Union Station or TCR station; no difference in fares from/to Fort Worth T&P or ITC terminal stations; and no difference between business and non-business baseline fares. The baseline fares assumptions are thus:

- $8.00 average passenger fare Dallas – Fort Worth
- $4.00 average passenger fare to/from intermediate stations to terminal stations

The study determined that in the interest of the evaluation of alternatives on a comparable basis, these baseline fare rates were used in the ridership estimation process and the resulting passenger revenue estimation.

4.4.7 Environmental Screening

The Step 2 environmental screening was based on a more detailed comparison of the corridor alternatives carried forward from the Step 1 screening to determine whether some of the alignment alternatives within the selected corridors would result in potential environmental impacts substantially greater than other alternatives. The more refined environmental screening was developed within the context of the overall NEPA process.

The corridor alignments that were evaluated included alignments north and south of the existing rights-of-way as well as “refined” alignments that shift from north to south/east to west of the existing rights-of-way. Thus, the refined environmental screening was performed for the following six potential alignment alternatives within the TRE and Hybrid corridors:

1. **TRE North:** Alignment that runs exclusively to the north of the existing TRE rail infrastructure.
2. **TRE South:** Alignment that runs exclusively to the south of the existing TRE rail infrastructure.
3. **TRE Refined:** Alignment that shifts from the north and south of the existing TRE rail infrastructure in order to minimize environmental issues/concerns and optimize operations.
4. **Hybrid North:** Alignment that runs exclusively to the north of the existing I-30 highway infrastructure and TRE rail infrastructure and west of the existing SH 360 highway infrastructure crossing at Post and Paddock Road as part of the curve to the TRE.
5. **Hybrid South:** Alignment that runs exclusively to the south of the existing I-30 highway infrastructure and TRE rail infrastructure and west of the existing SH 360 highway infrastructure crossing at Post and Paddock Road as part of the curve to the TRE.

6. **Hybrid Refined:** Alignment that shifts from the north and south of the existing I-30 and TRE rail infrastructure and west of the existing SH 360 highway infrastructure crossing at Post and Paddock Road as part of the curve to the TRE in order to minimize environmental issues/concerns and optimize operations.

This permitted an optimization of alignment alternatives from an environmental perspective. This Step 2 screening was based on a Geographic Information Systems (GIS) analysis and desktop level research from readily available state and federal databases. Fieldwork, modeling, and a detailed technical evaluation of alternatives in accordance with NEPA and FRA's procedures will be completed as part of the EIS.

Table 4-10, below, presents the environmental criteria that will be studied as part of the overall NEPA evaluation process, as discussed in the Dallas – Fort Worth Core Express Service Environmental Methodology Report provided in Appendix E. The table also specifies which criteria were screened as part of this alternatives analysis for the six alignment options described above, and those that will be studied in more detail as part of the EIS.

Table 4-10: Environmental Resources Analyses

Environmental Criteria	Studied In	
	AA	EIS
Air Quality		X
Water Quality and Water Resources	X	X
Noise & Vibration		X
Solid Waste Disposal	X	X
Natural Ecological Systems and Wildlife		X
Wetlands	X	X
Threatened & Endangered Species		X
Flood Hazards and Floodplain Management	X	X
Energy Resources		X
Utilities		X
Geologic Resources		X
Aesthetics		X
Land Use	X	X
Environmental Justice, Socioeconomic, Relocation, Elderly, Handicapped	X	X
Public Health, Safety, Security, and Hazardous Materials	X	X
Parks and Recreational Facilities and Section 6(f)	X	X
Historic Resources	X	X
Archaeological Resources		X
Transportation		X
Construction Impacts		X
Indirect and Cumulative Impacts		X
Section 4(f)	X	X

Table 4-11 presents the environmental evaluation criteria analyzed during the refined environmental screening process. In order to estimate potential effects, a preliminary environmental study area was identified for each alternative. The environmental study area for the alignments is limited to the ROW[1], with the exception of the environmental justice criteria, which includes a study area of the ROW plus 0.5 miles[2].

[1] While ROW widths can vary considerably, according to WSP / Parsons Brinckerhoff Inc., the right-of-way is approximately 70 feet wide throughout the project area (see Appendix E).

[2] The environmental justice study area was selected as the ROW plus 0.5 miles to assess the human health, economic, and social impacts on potential minority and low-income populations that utilize resources within the community (including accessibility to community resources and employment opportunities).

Table 4-11: Environmental Screening Criteria[3]

Environmental Screening Criteria	Measure	Alignment Study Area	Data Source	Description
Wetlands	Acres	ROW	-US Fish and Wildlife Service National Wetland Inventory -National Land Cover Dataset	National Wetland Inventory wetlands impacted
Streams	No. of Stream Crossings	ROW	National Atlas	Direct alignment crossing of waterways
Floodplains	Acres	ROW	Federal Emergency Management Act (FEMA)	100-year floodplain impacted
Parks & Recreational Facilities	No. Publically owned parks	ROW	-Texas Parks and Wildlife Department (TPWD) -Google Maps	Publically owned parkland
Threatened and Endangered Species	No. of elements of occurrence	ROW	-TPWD Texas Natural Diversity Database	Known locations of species based on at least one observation (representation of a known population of an element)
Historic Resources	No. of Historic Sites	ROW	-Texas Historical Commission -National Register of Historic Places	NRHP listed or eligible properties and districts impacted
Hazardous Material Sites	No. of sites	ROW	-Geosearch	Superfund, permitted industrial hazardous waste, radioactive waste, and treatment/disposal/ storage sites
Landfills	No. of sites	ROW	Texas Commission on Environmental Quality	Permitted solid waste disposal sites and landfills impacted
Land Use	Acres	ROW	North Central Council of Governments	Commercial, industrial, and residential land impacted
Environmental Justice	No. of census block groups of non-white residents (>50% of population)	ROW+ 0.5 mile buffer	US Census Bureau (2008-12)	Estimated non-white population affected
	No. of household income below poverty level	ROW + 0.5 mile buffer	US Census Bureau (2008-12)	Estimated population below the poverty line impacted
Relocations	No. of Buildings	ROW	Google Earth (manual count)	-Corridor: Residential and non-residential relocations required -Alignment: Residential relocations required

[3] In early 2015, the US Army Corps of Engineers (ACOE) issued a Record of Decision for the Dallas Floodway project, which will include the construction of the two recreational facilities: 1) Trinity River Standing Wave and 2) Santa Fe Trestle Trail. Both of these facilities are south of the DFWCES project and outside the project's area of impact. In addition, WSP/Parsons Brinkerhoff met with the ACOE in June 2015 to discuss potential impacts of the project and the ACOE did not express concern for the two recreational resources. NQ: Not Quantified

This information informed the approach utilized to assess each criterion and employed a ratio method to score the alignment, station, and O&M alternatives. Scoring for each environmental evaluation criterion was based on the lowest score having the least potential to create an environmental impact. The environmental screening criteria were not weighted during Step 2 because each has regulatory processes, mitigation requirements, public involvement and/or costs associated with impacting these resources.

Table 4-12 provides an example of scoring environmental evaluation criteria using the ratio method and shows the potential alignment alternatives and the scoring for floodplain criteria.

Table 4-12: Scoring Example: Ratio Methodology

Alignments	Floodplains	
	Acreage	Score
TRE South	62	6.000
TRE North	62	6.000
TRE Refined	60	5.583
Hybrid North	55	4.542
Hybrid South	38	1.000
Hybrid Refined	39	1.208

In this example, because there are six alternative alignments, the scores range from 1.000 to 6.000 (note that if there are only two alternatives, the scores range from 1.000 to 2.000). For each criterion, the lowest impact is scored a 1.000 (Hybrid South) and the greatest impact(s) is scored a 6.000 (TRE South and TRE North). The remaining potential alternative alignments are scored relative to the minimum and maximum scores using the following formula:

$$X = A - ((H - I_x)/(H - L)*(H - 1))$$

Where the variables for the equation above are presented in Table 4-13, below.

Table 4-13: Scoring Formula Variable Definitions

Variable	Units	Description
X	Point value	Score for the alternative environmental resource being analyzed
A	Number	No. of alternatives
H	Acre or number	Value of the highest impact
I_x	Acre or number	Value of impact of the alternative environmental resource being analyzed
L	Acre or number	Value of the lowest impact

4.5 Presentation Format for Summary Evaluation Results

The presentation of results for the evaluation of alternatives in Step 2 used both qualitative and quantitative values. The results are presented in a graphical format referred to as Consumer Reports' product review charts, or "Harvey Balls." Harvey Balls are round ideograms used for visual communication of information. They are commonly used in comparison tables to indicate the degree to which a particular item meets a particular criterion. This presentation format provides a clear structure to highlight the comparative benefits of alternatives.

They were used here as a means to communicate relative progress towards the highest value of each goal. Generally, there are five differing measures that are presented in the increasing cover of a circle. More coverage was always used to indicate a better measure performance.

○	Little or no contribution
◔	0-25% are the first quadrant
◑	25-50% the half full quadrant
◕	50-75% the three quarters full
●	75-100% full circle

5.0 Alternatives Analysis Evaluation Results

This chapter presents the results of the evaluation of alternatives in a comparative format to assist decision-makers and other stakeholders in identifying the preferred alternative(s) for the subsequent environmental documentation. The two-step evaluation framework was described in detail in Chapter 4 and the findings are provided below.

5.1 Evaluation of Alternatives – Step 1 Fatal Flaw Analysis

The Fatal Flaw Analysis was performed to identify the extent to which the three corridors (TRE, I-30 and Hybrid) have the potential to fulfil the purpose and need for the Project, have feasible engineering aspects or physical characteristics and have the potential to yield no significant impacts.

5.1.1 Overall Purpose and Need Evaluation Results

The impacts of the Project's Overall Purpose and Need measures were approximated using the consumer-based graphical presentation approach described in Chapter 4. This section applies the engineering and financial results from the alternatives analysis as an input to the study purpose and need elements to evaluate the three corridors, as shown in Table 5-1. Each measure's value was either directly applied based on the alternatives analysis results or inferred from these results as consumer-based graphics to illustrate the evaluation results.

Table 5-1: Overall Purpose and Need Evaluation Results

						TRE				I-30				Hybrid			
Identity	Objectives	Criterion	Measure	Quantity	Source	220	125E	125D	90D	220	125E	125D	90D	220	125E	125D	90D
Overall Purpose	Create a financially viable, safe, reliable, and environmentally sustainable intercity passenger rail service	Financially Viable	Additional Funding Requirement	$ Subsidy	NCTCOG Mobility 2040 Plan	◕	◕	◕	●	○	○	○	○	◔	◔	◑	◕
		Safety	Regional Traffic Accident Rate	per Million Vehicle Miles	NCTCOG Mobility 2040 Plan	◑	◑	◑	◔	●	●	●	●	●	●	●	◕
			At-grade Crossings	Eliminations	DFWCES	◕	◑	◑	◑	●	●	●	●	◕	◕	◕	◕
		Reliability	Grade Separated Alignment	% of Alignment	DFWCES	◕	◑	◑	◔	◕	◕	◕	◕	◕	◕	◕	◑
Overall Need	Need to reduce capacity constraints in transportation system	Reduce Congestion	Travel Time Increase Due to Congestion	Regional Travel Time	NCTCOG Mobility 2040 Plan	◑	◑	◑	◔	●	●	●	●	●	●	●	◕

The findings for the criteria to create a financially viable, safe, reliable and environmentally sustainable intercity passenger rail service are summarized below.

Financially Viable – the TRE alternatives with lower capital costs led to a lower local funding requirement. The I-30 alternatives all had the highest capital cost estimates, and thereby, the lowest ranked financially viable criterion. The lower speed technologies have relatively lower capital costs and thereby lower additional funding requirement.

Safety – the Hybrid alternatives yield the highest increase in rail travel (ridership) and corresponding reduction in auto vehicle miles of travel and more limited use of at-grade crossings. The I-30 alternatives had slightly better travel times achieved with less distances and fewer at-grade crossings. Reductions in auto vehicle miles combined with a lower number of at-grade crossings leads to improvements in safety measures.

Reliability – the I-30 alternatives measure better by the greater proportion of grade separated alignment. The Hybrid alternatives ranked next, followed by the TRE alternatives due to the extent of the grade separation. With a lower number of at-grade crossings, reliability, as well as safety, will also be improved.

Reduce or improve capacity constraints in the existing transportation system – The Hybrid alternatives, with higher ridership estimates provide better results to reduce congestion. While not evaluated for ridership due to the corridor engineering issues, the I-30 alternatives have slightly lower travel times, due to the shorter alignment lengths, and would thereby attract a correspondingly higher ridership than the other two corridors. These I-30 alternatives would contribute slightly more to improve capacity constraints. Ridership will reduce the east-west traffic within the region and reduce the congestion levels experienced along these corridors.

5.1.2 Engineering Feasibility

The findings of the assessment of engineering feasibility for each of the corridor alternatives relied heavily on the alignment considerations described for each of the corridors in Chapter 3. A detailed discussion of how each of the objectives was measured is provided below.

- **Space Availability:** Generally, all three corridors have sufficient room to accommodate a rail alignment with the exception of the eastern half of the I-30 Corridor. The complex interchanges do not have space to accommodate an alignment without an unacceptably high viaduct, expensive and difficult tunnelling.
- **Design Complexity:** All three corridors present design complexity, especially along the entrances to the Dallas and Fort Worth central areas. The I-30 Corridor presents the most complexity due to the highway interchanges entering Dallas and to a lesser extent Fort Worth. The TRE and the Hybrid corridors present a certain level of design challenges that can be accommodated through increased contingency amounts for these entry areas.
- **Construction Risks:** For all three corridors, construction within the central area approaches will be difficult and constrained by the density of highway and rail structures and the heavy vehicular traffic using them. The I-30 Corridor is especially constrained due to the additional highway density and its expanding aerial structure. TRE and Hybrid Corridors have construction risks due to their entry into Dallas along the rail corridor and entry into Fort Worth through the rail freight traffic, but not to the same extent as I-30 Corridor.

- **Construction Disruption:** While all three corridors will involve some degree of construction disruption at various locations, the disruption to traffic at the I-30 interchanges for tunnel construction beneath the highway lanes will be an order of magnitude higher.

Contributing to the assessment of the Engineering Feasibility was the development of capital costs for each corridor alternative. Although not called for in Step 1 of the evaluation, the information was used since it was available. The order-of-magnitude capital cost estimates developed for each corridor alternative confirm this assessment of the particular engineering complexity for the I-30 Corridor. Germaine to the engineering challenges, the capital costs show that the infrastructure costs alone for the I-30 Corridor are almost double the infrastructure costs for the TRE and the Hybrid Corridors. This is due to the challenges faced in the eastern and western ends of the corridor, approaching the Dallas and Fort Worth central areas.

A summary of the results of the Step 1 fatal flaw evaluation for engineering feasibility are illustrated in Table 5-2. The Engineering Feasibility factors were qualitatively measured using the consumer-based graphical presentation using the methodology described in Chapter 4 as the basis. The factor values were approximated and directly applied based on the physical constraints of each corridor.

The TRE and Hybrid Corridors, having the highest construction feasibility and lowest construction complexity and impact on other facilities, through the available rights-of-way present the highest values of the three corridors for the Step 1 measures. The I-30 Corridor is the most direct, but presents the greatest engineering challenges, the highest design and construction complexity and construction risks, and the highest capital cost. The Hybrid Corridor that includes the more feasible portions of the TRE and the I-30 Corridors performs well with these Step 1 measures. The Hybrid Corridor includes the easier segments for entry into Dallas and Fort Worth. There is a distinct difference among the three corridors, with the TRE and Hybrid Corridors demonstrating characteristics for a feasible solution to the high-speed rail needs between Dallas and Fort Worth.

Table 5-2: Fatal Flaw Engineering Feasibility Evaluation Results

			TRE				I-30				Hybrid			
Criterion	**Measure**	**Quantity**	**220**	**125E**	**125D**	**90D**	**220**	**125E**	**125D**	**90D**	**220**	**125E**	**125D**	**90D**
Integration within existing and proposed infrastructure	Space Availability	Level of Construction Feasibility	◑	◕	◕	◕	◔	◔	◔	◔	◕	●	●	●
	Design Complexity	Extent of Grade Separation	◔	◑	◑	◕	◔	◔	◔	◔	◕	◕	◕	◑
Operational envelope clearance options within corridor	Construction Risks	Level of Construction Complexity	◑	◑	◑	◕	○	○	○	○	◑	◑	◕	◕
	Construction Disruption	Impact on Transportation	◑	◑	◔	◔	○	○	○	○	◕	◕	◕	◑

Notes to this and all other tables in Chapter 5: The operating characteristic for each alternative are: 220 = operating speed at 220 mph; 125E = operating speed at 125 mph, with electric locomotive power; 125D = operating speed at 125 mph, with diesel-powered locomotives; and 90D = operating speed at 90 mph, with diesel-powered locomotives.

5.1.3 Environmental Considerations

As indicated in Section 4.3.3, the Step 1 environmental assessment showed that environmental resources are present within each of the three study corridors (I-30, TRE and Hybrid). However, there are opportunities to elevate, tunnel, or shift the alternative alignments within each corridor from one side of the existing infrastructure to the other at various locations to avoid or minimize effects to these and other environmental resources and established land uses. Therefore, no environmental fatal flaws were identified for the three study corridors (I-30, TRE and Hybrid). The station and operations and maintenance (O&M) facility locations were evaluated as part of the Step 2 environmental screening.

5.1.4 Step 1 Evaluation Conclusion

As illustrated by the Step 1 results, the alternatives proposed along the I-30 Corridor have significant design and construction feasibility and constraints that differentiate them from the other two corridor options. In addition, none of the speed and technology options for the I-30 Corridor were able to resolve these constraints. Although not required for the Step 1 evaluation, the capital costs associated with the I-30 Corridor are approximately double that of the other two corridors. For these reasons, the I-30 Corridor was eliminated from further consideration in this alternatives analysis and did not proceed to Step 2.

5.2 Evaluation of Alternatives – Step 2 Refined Screening Process

The Step 2 refined screening process focused on the speed and technology alternatives available for high speed rail service connecting Fort Worth and Dallas within the two remaining corridors—the TRE and Hybrid Corridors.

5.2.1 Ridership Estimation Results

The ridership demand estimation results for each of the alignment alternatives are provided in Table 5-3; the ridership numbers reflect average weekday totals. Important to this discussion is how the initial round of ridership estimates were employed to identify the preferred station combinations that were carried forward in the evaluation process. The TRE Corridor was used to illustrate the ridership effects of market-based fares. To accomplish this, the market-based fares for Dallas to Fort Worth travel of $22.00 for the 125mph alternatives and $27.00 for the 220mph alternative. These were tested on the TRE alternatives to establish the higher market-based fare effects on ridership within a particular corridor. Ridership estimates decreased in this corridor with these market-based fares. This TRE Corridor could not maintain demand levels with the higher fares for the higher speed rail alternatives.

The baseline fare, $8.00 for Dallas/Fort Worth trips, was applied to the other eight station options—S1, S2, S4, S5, S7, S8, S10, and S11 to identify the preferred station groupings for a consistent fare level. The baseline fare of $4.00 was included for intermediate station trips. No alternatives were eliminated, rather ridership scenarios were completed for only those scenarios to demonstrate the demand profile for the station options, market and baseline subsidized fare structures and the technology options.

These scenarios were selected to demonstrate the ridership potential of the alternative in the two remaining corridors. The TRE Corridor was used to test the ridership demand for the two terminal stations in both Dallas and Fort Worth. S1 includes all four of the terminal stations and the market-based fares for the higher speed technology options. S4 includes only the ITC Station in Fort Worth and both stations in Dallas. S7 includes only the ITC in Fort Worth and Union Station in Dallas. S10 includes the ITC in Fort Worth and only the TCR Station in Dallas. These ridership terminal station options were used to test the demand for the terminal stations under a single technology option of 90 mph diesel service. The TRE ridership scenarios also showed the lack of ridership differentiation between the diesel and electrical 125 mph alternatives. The TRE Corridor was used to illustrate the ridership demand of these station and technology options. This same approach was used to test the station options for the Hybrid Corridor, too.

Table 5-3: Ridership Estimates by Alternative

Characteristics	TRE Alternative				I-30/SH360/TRE (Hybrid) Alternative		
Speed	90 mph D	125 mph D	125 mph E	220 mph E	90 mph D	125 mph D/E	220 mph E
Station Groups	**S1**				**S2**		
Total riders	**3,468**	**2,356**	**2,310**	**1,959**	**5,520**	**6,368**	
TOPRS-related	1,254	921	921	786	3,366	3,497	
TCP-related	1,217	956	923	818	967	1,449	
Local riders	998	480	467	354	1,187	1,422	
Station Groups	**S4**				**S5**		
Total riders	**2,718**	**3,344**		**3,374**	**4,894**	**5,430**	**5,425**
TOPRS-related	1,254	1,379		1,379	3,341	3,497	3,497
TCP-related	889	1,260		1,285	935	1,166	1,163
Local riders	575	705		710	619	767	764
Station Groups	**S7**				**S8**		
Total riders	**1,488**				**3,611**		
TOPRS-related	1,254				3,341		
TCP-related	0				0		
Local riders	234				271		
Station Groups	**S10**				**S11**		
Total riders	**2,375**				**4,560**		
TOPRS-related	1,254				3,341		
TCP-related	947				1,026		
Local riders	174				193		

First round of scenarios evaluated in ridership forecasting

Scenarios eliminated based on first round forecasting results

By dropping T&P and County Line stations, dropping the I-30 alternatives altogether, and keeping both Union Station and TCP stations, all of the stations pairs in the table above were eliminated, except for S4 and S5.

125 D and E are similar enough that there is no need to test them separately.

Second round of scenarios evaluated

Final round/scenario evaluated

This run was performed after all other analysis, as it represents the highest ridership scenario.

Source: WSP/Parsons Brinckerhoff Inc. 2016

The second round of ridership estimation scenarios were used to complete the ridership estimates for the 125 mph and 220 mph technology options for S4 and S5 alternatives without the Fort Worth T&P Station. The highest ridership estimate was for the last S2 scenario. This scenario illustrates the highest demand for the Hybrid Corridor that combines the higher speed technology option with the intermediate demand of the Arlington Station.

These results support the following station conclusions:

- Texas Central Railway Dallas Terminal Station connection is important to the ridership success of the Dallas – Fort Worth connection.

- The T&P Station in Fort Worth appears similarly important. But this was found to be driven by the free parking available at this station. With comparable parking fees, these riders divert to the closer Fort Worth ITC Station and this T&P Station becomes unnecessary.
- Both TOPRS and TCR high speed rail services contributed significant portions of the ridership estimates - much higher than the local Dallas – Fort Worth ridership.
- The Arlington Station was the only midline station that contributed measurable passenger trips. This is due to both the greater trip destinations in the Arlington Station vicinity and the potential connection to the TOPRS rail service at Arlington proposed by that study.

The next stage of the ridership estimation process included model runs for the speed and technology options. Conclusions from this effort included the following:

- Differences between the 125 mph electric and diesel options were indiscernible because the simulation-based travel times were not very different, further ridership runs for both technology options were determined to be unnecessary.
- Both Dallas terminal stations provide measurable ridership contributions that justify the inclusion of both Dallas terminal stations in the evaluation process.

The third stage of the ridership estimation process involved the higher speed options for the preferred station stop series and the baseline $8.00 fare structure. The TRE Corridor S1 scenarios for the higher speed technology options used the higher value market-based fares. This consistent baseline fare option provided insight into the travel demand for the baseline fare rates and the most likely station stopping sequence at the constant fares. The Hybrid Corridor attracted the higher ridership estimates compared with the TRE alternatives. This is likely due to the Arlington Station as the midline station on this corridor. The 125 mph and 220 mph speed alternatives, with shorter travel times, garnered the higher ridership as expected when the baseline fare was consistently used. The key decision for the next phase of study is to determine the trade-offs between higher speed operations from the technology options and the higher capital and operating costs.

5.2.2 *Capital Cost Estimation Results*

These capital cost estimates demonstrate the cost levels of high speed rail, especially in congested urban corridors. In addition, these cost estimate results illustrate that the higher the speed, the higher the capital construction cost.

The TRE Corridor alternatives include a range of capital costs from a low of $3.49 billion for the 90 mph diesel service to a high of $6.87billion for the highest 220 mph electric service. The Hybrid Corridor that combines portions of the TRE and I-30 Corridors has the second highest range of capital costs—from a low of $5.27 billion for the 90 mph diesel alternative to $6.87 billion for the highest speed 220 mph electric service. The I-30 Corridor capital costs are at the highest range and are reflective of the engineering challenges faced in this corridor by each of the service and speed alternatives. Although not included in the Step 2 Screening Process, cost estimates for the I-30 Corridor were developed to support the Step 1 Screening Process relating to engineering feasibility/complexity. This is shown on Table 5-4, below.

Table 5-4: Capital Cost Estimation Results

TRE Corridor	
90 mph diesel electric	$3.49 Billion
125 mph diesel	$5.27 Billion
125 mph electric	$5.65 Billion
220 mph electric	$5.79 Billion
Hybrid (I-30/SH360/TRE) Corridor	
90 mph diesel electric	$5.27 Billion
125 mph diesel	$6.32 Billion
125 mph electric	$6.73 Billion
220 mph electric	$6.87 Billion
I-30 Corridor	
90 mph diesel electric	$10.8 Billion
125 mph diesel	$10.8 Billion
125 mph electric	$11.1 Billion
220 mph electric	$11.3 Billion

Source: WSP/Parsons Brinckerhoff 2016

5.2.3 Operating and Maintenance Cost Estimation Results

The annual operating cost estimates were prepared in year 2015 dollars for each of the speed/technology options in the two corridors. These operating cost estimates were based on comparable services, mainly in the US, and are shown in Table 5-5.

Table 5-5: Annual Operating and Maintenance Cost Results

TRE Corridor	
90 mph diesel electric	$29.5 Million
125 mph diesel	$29.2 Million
125 mph electric	$25.8 Million
220 mph electric	$27.9 Million
Hybrid Corridor	
90 mph diesel electric	$32.7 Million
125 mph diesel	$32.3 Million
125 mph electric	$28.9 Million
220 mph electric	$31.0 Million

Source: WSP/Parsons Brinckerhoff Inc. 2016

5.2.4 Study Planning Elements

The evaluation of alternatives used the Study Planning Elements information described in Chapter 4 and the same presentation process of results. The measures represent the study priorities established by the purpose and need assessment, and include both quantitative and qualitative measures.

5.2.4.1 Expanded Purpose and Need Evaluation Results

During early outreach efforts for the Project, several additional purpose and need elements were identified. These additional measures went beyond the overall purpose and need and reflect regional expectations for the Project. The evaluation results for these additional alternatives analysis measures are presented in Table 5-6 and highlighted below.

Table 5-6: Expanded Purpose and Need Evaluation Results

						TRE				Hybrid			
Identity	Objectives	Criterion	Measure	Quantity	Source	220	125E	125D	90D	220	125E	125D	90D
P1	Advance high-performance rail network	State Rail Plan Connections	State Rail Line Connections	Number of Rail Lines	DFWCES	◑	◑	◑	◑	◕	◕	◕	◕
P2	Enhance connectivity to existing and planned passenger rail services, airports, roadways, bicycle and pedestrian facilities, and be competitive with private automobile travel and air travel	Airports	Airport Connections	Number of Connections	DFWCES	◕	◕	◕	◕	◑	◑	◑	◑
		Station Access	Station Access Modes	Number of Modes	DFWCES	◑	◑	◑	◑	◕	◕	◕	◕
		Competitive With Auto Travel Time	Auto and Rail Travel Time	Auto - Number of Minutes	NCTCOG Mobility 2040 Plan	●	◕	●	◔	◕	◑	◕	◔
				Rail - Number of Minutes	NCTCOG Mobility 2040 Plan	●	◕	●	◔	◕	◑	◕	◔
P3	Promote improved air quality and reduced transportation energy consumption	Reduce Energy Consumption	Energy Savings	BTUs	NCTCOG Mobility 2040 Plan	◑	◑	◑	◔	●	●	●	◕
			Difference in Vehicle Miles Traveled	VMT	NCTCOG Mobility 2040 Plan	◑	◑	◑	◔	●	●	●	◕
P4	Augment economic development opportunities	Improve Accessibility	Difference in Vehicle hours spent in delay	Vehicle Hours	NCTCOG Mobility 2040 Plan	◑	◑	◑	◔	●	●	●	◕
N1	Planning for rapid population and economic growth	High Speed Rail Ridership	Average Daily Trips	Trips	DFW CES	◑	◑	◑	◔	●	●	●	◕
N2	Enhancing Metroplex transportation connectivity	Improved Accessibility	Hourly Capacity	Miles	NCTCOG Mobility 2040 Plan	◑	◑	◑	◔	●	●	●	◕
N3	Improving air quality within the Metroplex	Reduce Carbon Emissions	Carbon Emissions	Qualitative	NCTCOG Mobility 2040 Plan	◑	◑	◑	◔	●	●	●	◕

The table's measures were based on the following factors for each criterion:

- Advance the local, state and regional high-performance rail network – the Hybrid alternatives provide the additional TOPRS connection in Arlington.
- Enhance connectivity to existing and planned passenger rail services, airports, roadways, bicycle and pedestrian facilities, and be competitive with private automobile travel and air travel.
    - Airport Connections – the TRE alternatives with a Centreport midline station provide the nearest DFW connection.
    - Station Access Modes – the Hybrid alternatives provide the additional TOPRS connection in Arlington.
    - Competitive with Auto Travel Time and Rail Travel Time – based on travel times, higher speed alternatives within the TRE corridor perform the best.
- Promote improved air quality and reduced transportation energy consumption – the Hybrid alternatives, with higher ridership estimates, provide better results.
- Augment economic development opportunities – the Hybrid alternatives, with higher ridership estimates, provide better results to improve accessibility through reduced vehicle delay.
- Planning for rapid population and economic growth – the Hybrid alternatives, with higher ridership estimates, provide better population and economic growth results.
- Enhancing transportation connectivity to, from, and within the Metroplex – the Hybrid alternatives, with higher ridership estimates, provide better connectivity results.
- Improving air quality within the Metroplex – the Hybrid alternatives, with higher ridership estimates, provide better carbon emissions reduction results.

While the TRE alternatives performed well with the engineering and financial factors, the Hybrid alternatives rated higher with the Purpose and Need factors based mainly on their higher ridership and better connectivity through the Arlington Station.

5.2.4.2 Study Planning Evaluation Results

The Study Planning measures were approximated using the same consumer-based graphical presentation. The factor values were either directly applied based on the study results (refer to Table 4-4) or inferred from these results as consumer-based graphics. Table 5-7 presents the Summary Study Planning Evaluation Results. A list of the key findings is provided below.

- Financial/Economic Considerations are the ridership market demand, revenue and cost impacts of the alternatives.
    - Ridership Demand – the Hybrid alternatives have higher ridership demand estimates.

- Capital Cost per Alignment Mile – TRE alternatives have lower unit capital cost measures.
- Operating Cost per Annual Passenger – TRE alternatives have lower unit operating cost measures.
- Total Passenger Revenue – the Hybrid alternatives have higher revenue opportunity based on higher ridership and consistent average passenger fare for all alternatives.

- Regional Development Facilitation represents a regional planning priority of NCTCOG to improve accessibility throughout the region.
  - Number of jobs accessible within 30 minutes by automobile – This is the same for all alternatives except for the midline station, with Arlington offering better employment access for the Hybrid alternatives.
  - Number of jobs accessible within 60 minutes by transit – This is the same for all alternatives except for the midline station with Arlington offering better employment access for the Hybrid alternatives.

Table 5-7: Summary Study Planning Evaluation Results

						TRE				Hybrid			
Identity	Objectives	Criterion	Measure	Quantity	Source	220	125E	125D	90D	220	125E	125D	90D
F1	Financial/ Economic Considerations	Ridership Demand	Average Daily Ridership	Trips	DFWCES	◑	◑	◑	◔	●	●	●	◕
F2		Capital Cost	$ Capital Cost per Annual Passenger	$ Cap Cost / Psgr	DFWCES	◔	◔	◑	◕	◕	◕	●	●
F3			$ Capital Cost per Alignment Mile	$ Cap Cost/ Mile	DFWCES	◑	◑	◕	●	◔	◔	◑	◕
F4		Operating Cost	$ Operating Cost per Annual Passenger	$ Ops Cost / Psgr	DFWCES	◑	◑	◑	◔	●	●	●	◕
F5		Fare Revenue	Total Passenger Revenue	$ Revenue	DFWCES	◑	◑	◑	◔	●	●	●	◕
R1	Regional Development Facilitation	Improved Accessibility	Jobs Accessible within 30 Minutes by Automobile	Jobs in 30 Minutes	NCTCOG Mobility 2040 Plan	◑	◑	◑	◑	◕	◕	◕	◕
R2		Improved Accessibility	Jobs Accessible within 60 Minutes by Transit	Jobs in 60 Minutes	NCTCOG Mobility 2040 Plan	◑	◑	◑	◑	◕	◕	◕	◕

The result of the alternative evaluation with these Study Planning Measures is a preference for the Hybrid Corridor alternative, followed by the TRE Corridor. The Hybrid Corridor benefits from higher ridership and better access through the Arlington Station in particular.

5.2.5 Refined Environmental Screening Results

The refined environmental screening results are provided as outlined in Section 4.4.7, with the evaluation of alignment alternatives, station (both terminal stations and line stations) locations and operations and maintenance facility locations discussed in turn.

5.2.5.1 Refined Environmental Screening Results for Alignment Alternatives

Table 5-8 on the next page, presents the results of the Environmental Constraints Screening for the alignment alternatives. The table provides a comparison of the effects for each alignment alternative employing the methodology described in Section 4.4.7; the table illustrates the quantified impact, point allocation, and total score for each alignment.

Table 5-8: TRE & Hybrid Alignment Step 2 Environmental Screening Results

Environmental Screening Criteria		Alternative Alignments					
		TRE North	TRE South	TRE Refined	Hybrid North	Hybrid South	Hybrid Refined
Wetlands	Acres	2	2	2	2	2	2
	Score	1.000	1.000	1.000	1.000	1.000	1.000
Streams	No.	6	6	6	5	5	5
	Score	6.000	6.000	6.000	1.000	1.000	1.000
Floodplains	Acres	62	62	60	55	38	39
	Score	6.000	6.000	5.583	4.542	1.000	1.208
Parks & Recreational Facilities	No.	3	7	5	4	6	4
	Score	1.000	6.000	3.500	2.250	4.750	2.250
Threatened & Endangered Species	No.	14	14	14	16	16	16
	Score	1.000	1.000	1.000	6.000	6.000	6.000
Historic Resources (Properties)	No.	1	0	0	1	0	0
	Score	6.000	1.000	1.000	6.000	1.000	1.000
Historic Resources (Districts)	No.	4	3	2	4	3	2
	Score	6.000	3.500	1.000	6.000	3.500	1.000
Hazardous Material Sites	No.	1	1	1	0	2	0
	Score	3.500	3.500	3.500	1.000	6.000	1.000
Landfills	No.	8	9	9	0	0	0
	Score	5.444	6.000	6.000	1.000	1.000	1.000
Land Use (Industrial)	Acres	12	7	9	5	3	4
	Score	6.000	3.222	4.333	2.111	1.000	1.556
Land Use (Commercial)	Acres	70	75	57	65	55	45
	Score	5.167	6.000	3.000	4.333	2.667	1.000
Land Use (Residential)	Acres	35	43	24	31	9	16
	Score	4.824	6.000	3.206	4.235	1.000	2.029
Environmental Justice (Minority Population)	No.	82	80	81	114	113	113
	Score	1.294	1.000	1.147	6.000	5.853	5.853
Environmental Justice (Low Income Population)	No.	5,607	5,460	5,528	7,910	7,763	7,750
	Score	1.300	1.000	1.139	6.000	5.700	5.673
Residential Relocations (Single Family)	No.	5	22	2	27	12	0
	Score	1.926	5.074	1.370	6.000	3.222	1.000
Residential Relocations (Multi-Family)	No.	0	0	0	123	8	0
	Score	1.000	1.000	1.000	6.000	1.325	1.000
	Total Score	**57.455**	**57.296**	**43.779**	**63.471**	**46.017**	**33.570**

The scores of the alignment alternatives were totalled based on the aggregation of the individual scores received for each environmental screening criterion. The alignment alternatives were then ranked from lowest to highest score, with the lowest score (1) identified as the potential for least adverse environmental impact. Table 5-9, below, identifies the rank of the potential alignment alternatives from fewest effects to most effects.

Table 5-9: TRE & Hybrid Alignment Ranking

Alignment Alternative	Total Score	Rank	
Hybrid Refined	33.570	1	Least Adverse Environmental Effects ↓ Most Adverse Environmental Effects
TRE Refined	43.779	2	
Hybrid South	46.017	3	
TRE South	57.296	4	
TRE North	57.455	5	
Hybrid North	63.471	6	

The Hybrid Refined alignment alternative has the least adverse environmental impact. In addition, the TRE Refined alignment and the Hybrid South alignments have considerably fewer effects than the TRE South, TRE North, and Hybrid North alignments.

5.2.5.2 *Environmental Screening Results for Terminal Stations*

There are a total of four terminal station location options associated with the Hybrid Refined and TRE Refined alignments; two in Fort Worth (ITC and T&P) and two in Dallas (Union Station and DAL-TCR). Please refer to Section 3.3 for details on the terminal station locations. One, or a combination of terminal stations in Fort Worth and in Dallas, will ultimately be selected for either corridor alignment. Tables 5-10 and 5-11 present the Environmental Constraints Screening conducted for the two stations in Fort Worth and the two stations in Dallas, respectively.

Table 5-10: Fort Worth Terminal Station Environmental Screening Results

Environmental Screening Criteria		ITC	T&P
Wetlands	Acres	0	0
	Score	1.000	1.000
Floodplains	Acres	0	0
	Score	1.000	1.000
Parks & Recreational Facilities	No.	0	0
	Score	1.000	1.000
Threatened and Endangered Species	No.	0	0
	Score	1.000	1.000
Historic Resources (Properties and Markers)	No.	1	0
	Score	2.000	1.000
Historic Resources (Districts)	No.	0	1
	Score	1.000	2.000
	No.	0	0

Environmental Screening Criteria		ITC	T&P
Hazardous Material Sites	Score	1.000	1.000
Landfills	No.	0	0
	Score	1.000	1.000
Relocations – Industrial	No.	0	0
	Score	1.000	1.000
Relocations - Commercial	No.	1	0
	Score	2.000	1.000
Relocations – Residential	No.	0	0
	Score	1.000	1.000
Environmental Justice (Minority Population)	No.	5	3
	Score	2.000	1.000
Environmental Justice (Low Income Population)	No.	591	498
	Score	2.000	1.000
	Total Score	**17.000**	**14.000**

Table 5-11: Dallas Terminal Station Environmental Screening Results

Environmental Screening Criteria		Union Station	TCR
Wetlands	Acres	0	0
	Score	1.000	1.000
Floodplains	Acres	0	0
	Score	1.000	1.000
Parks & Recreational Facilities	No.	0	0
	Score	1.000	1.000
Threatened and Endangered Species	No.	0	0
	Score	1.000	1.000
Historic Resources (Properties and Markers)	No.	0	0
	Score	1.000	1.000
Historic Resources (Districts)	No.	1	0
	Score	2.000	1.000
Hazardous Material Sites	No.	0	0
	Score	1.000	1.000
Landfills	No.	0	0
	Score	1.000	1.000
Relocations – Industrial	No.	0	0
	Score	1.000	1.000
Relocations - Commercial	No.	0	0
	Score	1.000	1.000
Relocations – Residential	No.	0	0
	Score	1.000	1.000
Environmental Justice (Minority Population)	No.	4	5
	Score	1.000	2.000
Environmental Justice (Low Income Population)	No.	92	87
	Score	2.000	1.000
	Total Score	**15.000**	**14.000**

Based on the results of the terminal station screening, the station in Fort Worth that would have the least adverse effects is the T&P station and the station in Dallas that would have the least adverse effects is the TCR station. Since the scoring differentials between terminal stations (Fort Worth and Dallas) are relatively small it is recommended, based on the environmental constraints screening, that all terminal stations be further analyzed in the EIS.

5.2.5.3 *Environmental Screening Results for Line Stations*

There is one midline station alternative for the Hybrid Refined alignment (Arlington) located in the Arlington Entertainment District. Two potential midline stations for the TRE Refined alignment were considered; one at the existing CentrePort/Dallas – Fort Worth TRE station (CentrePort) and one potential new location immediately west of the Tarrant/Dallas county line near Trinity Way and the TRE commuter rail line (County Line); they are described in Section 3.3.

Since there is only one midline station alternative location for the Hybrid Refined alignment, the screening was not performed. There were no wetlands, floodplains, parks & recreational facilities, threatened and endangered species, historic resources, hazardous material sites, or landfills in the proposed Arlington line station location. In addition, no relocations would be required for the construction of this station.

Table 5-12, below, presents the screening conducted for both line stations along the TRE Refined alignment.

Table 5-12: Line Station Environmental Screening Results: TRE Refined Alignment

Environmental Screening Criteria		CentrePort	County Line
Wetlands	Acres	0	0
	Score	1.000	1.000
Floodplains	Acres	0	0
	Score	1.000	1.000
Parks & Recreational Facilities	No.	0	0
	Score	1.000	1.000
Threatened and Endangered Species	No.	0	0
	Score	1.000	1.000
Historic Resources (Properties and Markers)	No.	0	0
	Score	1.000	1.000
Historic Resources (Districts)	No.	0	0
	Score	1.000	1.000
Hazardous Material Sites	No.	0	0
	Score	1.000	1.000
Landfills	No.	0	0
	Score	1.000	1.000
Relocations – Industrial	No.	0	0
	Score	1.000	1.000
Relocations - Commercial	No.	0	0
	Score	1.000	1.000
	No.	0	0

Environmental Screening Criteria		CentrePort	County Line
Relocations – Residential	Score	1.000	1.000
Environmental Justice (Minority Population)	No.	6	4
	Score	2.000	1.000
Environmental Justice (Low Income Population)	No.	180	148
	Score	2.000	1.000
	Total Score	**15.000**	**13.000**

Based on the results of the line station Environmental Constraints Screening, -County Line would impact a smaller minority and low-income population. However, CentrePort is an existing station and therefore, the actual effects on the minority and low income populations could be greater by constructing County Line since it is not an existing facility. The CentrePort midline station along the TRE Refined alignment was ultimately selected based primarily on the ability to attract ridership.

5.2.5.4 Environmental Screening Results for Operations and Maintenance Facilities

A total of seven operations and maintenance (O&M) facility location alternatives are located along the TRE Refined alternative (M-FW1, M-FW2, M-FW3, M-DAL1, M-DAL2, M-DAL3, M-DAL4) and four of these O&M facilities are also located along the Hybrid Refined alignment (M-DAL1, M-DAL2, M-DAL3, M-DAL4); their locations are provided in Section 3.3.

Tables 5-13, below, presents the Environmental Constraints Screening conducted for the O&M facilities.

Table 5-13: O&M Facility Step 2 Environmental Screening Results (TRE Refined Alignment)

Environmental Screening Criteria		Maintenance Area Location Alternatives						
		Fort Worth			Dallas			
		M-FW1	M-FW2	M-FW3	M-DAL1	M-DAL2	M-DAL3	M-DAL4
Wetlands	Acres	0	0	0	0	0	0	0
	Score	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Floodplains	Acres	0	3.1	2.01	0	0	0	0
	Score	1.000	7.000	4.890	1.000	1.000	1.000	1.000
Parks & Recreational Facilities	No.	0	0	0	0	0	0	0
	Score	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Threatened and Endanagered Species	No.	0	0	0	0	0	0	0
	Score	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Historic Resources (Markers)	No.	0	0	0	0	0	0	0
	Score	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Historic Resources (Districts)	No.	0	0	0	0	0	0	0
	Score	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Hazardous Material Sites	No.	0	1	1	0	0	1	1
	Score	1.000	7.000	7.000	1.000	1.000	7.000	7.000
Landfills	No.	0	0	0	0	0	0	0
	Score	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Relocations (Industrial)	Acres	10	3	1	1	3	1	1
	Score	7.000	2.333	1.000	1.000	2.333	1.000	1.000
Relocations (Commercial)	Acres	4	2	3	1	25	34	26
	Score	1.545	1.182	1.364	1.000	5.364	7.000	5.545
Relocations (Residential)	Acres	0	0	0	1	0	0	0
	Score	1.000	1.000	1.000	7.000	1.000	1.000	1.000
Environmental Justice (Minority Population)	No.	1	1	1	12	2	1	1
	Score	1.000	1.000	1.000	7.000	1.545	1.000	1.000
Environmental Justice (Low Income Population)	No.	322	328	237	916	282	164	164
	Score	2.261	2.309	1.582	7.000	1.941	1.000	1.000
	Total Score	**20.806**	**27.824**	**23.836**	**31.000**	**20.184**	**25.000**	**23.545**

Hybrid Corridor O&M Facility

For the Hybrid Refined alternative, the O&M facility location alternatives (M-DAL1, M-DAL2, M-DAL3, and M-DAL4) were ranked from lowest to highest score, with the lowest score (1) identified as the potential for least adverse environmental impact. Table 5-14, below, identifies the rank of the potential O & M facility alternatives from fewest effects to most effects.

Table 5-14: Hybrid Corridor O&M Facility Environmental Screening Results

Alignment Alternative	Total Score	Rank	
M-DAL4	18.273	1	Least Adverse Environmental Effects
M-DAL2	18.925	2	↓
M-DAL3	19.000	3	
M-DAL1	22.000	4	Most Adverse Environmental Effects

The O&M facility that would have the least adverse effects is the M-DAL2 location. The significance of these effects and other environmental effects not quantified in the alternatives analysis are recommended for further analysis in the DEIS.

TRE Corridor O&M Facility

The O&M facility location alternatives for the TRE Refined alternative were ranked from lowest to highest score, with the lowest score (1) identified as the potential for least adverse environmental impact. Table 5-15, below, identifies the rank of the potential alignment alternatives from fewest effects to most effects.

Table 5-15: TRE Corridor O&M Facility Environmental Screening Results

Alignment Alternative	Total Score	Rank	
M-DAL2	20.184	1	Least Adverse Environmental Effects
M-FW4	20.806	2	
M-DAL4	23.545	3	↓
M-FW6	23.824	4	
M-DAL3	25.000	5	
M-FW5	27.824	6	
M-DAL1	31.000	7	Most Adverse Environmental Effects

The M-DAL2 O&M facility location alternative has the least adverse environmental effect, followed by M-FW1, based on the Environmental Constraints Screening process. The significance of these effects and other environmental effects not quantified in the alternatives analysis are recommended for further analysis in the DEIS.

Table 5.16 below, provides a summary of the evaluation results for the environmental elements that were evaluated.

Table 5-16: Environmental Elements Summary

						TRE				I-30/SH 360/TRE			
Identity	**Objective**	**Criterion**	**Measure**	**Quantity**	**Source**	**220**	**125E**	**125D**	**90D**	**220**	**125E**	**125D**	**90D**
Env1	Potential Environmental Impacts	Alignments	Viable alignment options available	Potential Environmental Impacts	DFWCES	◑	◑	◑	◑	◕	◕	◕	◕
Env2		Terminal Stations	Viable Locations Available	Potential Environmental Impacts	DFWCES	◑	◑	◑	◑	◑	◑	◑	◑
Env3		Line Stations	Viable Locations Available	Potential Environmental Impacts	DFWCES	●	●	●	●	◕	◕	◕	◕
Env4		Operation and Maintenance Facility	Viable Locations Available	Potential Environmental Impacts	DFWCES	◔	◔	◔	◔	◕	◕	◕	◕

5.2.6 Environmental No Build

The project would not be constructed under the No-Build Alternative and therefore would not present major environmental challenges. However, the current rail routes between Fort Worth and Dallas would continue to be used, resulting in continued minor environmental effects such as erosion and sedimentation from railroad grades to adjacent waterbodies and wetlands and noise. Other travel modes would continue to be used and would likely become more congested in the future as travel demand increases, resulting in potential effects on sensitive areas (i.e., air emissions, right-of-way acquisitions for infrastructure improvements). In addition, other passenger rail sections in this area could be developed and result in acquisition of right-of-way and effects on sensitive areas.

5.3 Presentation Format for Summary Evaluation Results

The presentation of results for the evaluation of alternatives in Step 2 used both qualitative and quantitative values. The results are presented in the same graphical format described in Section 4.6, employing the use of Harvey Balls.

6.0 Conclusion and Recommendation

6.1 Technical Results

Both the Step 1 and Step 2 technical results from the analysis of alternatives are presented in Chapter 5; the Step 1 Evaluation Conclusion is provided in Section 5.1.4. The Step 2 analysis results are summarized below.

Table 6-1: Summary Step 2 Alternatives Analysis Measures

						TRE				Hybrid			
Identity	**Objectives**	**Criterion**	**Measure**	**Quantity**	**Source**	**220**	**125E**	**125D**	**90D**	**220**	**125E**	**125D**	**90D**
Overall Purpose	Financially viable, safe, reliable, and environmentally sustainable	Financial Viability, Safety and Reliability	Additional Funding Requirement	$ Subsidy	NCTCOG Mobility 2040 Plan	◕	◕	◕	●	◔	◔	◑	◕
Overall Need	Improve capacity constraints in transportation system	Reduce Congestion	Travel time increase due to congestion	Regional Travel Time	NCTCOG Mobility 2040 Plan	◑	◑	◑	◔	●	●	●	◕
Summary 1	Financial/ Economic Considerations	Ridership Demand	Average Daily Ridership	Trips	DFWCES	◑	◑	◑	◔	●	●	●	◕
Summary 2		Capital Cost	$ Capital Cost per Alignment Mile	$ Cap Cost/ Mile	DFWCES	◑	◑	◕	●	◔	◔	◑	◕
Summary 3		Operating Cost	$ Operating Cost per Annual Passenger	$ Ops Cost / Psgr	DFWCES	◑	◑	◑	◔	●	●	●	◕
Summary 4	Environmental Impacts	Screening Results	Viable Options	Potential Environmenta l Impacts	DFWCES	◑	◑	◑	◑	◕	◕	◕	◕
Summary 5	Engineering Feasibility	Integration within infrastructure	Impact on Infrastructure	$ Construction Planned	DFWCES	◔	◔	◑	◑	◑	◑	◕	◕
Summary 6	Development Facilitation	Improved Accessibility	Jobs accessibility	Jobs in 30 Minutes	DFWCES	◑	◑	◑	◑	◕	◕	◕	◕

Notes to table: "DFWCES" refers to the alternatives analysis study team evaluation results. "D" refers to diesel locomotive power. "E" refers to electric locomotive power.

6.2 Recommendation

Based on these findings, both of the corridors evaluated in Step 2 are clearly viable, but at the 90 mph and 125 mph operating scenarios. Safety requirements for passenger equipment (rolling stock) intended for operations up to 220 mph have not been issued by the FRA; this issue is described in Section 6.3.2. The Hybrid Corridor performs slightly better, mainly due to higher ridership from serving the Arlington Station connection with TOPRS service, and lower overall environmental impacts. However, the TRE Corridor offers the best financial viability, with the lower capital costs. It is therefore recommended that both corridors proceed into the EIS process.

6.3 Topics Requiring Additional Review

In addition to the traditional analysis of environmental impact areas included in the EIS process, there are a number of topics that need future consideration.

6.3.1 Public and Stakeholder Input

The alternatives analysis was completed following an extensive public outreach effort. The Project's Purpose and Need and definition of alternatives reflect regional priorities and stakeholder input. The findings and recommendation provided above will need to be shared with the public and stakeholders, as the project continues into the EIS process.

6.3.2 High Speed Rail Operation at 220 Miles per Hour

Current FRA regulations do not address rolling stock requirements for train speeds above 150 mph. The Texas Central Railway has applied for an exemption from existing FRA regulations that will employ Shinkansen-type of service with planned speeds of 220 mph. The operation at this speed on either corridor would require a similar application for this exemption. In addition, a potential operator for the service along the Dallas to Fort Worth corridor needs to be identified.

6.3.3 Project Uses of State of Texas Owned Right-of-Way

The Hybrid Corridor in particular, proposes to use or impact State Highway 360 and portions of the Interstate highway system. Approval from the Texas Transportation Commission will be required if any state-owned right-of-way is dedicated for the Project. This will require ongoing coordination as the Project continues into the EIS process.

6.3.4 Type of Rolling Stock

Two alternative forms of locomotive power were identified in the scenarios for 90 mph and 125 mph operation. Both diesel and electric locomotives have been considered and their performance characteristics are reflected in the analysis. Each type of locomotive has benefits and drawbacks, when considering the cost, environmental impact, visual impact and performance. While more costly, the electric locomotives are faster, mainly because they accelerate faster than diesel trains and have higher maximum speeds. There are also differences affecting their respective operating and maintenance costs and need for additional infrastructure (electrification). This issue will need to be addressed in the EIS.