TEXAS CENTRAL PARTNERS
AMERICA'S BULLET TRAIN

Texas Central Partners, LLC
1409 S Lamar Street
Suite 1022
Dallas, TX 75215

RE: FRA releases detailed alignment report

Dear Stakeholder,

We are writing to inform you of another important milestone for Texas Central. Last week, the Federal Railroad Administration (FRA) published the Alignment Alternatives Analysis Report, which includes maps and descriptions of the various alignments (routes) that will be studied in subsequent phases of the ongoing environmental review of the project. The publication of these maps allows Texas Central to communicate directly with landowners, community leaders and other stakeholders on the specific impacts and benefits of these potential alternatives.

The report, published by the FRA on its website and available here, describes the six end-to-end alignments that will be evaluated in the Draft Environmental Impact Statement. The FRA report references the "Last Mile Analysis Report" and the "Step 2 Screening of Alignment Alternatives Report," which were prepared by affiliates of Texas Central and are available online here. The FRA prepared an independent analysis of the potential routes based on potential routes proposed by Texas Central.

A detailed study of these technical reports is likely to generate questions. In anticipation, we put together a "Frequently Asked Questions" document to provide responses to potential questions that you may have. It is attached herein. Additionally, to make other information on the project easily accessible, we have created an online Project Resource Kit. I encourage you to visit the Texas Central website to access this information.

It is our priority to maintain an open line of communication with all stakeholders throughout this process. Should you have any questions or require any additional information, please do not hesitate to contact me directly.

Sincerely,

Tim Keith
CEO

Step 2/Last Mile FAQs

On November 6, the Federal Railroad Administration (FRA) published its Alignments Alternatives Analysis Report for the Environmental Impact Statement (EIS) related to the Project. The report documents the FRA's environmental evaluation of potential alignment location options proposed by Texas Central's Project (the Project). Additionally, the report identifies the alternatives that will advance to a more detailed analysis.

In preparation for the FRA's report, the Project produced a number of technical reports and analyses for submission to the FRA. We will be preparing and submitting similar engineering reports throughout the development of the EIS. We submit these reports as part of the overall administrative record of documents.

We've provided the FRA with our studies that look at potential alignments and screen out unreasonable alternatives that cannot address the purpose and need of our project. These analyses include our "Step 2 Screening of Corridor Alternatives Report" (the Report). Our environmental and engineering consultants reviewed available information and used their expertise to help develop our Report. Again, the Report is only one source of information the FRA is assessing.

We understand this kind of technical study will generate questions. As such, we are providing the responses below to possible questions on the "Step 2 Screening of Corridor Alternatives Report." We appreciate your interest and should you have additional questions, please contact us.

Q: **How did the Project select the alternatives (potential track locations) considered in the Report ?**

A: We recognize there are multiple potential alignments for high-speed rail service and that a project of this scale will generate significant interest across a broad array of stakeholders. As such, we developed a number of potential alignment alternatives within and associated with the Utility Corridor and evaluated each using a broad range of criteria including engineering, environmental and project delivery considerations. We identified the alternatives that best met the criteria amongst those based on our analyses, as documented in the *Step 2 Screening of Alignment Alternatives Report*.

While the Report identified the alternatives we found to be most viable, all alternatives considered were included in the Report. The FRA reached its independent conclusions - as described in the FRA's report - after undertaking its own analysis.
Our approach to analyzing potential alignments and sharing with the public and the FRA

demonstrates our interest in minimizing environmental impacts and addressing stakeholder concerns.

Q: Why is the Project's "Purpose and Need" so important?

A: The Project's purpose and need statement describes to the public Texas Central's intention as a private entity to provide reliable, safe and economically viable passenger rail transportation between North Texas and Houston using proven Japanese high-speed rail (HSR) technology. This reflects the need for competitive transportation options that serve the people traveling between North Texas and Houston.

The Project's purpose and need statement also drives the process for alternatives consideration, in-depth analysis and ultimately the selection of a preferred route. The evaluation of all alternatives should be founded on the question of whether the alternative satisfies the purpose and need for the project. The Council on Environmental Quality (CEQ) requires the EIS also address the "no-action" or "no-build" alternative and "rigorously explore and objectively evaluate all *reasonable* alternatives."

Q: Will there be additional opportunities for public involvement and comment?

A: Yes. Texas Central will host a number of Open House meetings this quarter to gather input from communities and landowners and to provide information regarding the Project. We are also meeting regularly with various project stakeholders along the corridor, including regulatory agencies, government bodies, business interests and community groups.

The FRA has been soliciting public comments on the project since the agency published its Notice of Intent in June 2014, and will continue to do so throughout the EIS process, including public hearings along the corridor when the Draft EIS is published

Q: It appears Texas Central is willing to make adjustments and operate at a slower speed for some reasons, but not for others. How are these decisions made?

A: The project's final route must have an appropriate curvature and grade to allow the train to travel at sustained speeds sufficient to provide competitive service between North Texas and Houston, by meeting the 90-minute travel time goal. The ability to sustain speeds also helps to improve ride quality, reduce maintenance requirements and improve energy efficiency.

If necessary to minimize potential environmental impacts or avoid constraints, alignment variations that may limit speeds may also be considered during the FRA environmental review.

Q: Why are some Project documents (such as ridership numbers and per-mile construction costs) not available online?

A: We are committed to providing our stakeholders with accurate information in a timely manner. While the project is in the planning stage, much of the information we're developing evolves with changes in project design. The design process is dynamic and subject to refinement. In addition, with Texas being an ideal market for high-speed passenger rail, Texas Central is developing its project in a competitive environment and must keep certain proprietary information, including ridership and cost estimates, confidential.

Q: The report mentions "various ancillary facilities to support operations and maintenance, including systems buildings and infrastructure, train storage yards and maintenance facilities, and smaller facilities located along the ROW to support routine maintenance of the ROW and systems." How will Texas Central acquire all of the land necessary for these facilities?

A: Texas Central will negotiate with property owners to purchase the property required for all of the permanent and temporary construction needs for the project. As a private entity, Texas Central is able to negotiate the purchase of property with more flexibility than a public entity or project.

Q: The report mentions "freight line reconfigurations." What is this? Will this require more land acquisition? If so, how much? Will additional impacts result from these reconfigurations?

A: While the overall impact on existing freight railroad facilities is expected to be minimal by using the Utility Corridor for the alignment, the high-speed rail (HSR) system will cross freight rail lines. Texas Central will work closely with the owners of the freight lines to minimize impacts to their operations during construction of the HSR system. The portion of the alignment immediately south of the downtown Dallas station will require close coordination with the Burlington Northern Santa Fe railroad and the Union Pacific Railroad; however, permanent personal property or freight transportation service impacts are expected to be avoided as a result of this coordination. In cases where roadways are re-profiled to allow them to pass above the proposed HSR system, Texas Central will investigate opportunities to eliminate existing roadway crossings with freight rail. This would benefit both freight operations and the local communities.

Q: These reports reference road closures, especially smaller roads in rural areas. I thought Texas Central said it will not be closing roads?

A: Texas Central's position on preserving roads remains the same. It is our expectation that every existing public road will remain in service and the train will pass over or under each.

Additionally; state, county and municipal agencies and governments will examine each road crossing to determine the best way to accommodate the needs of the traveling public and the project. These entities are empowered to make decisions about roadways, Texas Central is not. Those agencies and governments may at their discretion decide that a few local road closures will best enhance safety and minimize impact to the public.

We also expect the Project will bring transportation improvements to communities through improved access for emergency services and utilities. As a transportation company, we believe easy movement of people, goods and services throughout the entire state is good for Texas and its citizens.

Q: Assuming construction proceeds without problems or delays, how long might a construction crew be on my property or in my neighborhood?

A: Texas Central's design-build partner, Dallas to Houston Constructors (DHC), will conduct a "pre-construction" analysis as part of the plan for construction. This work makes the construction process run more efficiently by determining in advance how materials will be transported to the construction sites, where materials and equipment will be stored, and the duration of all construction-related activity. Once this analysis is complete, we will let communities and property owners along the route know what they can expect.

Q: The report references "service frequency" and "system capacity" – what is the difference?

A: Service frequency is generally considered the number of trains traveling along the line in a given hour. This can vary throughout the day. System capacity is the maximum practical frequency the railway systems and stations can safely operate.

The high-speed railway Texas Central is designing will serve generations of future Texans. The Project's design anticipates decades of continued use, serving a growing Texas population. The service frequency planned for the first day of service will be far below the system's practical capacity. As part of the environmental review, the FRA will take into consideration the benefits and impacts of future increased service.

Q: Why is the project serving downtown Dallas but not downtown Houston?

A: As a market-led, consumer-driven project, Texas Central seeks to provide service to as large a service area as possible, while keeping construction costs and community impact low. Following existing transportation and utility rights of way, the alignments serving downtown Dallas provide a clear path to a large high-speed rail market and an easy interconnection with the North Texas multimodal transportation network.

Likewise, the proposed station location in Houston allows the train to follow existing rights of way, while providing high-speed rail passengers with easy, efficient roadway access and connectivity with planned transit improvements. Travelers arriving from North Texas or the Brazos Valley can easily take advantage of Houston's vast transportation system.

Serving downtown Houston directly would potentially create significant community and property impact, and would potentially result in significant construction impacts, risks and extended schedules. The associated cost to both the project and to the public outweighs the benefits. This analysis is documented in TC's *Last Mile Analysis Report*.

Q: Why do some segments have multiple alternatives, while others do not?

A: The areas without multiple alternatives are generally through the highly developed approaches to Dallas and Houston where our engineering and environmental analysis identified no other feasible alternatives, and along the long segments where running parallel to an electrical transmission line right of way presented no significant engineering or environmental challenges. In places where it was impractical or presented significant challenges to follow the electrical transmission line right of way, we evaluated and presented multiple alternatives.

Q: What can we, the public, expect next?

A: Texas Central will host another round of Open House meetings along the proposed corridor and will begin speaking directly with landowners. We look forward to answering questions and listening to what's on our stakeholders' minds.

We will also begin surveying individual land parcels and FRA will be conducting field studies to more accurately assess potential impacts in support of the environmental review process.

Texas Central High-Speed Railway

Step 2 Screening of Alignment Alternatives Report

Dallas-Houston, Texas, High-Speed Rail Project

Issue | November 5, 2015

Job number 234180-00
Texas License #:1990

10370 Richmond Ave
Suite 475
Houston
TX 77042
United States of America

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1 Executive Summary

Texas Central High-Speed Railway, LLC (TCR[1]), a private Texas-based entity, desires to promote the development of a reliable, safe and profitable passenger rail transportation system between Houston and Dallas, Texas using proven Japanese high-speed rail (HSR) technology (hereafter the "Project"). Advancing the Project requires an assortment of regulatory approvals, including a favorable Record of Decision (ROD) resulting from an Environmental Impact Statement (EIS) as required under the National Environmental Policy Act (NEPA). The Federal Railroad Administration (FRA), as a joint lead agency, is tasked to review reasonable alternatives, including Alignment Alternatives proposed by TCR, to develop an EIS, and to document the Preferred Alternative alignment resulting from the NEPA analysis. This *Step 2 Screening of Alignment Alternatives Report* (the Step 2 Report) documents the alignment alternatives analysis performed by TCR (see Figure 1) and identifies proposed end to end alignment alternatives within the Utility Corridor for further study by the FRA through the NEPA process (see Figure 4).

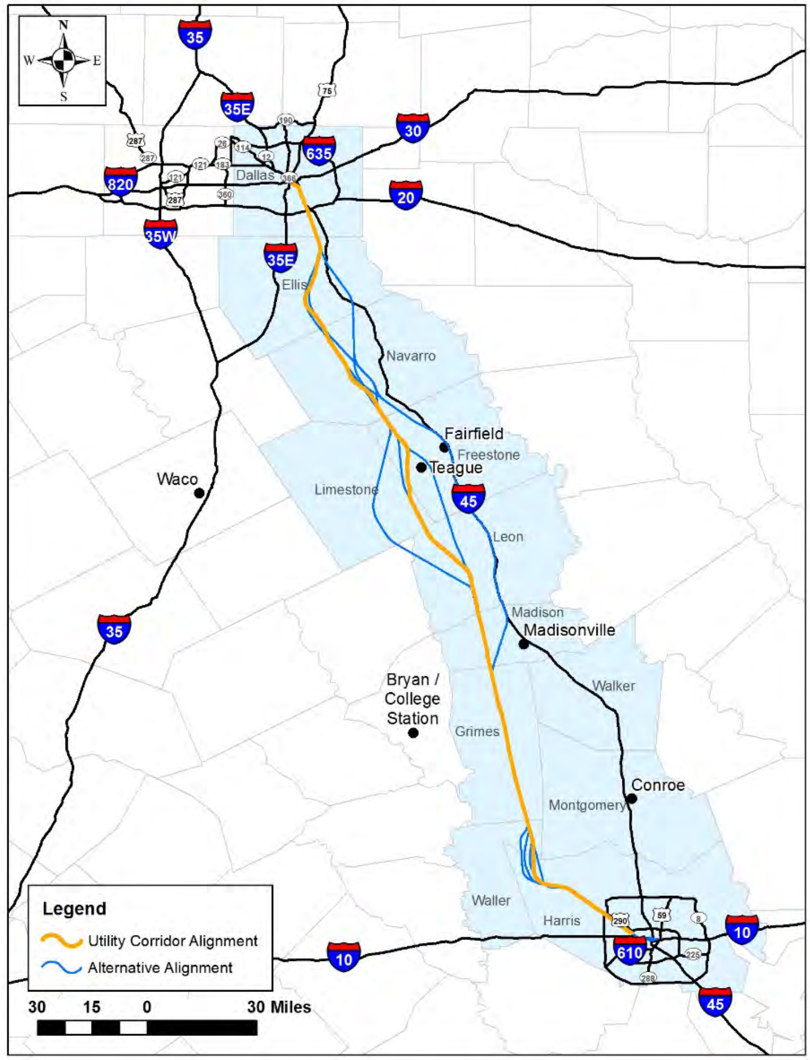
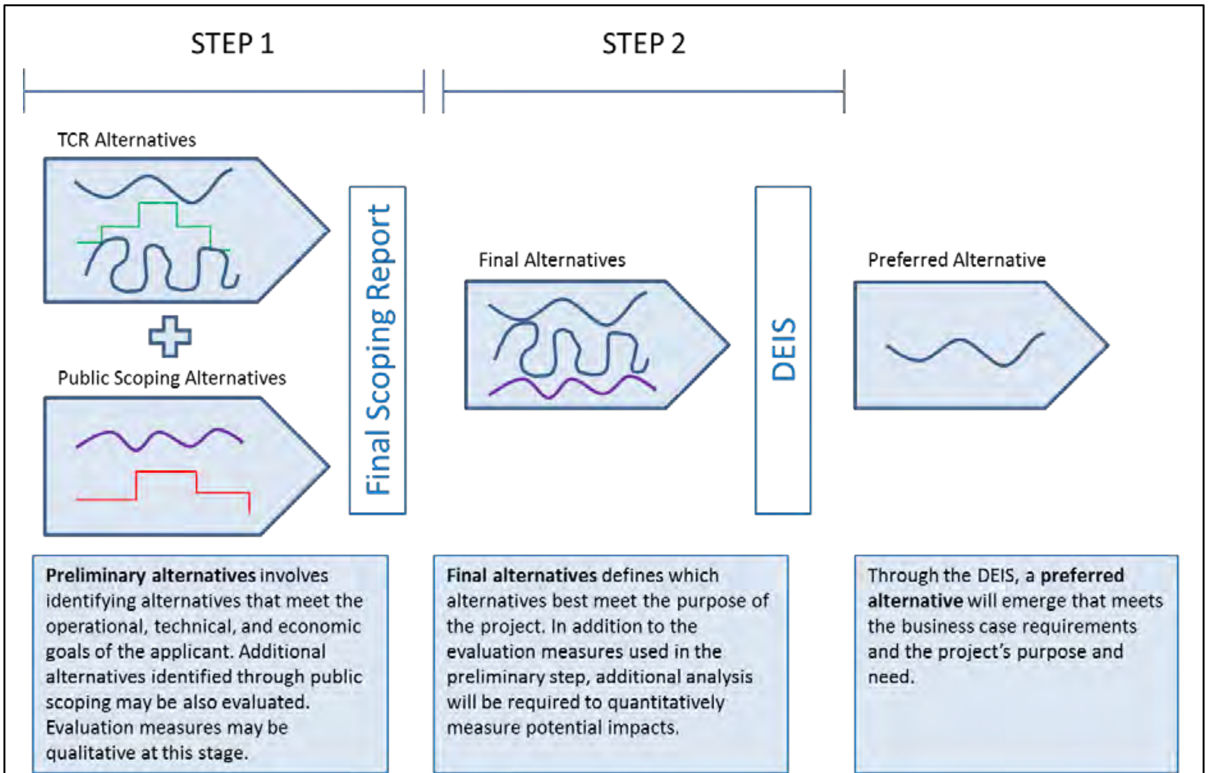


Figure 1 – Step 2 Screening of Alternatives Studied

This Report builds upon more than four years of effort by TCR to advance the Project. In May, 2013, TCR provided to FRA its Draft Alternatives Analysis Report that, in part, analyzed both corridor and station alternatives[2]. In September,

[1] Texas Central High-Speed Railway, LLC (TCR) or its affiliates Texas Central Partners, LLC (TCP).
[2] See *Draft Alternative Analysis Report*, May 2013, that originally studied 3 corridors: the BNSF corridor, IH-45 corridor and the UPRR corridor.

2014, the FRA responded with a technical memorandum[3] that set forth a two-step approach to determine the preferred corridor and alignments for further evaluation. This two-step approach is shown in Figure 2.



Source: URS, 2014.

Figure 2 – FRA Proposed Two-Step Process for Alternatives Development

In accordance with FRA guidance on the alternatives development process as illustrated below, TCR revisited the analysis of corridor alternatives and added an additional corridor for study, the Utility Corridor. That additional corridor met the Project's screening criteria and Purpose and Need. In October and December 2014, the FRA held public scoping meetings that presented two corridors for further study, the BNSF corridor and the Utility Corridor. As TCR further studied the two corridors, TCR notified FRA of TCR's intent[4] to focus its efforts solely on the Utility Corridor.

[3] Technical Memorandum re: *Texas Central Railway – Third Party Review of Draft Alternative Analysis Report*, dated September 2, 2014. The purpose of the memorandum is to provide an assessment of TCR's draft Alternatives Analysis Report. It is the intent of URS and FRA to review TCR's engineering information and determine if TCR's alternative development process is logical and provides a sound basis for continuing the alternatives into the NEPA process.
[4] Letter from TCR to the FRA dated February 17th, 2015. TCR concluded that "Because the Teague Line has significant economic, engineering, environmental and sustainability challenges we have concluded that the corridor will not satisfy the Federal Railroad Administration's ("FRA's") mission to "enable the safe, reliable, and efficient movement of people and goods" and cannot be considered a reasonable alternative for addressing traffic issues along the I-45 corridor or improving intercity mobility." The "Teague Line" is a part of the BNSF corridor from Teague, Texas south to Houston which is proximate to BNSF's right of way.

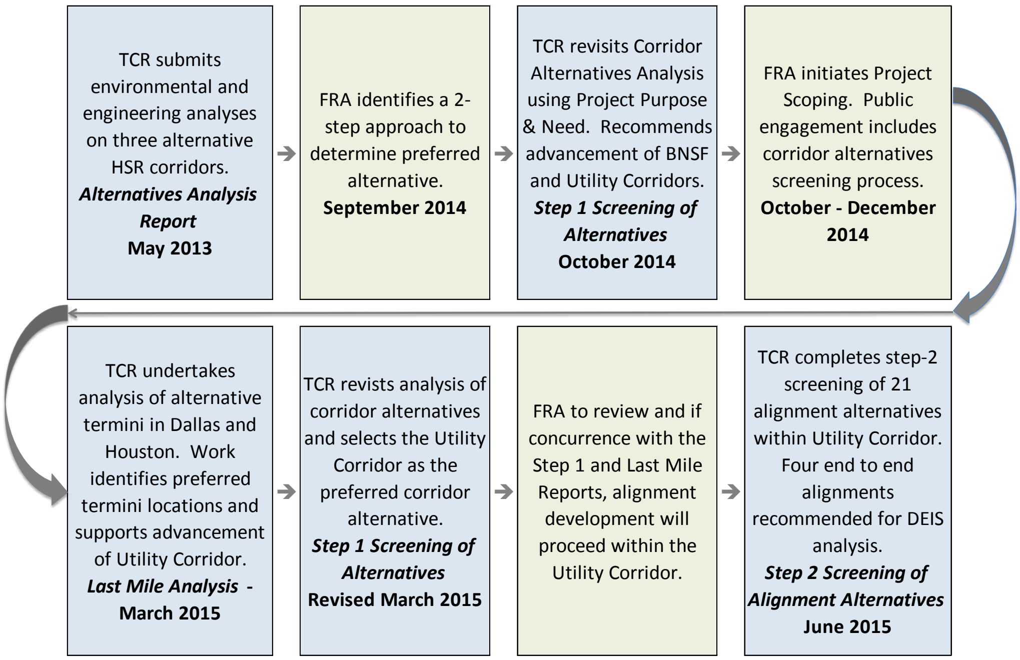


Figure 3 – Alternatives Development Process

In March 2015, TCR provided its Step 1 Screening of Alternatives Report[5] to the FRA. The Step 1 Report documented that the Utility Corridor was found to be the only reasonable corridor because other corridors considered were determined to have fatal constructability flaws, to have more impact on the environment and existing development, and to present unreasonable construction difficulty, risk, and costs. The Utility Corridor does not present those problems.

Also in March 2015, TCR provided its Last Mile Analysis Report[6] to the FRA, which documented a detailed analysis of alternative terminus station locations within the Houston and Dallas urban areas. This effort focused on the marginal benefits and impacts associated with reaching incrementally further into the urban core within each market to access alternative station sites and concluded that the Downtown Dallas Station location and the US 290/IH-610 Houston Station locations were the reasonable alternatives.

Accordingly, and in keeping with FRA direction on the alternative development process, this Step 2 Screening of Alignment Alternatives Report (Step 2 Screening) documents the development and analysis of Alignment Alternatives within the Utility Corridor, and incorporates input received through the FRA's Project Scoping efforts and through TCR's own public and stakeholder outreach efforts.

The Step 2 Screening first studied environmental and engineering constraints along the Utility Corridor and identified potential significant environmental impacts and construction complexities along the base alignment used to define the Utility

[5] *Step 1 Screening of Alternatives Report,* dated February 25th, 2015 and submitted to the FRA documents environmental and engineering efforts to evaluate nine (9) alternative alignments within the four potential HSR corridors and to screen out corridors found to be flawed from an engineering, environmental, or financial feasibility perspective.
[6] *Last Mile Analysis Report,* dated March 30, 2015 and submitted to the FRA.

Corridor in the Step 1 Screening. The specific categories of constraints and impacts studied along the Utility Corridor were 1) Environmental, 2) Constructability, 3) Development/Existing Infrastructure, 4) Geometry, and 5) Financial Viability. Alignment alternatives were then developed that met HSR alignment requirements and attempted to avoid identified constraints and to potentially mitigate impacts with the base alignment. In all, 21 alignment alternatives including the Base Utility Corridor were developed and organized into six separate geographic alternative groups to support comparisons between competing alternatives in the same segment of the corridor.

To evaluate those alignment alternatives, a two-phased alignment screening approach was used whereby all alignment alternatives were evaluated under Phase 1 and the alignments that best met the Project Purpose and Need, those with lesser impacts and reduced complexity, cost, and schedule concerns, proceeded to Phase 2 screening.

Alignment alternatives were quantitatively evaluated in the **Phase 1** screening effort under two evaluation groups:

<u>Group A – Engineering</u>

- Alignment Length
- Alignment Geometry
- Viaduct Length & Major Structures
- Crossings
- Hydrology

<u>Group B – Environmental</u>

- Streams, Waterbodies, Wetlands
- Natural Resources & Land Cover
- Cultural Resources
- Environmental Justice
- Hazardous Sites

Alignment alternatives were then both quantitatively and qualitatively evaluated in the **Phase 2** screening effort under three categories:

- Cost Analysis
- Construction Duration Analysis
- Constructability Analysis

In summary:

- The Utility Corridor Base Alignment developed in the *Step 1 Screening of Alternative Report* was carried into the Step 2 Screening effort.
- The first effort of the Step 2 Screening involved the development of alignment alternatives that met HSR design requirements, that were sensitive to environmental constraints within the Utility Corridor, and that attempted to avoid those constraints and to mitigate impacts and constructability concerns identified with the Utility Corridor Base Alignment during the Step 1 Screening.
- Alignment alternatives within the Utility Corridor were not developed over the full length of the corridor given that 1) no significantly different alternatives that

would not yield significant impacts were found feasible for the approach into either Houston or Dallas (each approximately 20 miles long), and 2) approximately 70 miles of the baseline alignment ran directly adjacent to the electrical transmission line with no major concerns identified.

- Through the Step 2 Screening process documented herein, 21 separate alignment alternatives within Alternative Groups were studied through a two phase evaluation process covering a broad range of engineering, environmental, and project delivery considerations.
- In Phase 1 of the Step 2 Screening, a quantitative GIS-based environmental analysis and a tabulation of key engineering metrics was performed for all 21 alternative alignments to determine those best aligned with the Project Purpose and Need.
- In Phase 2 of the Step 2 Screening, additional metrics were tabulated for the 10 alignment alternatives passing the Phase 1 screening and a qualitative assessment of key project delivery considerations was performed to determine the most feasible alignment alternatives.
- As a result of the Phase 1 and Phase 2 efforts of the Step 2 Screening, six alignment alternatives are recommended for further environmental analysis. Table 1 lists the alignment alternatives advancing through each phase of the Step 2 Screening process.
- The alignment alternatives recommended for further study within each geographic Alternative Group were then combined with segments of the original Utility Corridor Base Alignment to create four end-to-end alignment alternatives from Houston to Dallas within the Utility Corridor. It is expected that these alignment alternatives would be further refined through the NEPA analyses to mitigate any identified impacts.

Table 1 – Summary of Alternatives Studied and Recommended for NEPA Analysis

Alternative Groups	**Alternatives Considered in Phase 1**	**Alternatives Studied in Phase 2**	**Recommended Alignment Alternatives for Further Analysis**
Downtown Houston	2	None*	---
Hockley	5	HC-2 and HC-4	HC-4
Middle	5	MD-1 and MD-4	MD-4
Bardwell	4	BA Base and BA-3	BA Base and BA-3
IH-45	2	IH-45 Base** and IH-45 Alt	IH-45 Alt***
Corsicana	3	CR Base and CR-1	CR-1

*A Phase 2 analysis within the Step 2 Screening was not considered warranted for access to Downtown Houston due to the low DH-2 score and *Last Mile Analysis Report* results of DH-1.

**IH-45 Base includes MD-4 which was found to be preferred over the Base UC Alignment in Phase 1

***The IH-45 Base was also found to be a recommended alternative within the IH-45 Alternative Group, but this base alignment reflects MD-4 in combination with portions of the original Utility Corridor Base Alignment. As such, the IH-45 Base is not a unique alternative.

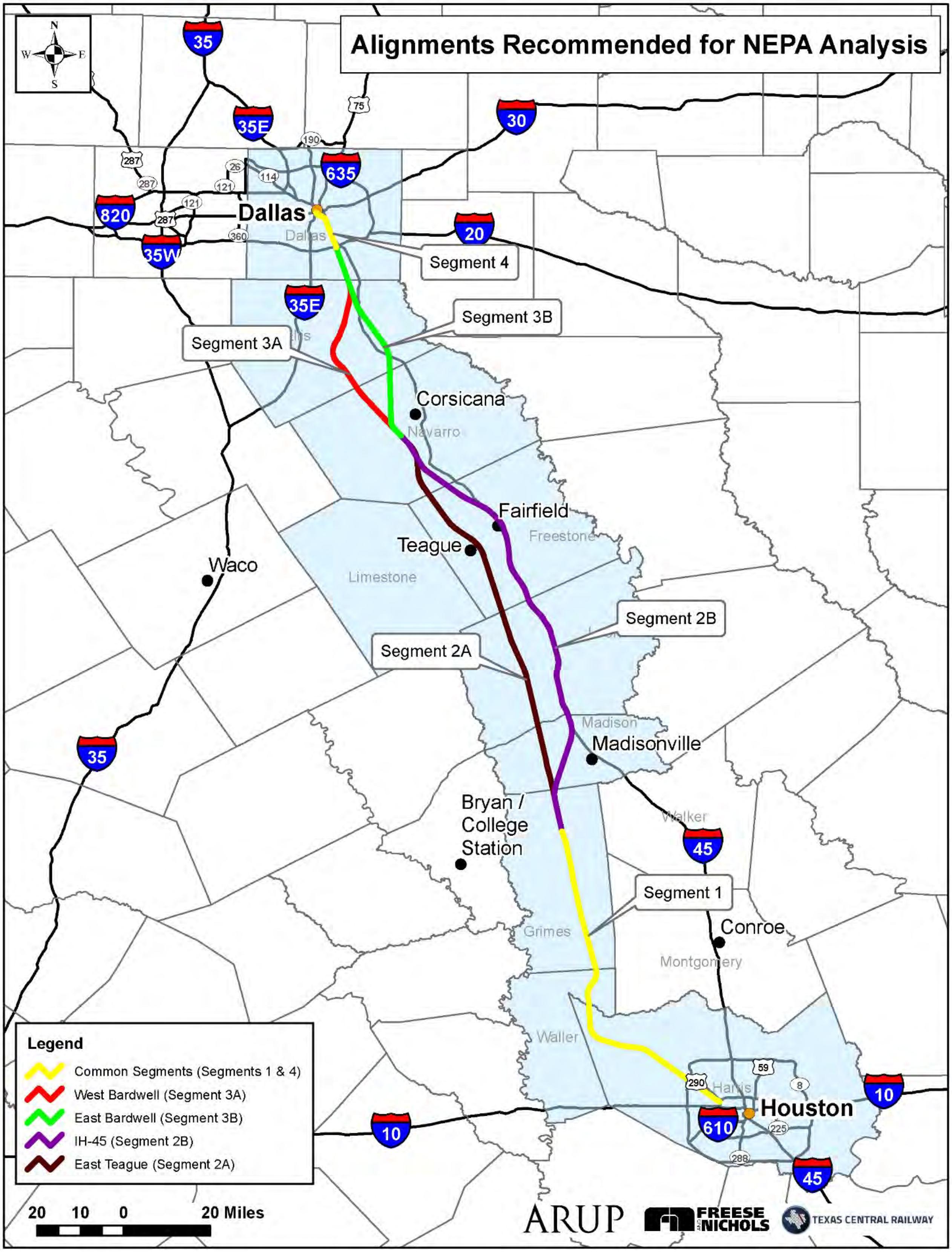


Figure 4 – Alternatives Recommended for Advancement to NEPA Analysis

2 Introduction

2.1 Background

Texas Central High-Speed Railway LLC (TCR), a private Texas-based entity, desires to promote the development of a reliable, safe and profitable passenger rail transportation system between Houston and Dallas, Texas, using proven Japanese high-speed rail (HSR) technology (hereafter the "Project"). Advancing the Project will require an assortment of regulatory approvals, including a favorable Record of Decision (ROD) resulting from an Environmental Impact Statement (EIS) as required under the National Environmental Policy Act (NEPA). The EIS is being advanced separately by the Federal Railroad Administration (FRA).

Following the FRA's proposed two-step approach for alternatives development (See Figure 6), a *Step 1 Screening of Alternatives Report* was created to document TCR analysis of alternative corridors as input to the EIS effort. The Step 1 Screening of Alternatives (hereafter referred to as the Step 1 Screening) effort served as the first step in the alternatives development and analysis process and established criteria for the corridor analysis based on the Project's Purpose and Need. The goal was to identify reasonable corridor alternatives in which to develop the proposed HSR system. After the Step 1 Screening, a more detailed assessment of alignment alternatives was undertaken in the Step 2 Screening of Alignment Alternatives (hereafter referred to as the Step 2 Screening). The *Step 1 Screening of Alternatives Report* also provided a method and framework for TCR's environmental and engineering analysis of competing alternatives. The method documented in that report was subsequently used in the Last Mile Analysis and has been incorporated into the Step 2 Screening to ensure a clear and consistent approach to alternatives screening and decision making.

More specifically, the *Step 1 Screening of Alternatives Report* evaluated nine alternative HSR routes within four HSR corridors to screen out those corridors found to be unreasonable from an engineering, environmental, safety, or financial viability perspective. The preferred corridor resulting from the Step 1 Screening analysis and documented within the *Step 1 Screening of Alternatives Report* was found to be the Utility Corridor as shown in Figure 5. Development of the HSR system within the Utility Corridor was determined to be more constructible, to have less environmental impact, and to minimize construction costs, thereby allowing for accelerated project delivery and greater financial viability.

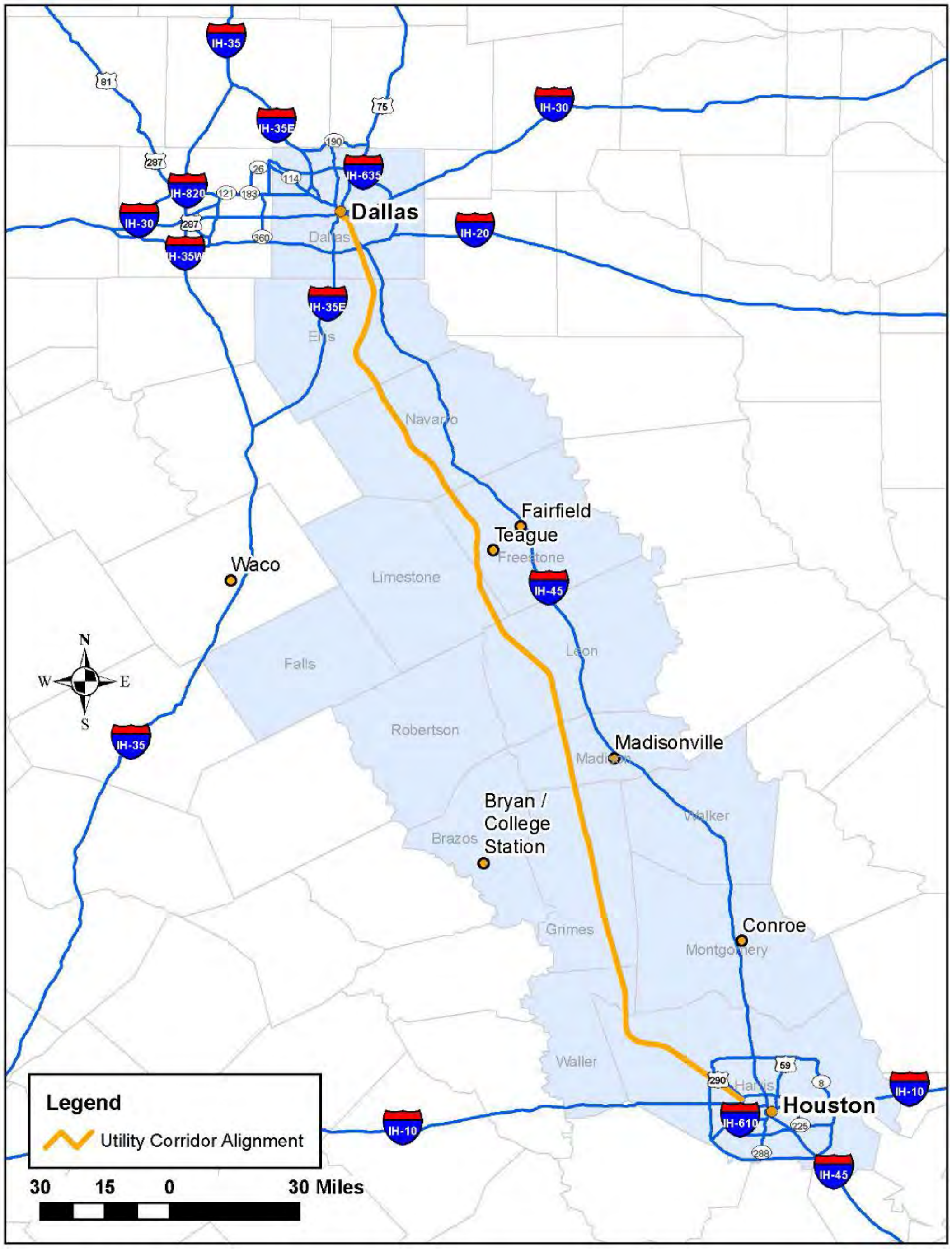


Figure 5 – Preferred Step 1 Screening Utility Corridor "Base Alignment"

Additionally, a *Last Mile Analysis* was undertaken to evaluate alternative terminus station locations within the Houston and Dallas markets to analyze the marginal benefits and impacts associated with reaching incrementally further into the urban core to access each station site. The Downtown Dallas Station and US 290/IH-610 Houston Station locations were found to be the only reasonable alternatives.

Based on these detailed analyses, the alignment used to define the Utility Corridor in the Step 1 Screening with terminus locations near the convention center in Downtown Dallas and near the US 290/IH-610 interchange in Houston, the Utility

Corridor Base Alignment, was defined as the "Base Alignment" for the purpose of the Step 2 Screening as documented in this Report and the baseline for comparative assessments of competing alternatives.

This progressively refined step-by-step alternatives analysis by TCR identified recommended HSR alignments linking Dallas and Houston for further study by the FRA through the NEPA process as shown in Figure 6. The four end-to-end alignment alternatives identified through this process and proposed for further study in this Step 2 Screening report were found to best meet the overall Project Purpose and Need. Through further environmental studies under the NEPA process, and further engineering development by TCR, it is expected that a preferred HSR alignment alternative that meets project goals and objectives, and minimizes environmental impact can be advanced.

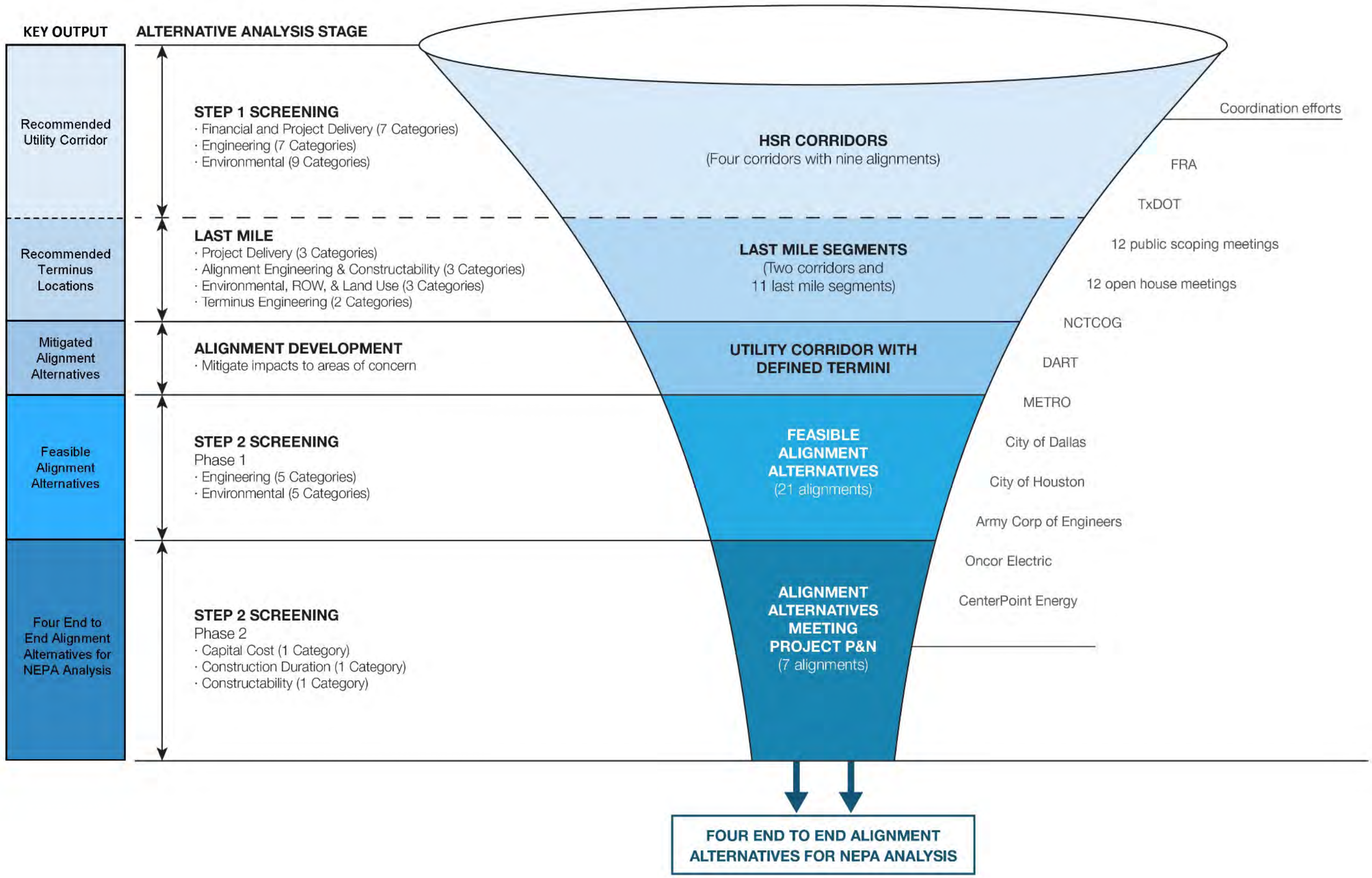


Figure 6 – Overall Analysis Process

2.2 Design Standards and Service Requirements

The general infrastructure requirements and system characteristics of the proposed HSR system and associated facilities are described in this section. Alignments developed for screening were designed to meet the design standards and service requirements outlined in this section.

2.2.1 Service Characteristics

The HSR alignment must satisfy the following key service characteristics:

- **Technological:** The HSR system must employ the train set and operating procedures based on the N700-I, the international version of the Tokaido Shinkansen. Each train set will seat approximately 400 passengers.
- **Operational:** The HSR alignment must be able to support operating speeds exceeding 200 mph in a fully sealed corridor. The preliminary operating schedule for service is planned to be 5:30am to 11:30pm with the peak periods occurring from 5:30am to 9:00am and from 4:00pm to 7:00pm.
- **Travel time goal:** Alignments must support a travel time goal of 90 minutes from Houston to Dallas, which was set in close coordination with ridership analyses.
- **Train volumes/frequencies:** The HSR alignment must support a minimum unimpeded (no increase in travel time due to congestion) capacity of 10 trains each direction per hour (6 minute headway).
- **Terminal Capacity:** Terminals must be configured to match the planned service volumes with some additional spare capacity for staging of trains. Terminals should be capable of future expansion to support additional throughput up to the practical line capacity and should support multimodal connectivity.

2.3 Alignment Objectives

Consistent with the purpose and need of this Project, alternative HSR alignments were developed to minimize impacts to the environment and to existing development. The primary objectives in development of alternative alignments were:

- Alignments must be configured as a dedicated, fully grade separated, two-track alignment to meet safety, service planning, and travel time goals. No shared use of track or connections to existing railroad network.
- Maximize co-location opportunities with transportation and utility corridors.
- Minimize relocation of any existing roadways or freight railroad tracks.
- Optimize the alignment to allow for the desired maximum operating speed and operational efficiency.
- Minimize the number of times the HSR tracks must cross existing freight tracks or major roadways.

- Minimize expected impacts of construction to traffic and freight operations.
- Minimize expected environmental impacts and constructability concerns.
- Minimize expected ROW and construction costs associated with heavy infrastructure requirements.
- Achieve both the travel time and economic objectives.

2.4 General Design Guidelines

In order to develop the conceptual alignments, general design guidelines were established based on engineering judgment and professional experience. The alignment design guidelines were largely limited to alignment curvature, profile gradient, and constructability considerations. The focus of the effort was also to avoid environmental impacts and constructability concerns by design. Conservative design guidelines were used to ensure that the results of the engineering, constructability and environmental reviews, operational analyses, travel time predictions, and construction feasibility assessments would remain valid during the more detailed planning and design at the later stages of Project development.

The general design guidelines used in developing the alignments analyzed in this report were as follows:

- **Maximum Operating Speed:** A desired maximum operating speed of 330 km/h (205 mph) was chosen to be consistent with N700-I technology. The alignment was designed to provide for maximum operating speeds throughout to the extent practical, but in some locations alignment curvature that would restrict speeds to minimize property and environmental impacts would be permitted.
- **Separation from Existing Freight Rail Lines:** The proposed HSR system would not operate on any existing freight rail lines. Safe separation of HSR operations from freight operations consistent with best practices would be required in areas where the proposed HSR crosses or runs adjacent to freight operations.
- **Alignment Curvature and Cant:** A desired minimum radius of 17,000 ft (5,200 m) was used for development of the preliminary alignments. Desired maximum cant (actual superelevation) was set at 7 in (175 mm) for project planning. This minimum radius curve would allow for operations at 205 mph (330 km/h) using the maximum cant (actual superelevation) of 7 in (175 mm).
- **Maximum Grade:** The desired maximum grade was set at 1.5%.
- **Special Trackwork:** All special trackwork designs would be based upon JRC standards.
- **Recommended Minimum Offset between HSR and Utility ROW:** A 50 m (165 ft) offset was established as the minimum separation distance from the centerline of the electrical transmission line corridor to the centerline of the HSR corridor.

2.4.1 General Civil Infrastructure Configuration

This section describes the general infrastructure configuration of the proposed HSR system. Site specific design at the appropriate level of detail would be developed during more advanced planning in support of the EIS.

2.4.1.1 Trackway

The proposed HSR system will typically consist of a two-track ROW with additional tracks added at stations, maintenance of way (MOW) facilities, and maintenance yards. The conceptual design was configured to be raised slightly above the surrounding grade when on an embankment, with elevated sections on viaducts as required to suit topography, to minimize environmental and property impacts, and to provide for grade-separated rail and road crossings. During more detailed design, the use of embankments and viaducts along the alignment will be optimized to balance earthwork, to minimize environmental and property impacts, and to address constructability concerns and capital cost requirements.

The typical ROW width for the two-track HSR system will vary based on site specific conditions, including the height of embankments, the provision of access roads, drainage swale requirements, wildlife crossing provisions, and other requirements. In general, the ROW width for viaduct sections could be as low as 70 ft and ROW width could be as much as 200 ft in areas where tall embankments with adjacent access roads to provide for maintenance and emergency response and drainage swales are required. It is expected that the entire ROW will be fenced except where elevated and that an access road would be provided along the HSR tracks to facilitate maintenance, inspection, and emergency access. The exact configuration to meet regulatory requirements and operating and maintenance needs will be developed through more detailed design, consideration of local conditions, close coordination with any adjoining freight railroad, roadway authority, or utility owner, and would require agreement with the FRA regarding risk mitigation requirements.

2.4.1.2 Separation Distance

Based upon JRC design standards and experience with the N700-I rolling stock technology, a desired minimum track separation of 15 ft 9 in between the two HSR track centers was selected to avoid overlapping vehicle dynamic envelopes of passing HSR trains. To accommodate a yet unidentified variety of embankment slope and drainage requirements, the distances from the ROW line to the centerline of the nearest HSR track is projected to be no less than approximately 30 ft. This results in a minimum ROW width of approximately 76 ft. This minimum ROW width does not consider secondary requirements such as access roads and drainage swales, which would be based upon location specific requirements.

Through review of the latest research and other HSR studies within freight rail corridors, the design established a minimum offset of 50 ft between the HSR line and the centerline of an adjacent freight track. This minimum distance would permit appropriate risk mitigations, such as barrier walls, between the two tracks.

Similar requirements would be identified by the Texas Department of Transportation (TxDOT) for alignments following a highway. In all cases, final alignment and structural design would require close coordination with affected stakeholders on a location-by-location basis.

2.4.1.3 Alignment Crossings

The analyzed HSR alignments cross a number of existing highways and roads, and in all cases the new HSR system will be fully grade separated from rail and roadway traffic. In some cases, it will be more cost-effective to carry the roadway over the HSR alignment rather than carry the railway over the roadway. In some cases raising the HSR alignment over the roadway will be the preferred option to minimize potential impacts. In general, it is assumed that the HSR tracks will cross over US Interstates, US Highways and State Highways, while Farm to Market (FM) Roads, County Roads, and local roads will cross over the HSR tracks. Where roads cross over the HSR ROW, suitable safety features will be constructed in order to minimize the possibility of intrusion onto the ROW. Some smaller local roads may be closed and traffic rerouted to an adjacent roadway. Each roadway crossing would be evaluated on a case-by-case basis during design to determine the roadway reconfiguration that would best minimize impacts.

Where the HSR alignment crosses existing freight lines, the freight lines would be fully grade separated from HSR operations. In all cases close coordination with freight rail operators would be undertaken to minimize any impacts. In some cases this may mean localized realignment of the freight line. It is expected that elevating roadways above HSR operations would also eliminate existing freight rail grade crossings in some locations, which would be a benefit to the affected community.

2.4.1.4 Structure Types

Many types of structures would be required, including HSR bridges, highway and roadway bridges, barrier walls, retaining walls, noise walls, and fences. The HSR bridges would primarily be viaducts to carry the high-speed trains over waterways, flood plains, freight railway crossings, and roadway crossings. Where the HSR alignment remains at-grade, road bridges would be used to carry streets and highways across the alignment in accordance with TxDOT standards.

The size and locations of noise walls, barrier walls, and retaining walls would be based on site constraints, design criteria, and impact mitigation requirements. Barrier walls or other risk mitigation measures would be required in locations where the distance between the HSR tracks and an adjacent freight track or highway lane is less than desired to minimize the risk of intrusion into the HSR ROW by a derailed freight train or roadway vehicle. Barrier walls would also be required in locations where the HSR tracks must pass close to existing structures due to site constraints in order to protect both the structure and the HSR train from the possibility of impact.

2.4.1.5 Rail Systems

All of the analyzed alignments would be constructed using the same system technology for traction power, communications, and signaling. As such, these system elements would not be a determining factor in comparative assessments of alignments, except that the costs for system elements would be higher for longer alignments.

2.4.1.6 Facilities Requirements

The HSR system would include various ancillary facilities to support operations and maintenance, including systems buildings and infrastructure, train storage yards and maintenance facilities, and smaller facilities located along the ROW to support routine maintenance of the ROW and systems. All of the analyzed alignments would require similar facilities; therefore, facilities requirements were not included in the comparative assessments of alignments during the alternatives screening process.

2.5 Step 2 Screening Overview

The purpose of the Step 2 Screening effort was to perform a comparative evaluation of competing alignment alternatives, including the Base Alignment. The goal was to identify a range of alignment alternatives that best met TCR's Project Purpose and Need, including financial viability. The analysis also sought to identify alignment alternatives with the least environmental impact. The resulting alignment alternatives are intended to serve as input to the FRA's environmental study and public coordination process. The preferred alignment alternatives resulting from the Step 2 Screening effort documented herein may then be revised as needed based upon the Draft EIS (DEIS) analyses to meet the Purpose and Need as defined by NEPA.

To best evaluate the alignment alternatives, a two-phase approach to the Step 2 Screening was established to quantifiably and qualitatively assess the alignment alternatives.

The Phase 1 effort analyzed each alignment alternative against the Project's Purpose and Need with respect to various engineering (technological and operational) and environmental criteria. Phase 1 employed a quantitative analysis of specific engineering and environmental data using Geographic Information Systems (GIS) tools and professional evaluation of alignment characteristics and existing conditions mapping along the alignment to comparatively rate each alternative. Rather than employing a weighted approach for all data obtained in the Phase 1 analysis, ten categories (five engineering and five environmental) were established using professional judgment to represent the key indicators of an alternative's ability to meet the Project's Purpose and Need.

Given that alternatives were developed with careful consideration of environmental, engineering, and project delivery concerns, all alternatives evaluated were considered feasible, and in most cases there was relatively small variation amongst alternatives within Alternative Groups with respect to the Phase 1 screening criteria. However, given the magnitude of the proposed 240 mile long HSR project, even slight variation in expected impacts and construction complexity can result in significant project costs, risks, and threaten project funding. As such, only the top two ranked alignment alternatives from the Phase 1 analysis were considered suitable for advancement to the Phase 2 analysis.

The Phase 2 analysis evaluated each alignment alternative's ability to meet the key delivery (economic, schedule, constructability) requirements of the Project's Purpose and Need. Phase 2 utilized a quantitative approach to rate alternatives based on construction cost and duration and a qualitative approach to rate alternatives based on constructability challenges. Constructability challenges are difficult to compare quantitatively; therefore, the Phase 2 comparison of alternatives was based on engineering judgment, corridor understanding, and professional judgment and experience with the delivery of passenger rail and heavy infrastructure projects.

Figure 7 provides an overview of the Step 2 Screening process and a roadmap to the analyses as documented in this report.

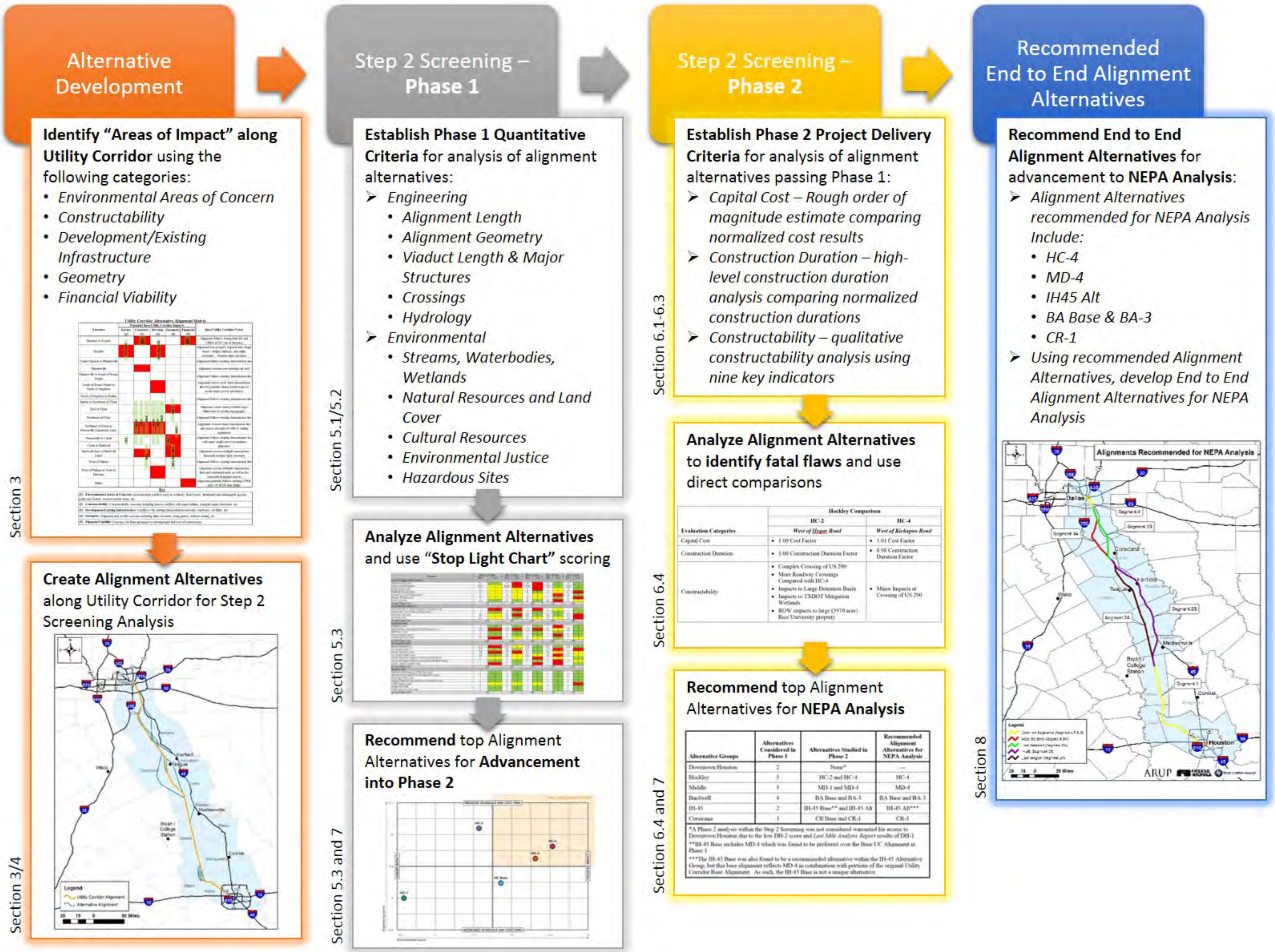


Figure 7 – Step 2 Screening of Alignment Alternatives Analysis Process and Approach

3 Alternative Development

The Utility Corridor was reviewed using the data collected in the *Step 1 Screening* to identify environmental constraints along the corridor as shown in Figure 8.

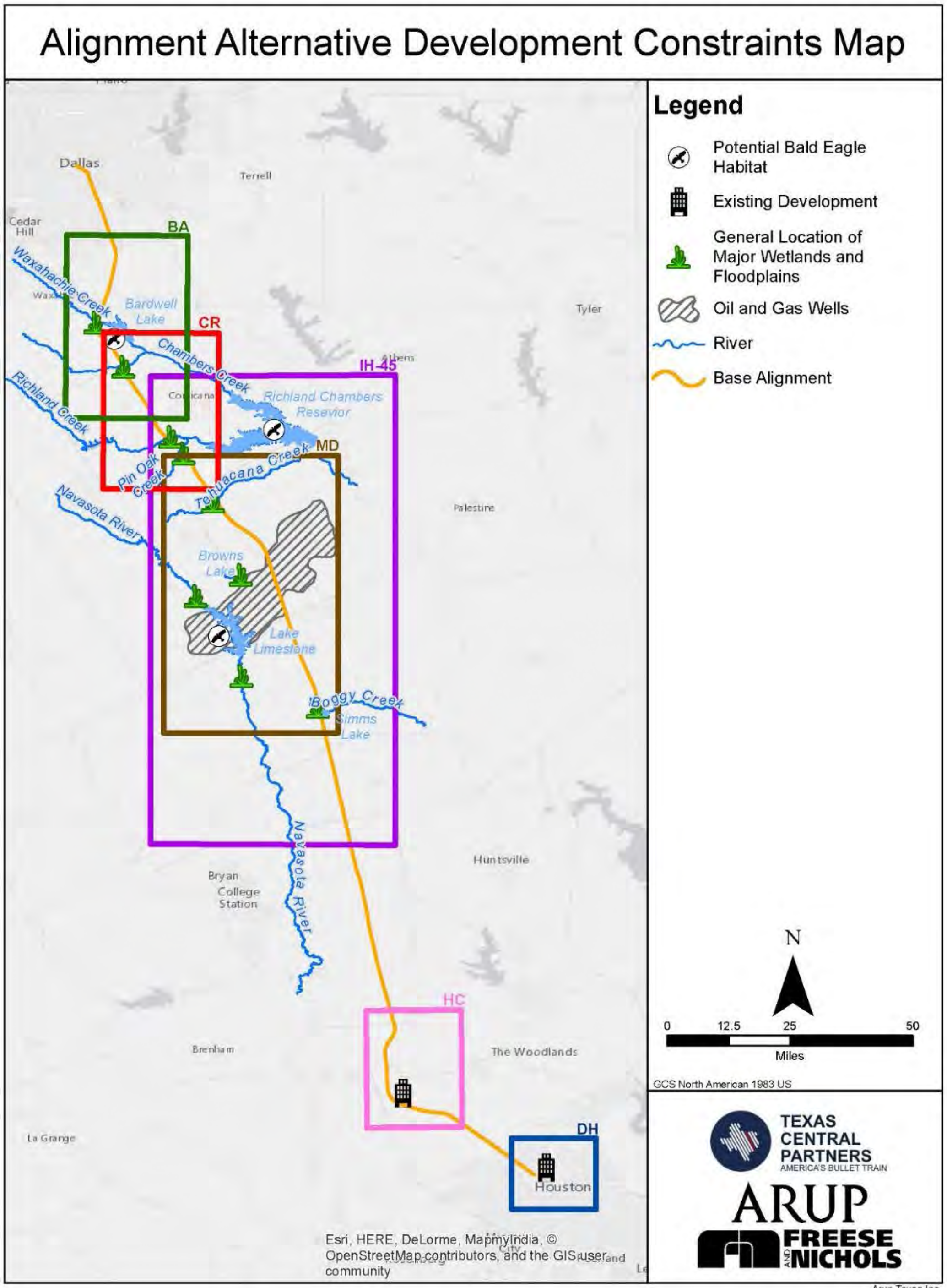


Figure 8 – Utility Corridor Alignment Alternative Development Constraints Map

Additionally, the Utility Corridor Base Alignment was reviewed to identify specific areas of significant environmental impact or construction complexity. The Utility Corridor Alternative Alignment Matrix shown in Figure 9 was developed to highlight in red the areas of environmental concern, construction complexity, geometric challenges, economic impact, or other major concern along the Base Alignment that should be addressed by an alternative alignment. These red impact areas were used to focus the development of alignment alternatives. The geographic limits of the alternative alignments developed to address these concerns are shown in green bars based on the geographic location and category of impact they attempt to mitigate. As shown, the alternatives developed cover the Base Alignment segments where impacts or concerns were identified.

Utility Corridor Alignment Alternative Matrix

Location	Potential Base Utility Corridor Impacts					Base Utility Corridor Notes
	Enviro. (1)	Construct. (2)	Develop. (3)	Geometry (4)	Financial (5)	
Downtown Houston to IH-610/ US 290 Interchange		DH1, DH2			DH1, DH2	Alignment extends into Downtown Houston - has property, highway and freight impacts
IH-610/ US 290 Interchange to Cypress						Alignment follows Hempstead Rd and UPRR ROW out of Houston
Cypress to Todd Mission (Including Hockley)	HC3,HC4		HC1,HC2,HC4			Alignment has property impacts near Hegar Road - freight, highway, and utility crossings - requires tight curvature
Todds Mission to Southeast of Flynn						Alignment follows existing transmission line
East of Flynn				MD1		Alignment could cause possible slope failure due to existing topography
Northeast of Flynn						Alignment follows existing transmission line
Northeast of Flynn to Personville (Limestone Lake)		IH-45, MD3, MD4	IH-45, MD3, MD4	MD2		Alignment crosses major transmission line and passes through oil wells & mining operations
Personville to Currie	CR1			CR2		Alignment follows existing transmission line with many small curves to maintain adjacency
Currie to Bardwell						
Bardwell (East of Bardwell Lake)		BA3		BA1, BA2, BA3		Alignment crosses multiple transmission lines and requires tight curvature
North of Bardwell to West of Ferris						Alignment follows existing transmission line
West of Ferris to Downtown Dallas						Alignment generally follows existing UPRR and I-45 ROW into Dallas

Key

(1) - Environmental Areas of Concern: Environmental conflicts such as wetlands, flood zones, threatened and endangered species, parks and forests, socioeconomic areas, etc.
(2) - Constructability: Constructability concerns including known conflicts with major utilities, complex major structures, etc.
(3) - Development/Existing Infrastructure: Conflicts with existing transportation networks, roadways, oil fields, etc.
(4) - Geometry: Alignment and profile concerns including tight curvature, steep grades, indirect routing, etc.
(5) - Financial Viability: Concerns for financial impact to development and cost of construction.

Legend:

X	Design issue along alignment
XX	Alternative alignment (XX)

Figure 9 – Utility Corridor Alignment Alternative Matrix

Each area of impact was reviewed and alignment alternatives were developed to mitigate the identified impact within that local area (See Appendix A). These new HSR alignment alternatives deviated from the Base Alignment as needed to avoid the identified environmental impact, to improve constructability, to reduce conflicts with existing development, to improve alignment geometry, or to improve financial viability. This approach was intended to ensure that a sufficient range of alignment alternatives were studied to address all major impacts identified. However, through the review process, it became clear that not all impacts could be mitigated through alignment alternatives. For example, some areas of the Base Alignment, the identified impact spans a large area (e.g., transmission lines) or an alignment shift would result in even greater impacts (e.g., adjusting the alignment to improve alignment geometry would have extensive residential impacts).

In addition to review of constraints within the Utility Corridor and impacts and concerns identified along the Base Alignment, significant stakeholder and community engagement was undertaken by TCR to drive the alternative development effort. As shown in Figure 6, stakeholder engagement is considered by TCR to be a parallel effort to alternatives development and analysis. Over the last several years TCR has meet with various regulatory bodies, transit agencies, and governing bodies. In addition, TCR participated in FRA led Public Scoping meetings and held its own Public Open Houses to listen to the affected communities and property owners along the corridor. These outreach efforts directly led to the study of two key alternatives within the Step 2 Screening, Downtown Houston Alternative 2 following IH-10 to downtown and the IH-45 Alternative (IH-45 Alt).

During the alignment alternative establishment process, 16 alignment alternatives were developed based on the “System Description” and “Planning Approach for Alternative Development in addition to the Base Utility Corridor” sections in the *Step 1 Screening of Alternatives Report* to mitigate the identified impacts along the Base Utility Corridor. Table 2 below identifies the 16 alignment alternatives (in addition to the Base Utility Corridor) and summarizes the general impact the alignment alternative was created to address.

Table 2 – Alignment Alternatives Developed and Potential Base UC Impact Mitigated

Alignment Alternative Name	Reason for Alignment Alternative Development
Downtown Houston Alternative 1 (DH-1)	• Extension Downtown (Follows UPRR ROW)
Downtown Houston Alternative 2 (DH-2)	• Extension Downtown (Follows IH-10 ROW)
Hockley Alternative 1 (HC-1)	• Follows utility ROW
Hockley Alternative 2 (HC-2)	• Minimizes property impacts
Hockley Alternative 3 (HC-3)	• Minimizes floodplain and property impacts
Hockley Alternative 4 (HC-4)	• Follows pipeline ROW • Minimizes floodplain and property impacts
Middle Alternative 1 (MD-1)	• Avoids impacts to Simms Lake
Middle Alternative 2 (MD-2)	• Improves track geometry • Avoids impacts to Browns Lake
Middle Alternative 3 (MD-3)	• Follows pipeline ROW • Minimizes impacts to oil and gas wells
Middle Alternative 4 (MD-4)	• Minimizes impacts to oil and gas wells
IH-45 Alternative (IH-45 Alt)	• Follows IH-45 ROW • Minimizes impacts to oil and gas wells
Bardwell Alternative 1 (BA-1)	• Improves track geometry
Bardwell Alternative 2 (BA-2)	• Improves track geometry
Bardwell Alternative 3 (BA-3)	• Minimizes impacts to residential area • Removes impacts on Bardwell Lake
Corsicana Alternative 1 (CR-1)	• Reduces floodplain impacts
Corsicana Alternative 2 (CR-2)	• Improves track geometry

For the purposes of a comparative assessment, the alignment alternatives were grouped into six separate geographic analysis areas (referred to as “Alternative Groups”), with common start and end points established along the Base Alignment to allow for a consistent analysis of all alignment alternatives within each geographic area as shown in Figure 10. (For more detail see Appendix A, Figure A-1).

The following sections describe each alignment alternative in additional detail and the corresponding portion of the Base Alignment utilized for comparative purposes for the six Alternative Groups in the Step 2 Screening analysis. Appendix A includes figures for all alignment alternatives evaluated in Phase 1 and the six Alternative Groups.

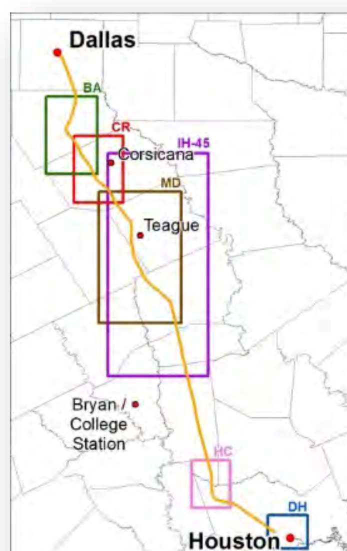


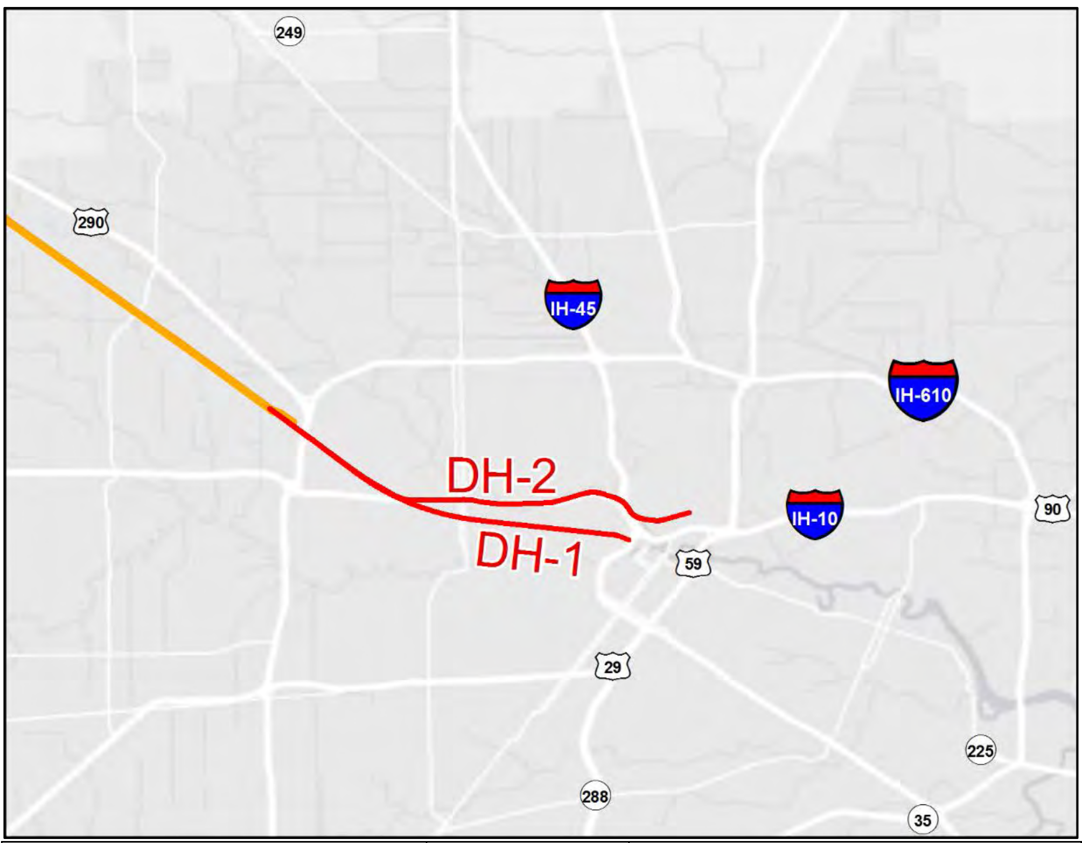
Figure 10 – Six Alternative Groups

4 Alignment Descriptions

4.1 Downtown Houston

For the purposes of this report, the Downtown Houston area, as defined for the Step 2 Screening analysis, begins southwest of the US 290 and IH-610 interchange.

Based upon the findings of the Last Mile Analysis, the Base Utility Corridor Alignment would terminate near Loop 610 along Hempstead Road. However, based on comments received during the FRA's Scoping process for the Project EIS and through TCR's own Public Open House meetings along the corridor, and based on a request from the City of Houston to study alignments serving downtown, alignment alternatives to Downtown Houston were studied in the Step 2 Screening as described in this section.



Name	Abbreviation	Description
Downtown Houston Alternative 1	DH-1	Downtown Amtrak
Downtown Houston Alternative 2	DH-2	Downtown IH-10

Figure 11 – Downtown Houston Alignment Alternatives

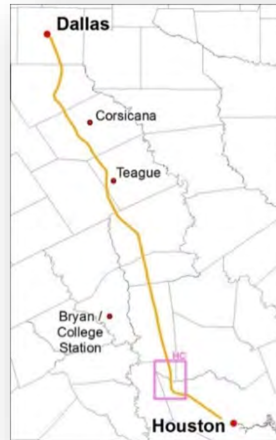
4.1.1 Downtown Houston Alternative 1 (DH-1) – *Downtown Amtrak*

Extending from the Base Alignment, the DH-1 alignment alternative continues southeast between the UPRR ROW and Hempstead Road and continues past Loop 610 (See Appendix A, Figure A-2). The alignment crosses over IH-610 and the existing UPRR freight line. DH-1 follows the freight line before crossing over IH-10 and curving east towards Downtown Houston. The proposed alignment continues east along the south side of the UPRR ROW and terminates near the existing Amtrak station. The DH-1 alternative alignment is the same alignment studied in the Last Mile Analysis, which was found to be financially infeasible given the high level of expected impacts and major constructability concerns.

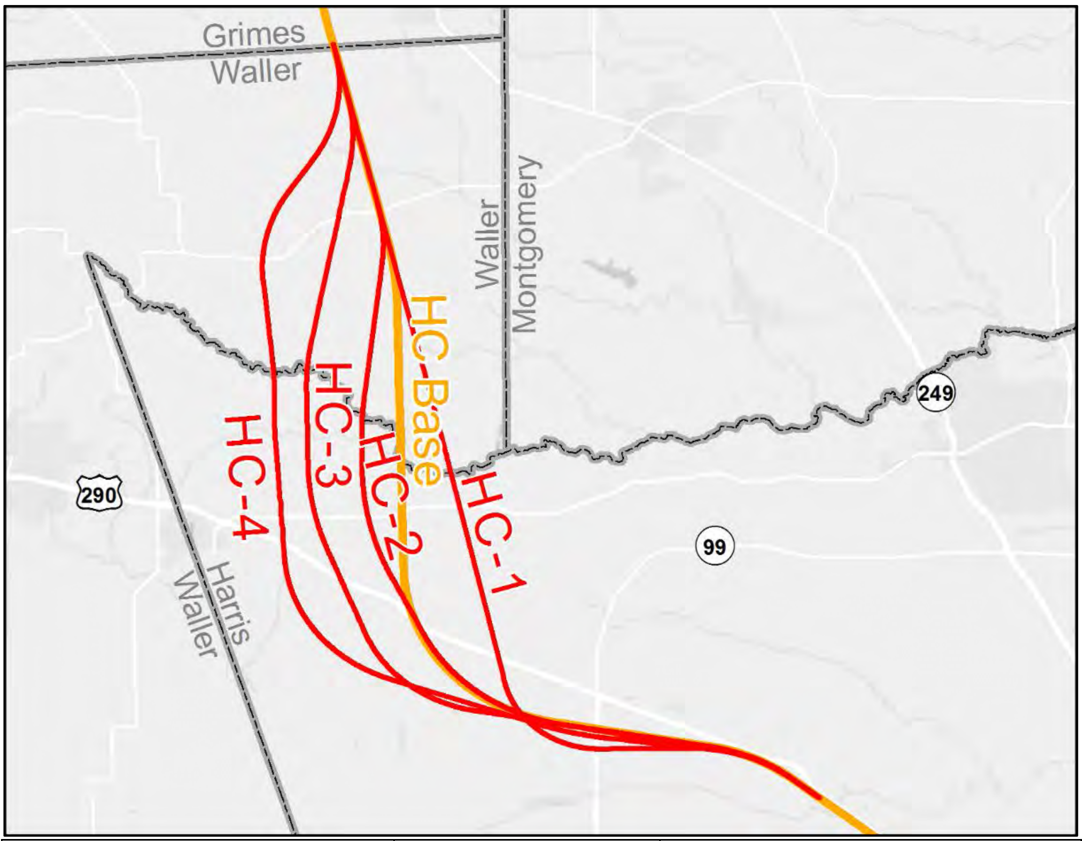
4.1.2 Downtown Houston Alternative 2 (DH-2) – *Downtown IH-10*

Extending from the Base Alignment, the DH-2 alignment alternative continues southeast between the UPRR ROW and Hempstead Road, crosses over IH-610, and follows along the north side of the existing freight line (See Appendix A, Figure A-3). DH-2 then curves east to align with the median of IH-10. At Studemont Street the alignment turns north from the median to follow the north side of IH-10 ROW. The proposed route crosses over IH-45 entrance and exit ramps, before curving east to pass over the White Oak Bayou and terminate at the Hardy Yards site. The alignment to Downtown Houston via IH-10 studied as DH-2 was initially proposed by the City of Houston through TCR's stakeholder engagement efforts.

4.2 Hockley



The Hockley area begins west of Cypress in Harris County and ends to the west of Todd Mission in Grimes County. From the start of this Alternative Group in Cypress, all options bear west to cross over SH 99 and generally follow the CenterPoint Energy electrical transmission line headed north towards Dallas. The Hockley Alternative Group evaluates alternative crossings of SH 99 and alignment alternatives through Harris and Waller counties before aligning along the east side of the electrical transmission line. The alignment alternatives all converge near Todd Mission. Four alternatives were developed to address the potential impacts to floodplain crossings, existing communities, and tight curvature.



Name	Abbreviation	Description
Hockley Base	HC Base	Hegar Road
Hockley Alternative 1	HC-1	East of Hegar Road
Hockley Alternative 2	HC-2	West of Hegar Road
Hockley Alternative 3	HC-3	Kickapoo Road
Hockley Alternative 4	HC-4	West of Kickapoo Road

Figure 12 – Hockley Alignment Alternatives

4.2.1 Hockley Base (HC Base) – *Hegar Road*

The Base Alignment within the Hockley Alternative Group begins near the town of Cypress and curves west to cross both SH 99 and the CenterPoint Electrical Transmission lines. The alignment then curves north to the east of Hockley and crosses over US 290 before following on the west side of Hegar Road. The Base Alignment continues north along Hegar Road before crossing to the east side of the existing utility line. The alignment continues heading north following the east side of the existing utility line and passing to the west of Todd Mission.

4.2.2 Hockley Alternative 1 (HC-1) – *East of Hegar Road*

The HC-1 alignment alternative was introduced to maximize the length adjacent to the utility line through the Hockley area (See Appendix A, Figure A-4). West of SH 99, the alignment turns north to parallel the existing electrical transmission line along the eastern side. This alternative parallels the existing utility line, crossing over US 290 and ending to the west of Todd Mission.

4.2.3 Hockley Alternative 2 (HC-2) – *West of Hegar Road*

The HC-2 alignment alternative begins near the town of Cypress and curves west crossing both SH 99 and the existing CenterPoint transmission line (See Appendix A, Figure A-5). After the alignment crosses SH 99 and the existing utility line, it curves north to the east of Hockley and crosses over US 290. HC-2 continues north generally following property boundaries north of Kermier Road. The alignment curves northeast and crosses to the east side of the CenterPoint electrical transmission line. The alignment continues north following the east side of the existing electrical transmission line and ends just west of Todd Mission.

4.2.4 Hockley Alternative 3 (HC-3) – *Kickapoo Road*

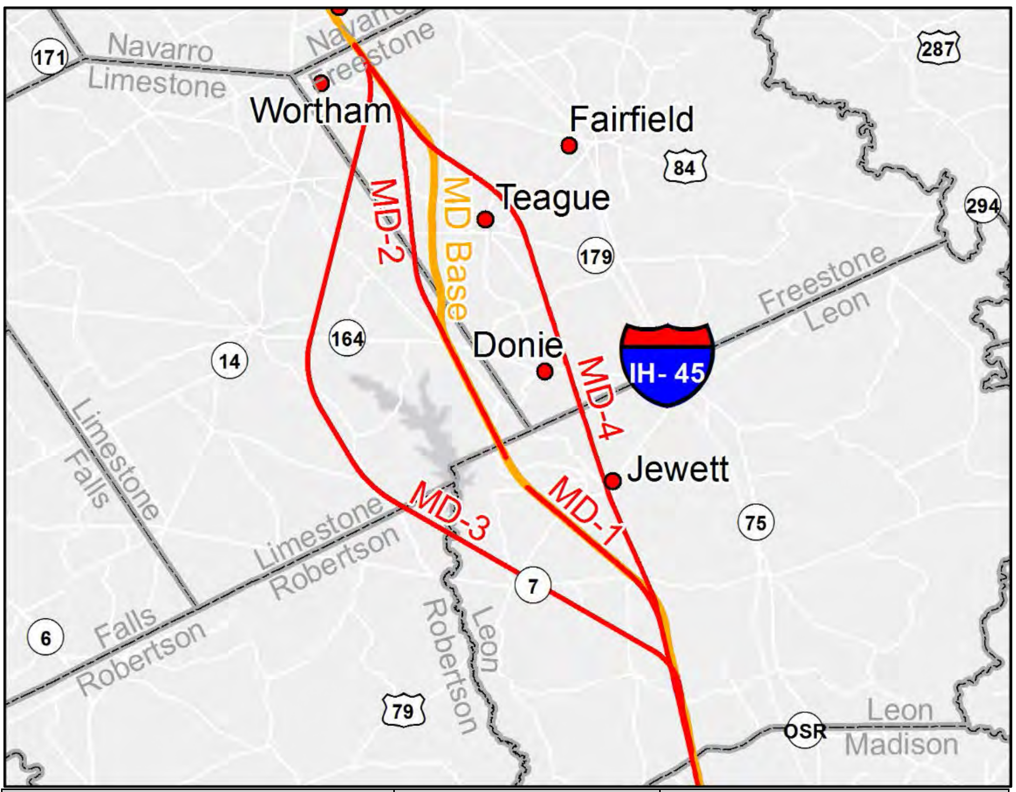
The HC-3 alignment alternative begins near the town of Cypress and curves west, crossing both SH 99 and the existing electrical transmission line (See Appendix A, Figure A-6). It then curves north to the west of Hockley and crosses over US 290. Continuing north, it runs parallel to Kickapoo Road before curving northeast towards the existing electrical transmission line. The alignment then crosses to the east side of the existing electrical transmission line and follows the utility line north before ending west of Todd Mission.

4.2.5 Hockley Alternative 4 (HC-4) – *West of Kickapoo Road*

The HC-4 alignment alternative begins near the town of Cypress and curves west crossing both SH 99 and the existing electrical transmission line (See Appendix A, Figure A-7). It then continues west before curving to the north just before Binford Road, approximately 3.3 miles west of Hockley and crosses over US 290. HC-4 then continues north parallel to an existing underground pipeline before curving northeast towards the existing electrical transmission line. The alignment continues heading northeast and crosses to the east side of the existing electrical transmission line before ending west of Todd Mission.

4.3 Middle

The Middle Alternative Group begins at the Grimes/Madison county line and continues north until it ends at the Freestone/Navarro county line. North of the Hockley Curve area, all alternatives merge and closely follow the existing CenterPoint electrical transmission line along either its east or west side to the vicinity of Jewett. There are no alternatives through this area given that no significant issues were identified following the transmission line. Near Jewett several electrical transmission lines converge, there are major electrical facilities at grade, and there are several towns and developments. As such, the HSR system would need to separate from the electrical line to minimize impacts to existing critical utility infrastructure. Hence, multiple alignment alternatives deviating from the existing utility line were studied from just south of Jewett to approximately the Freestone/Navarro county line. The four Middle alignment alternatives developed present options to pass these electrical facilities, towns, and developments.



Name	Abbreviation	Description
Middle Base	MD Base	East of Utility Corridor
Middle Alternative 1	MD-1	West of Utility Corridor
Middle Alternative 2	MD-2	West of Browns Lake
Middle Alternative 3	MD-3	West of Lake Limestone
Middle Alternative 4	MD-4	East of Teague

Figure 13 – Middle Alignment Alternatives

4.3.1 Middle Base (MD Base) – *East of Utility Corridor*

From the Grimes/Madison county line, the Base Alignment continues north on the east side of the electrical transmission line. Ten miles south of Jewett, the alignment separates from the electrical line to pass through the dense oil and gas well fields west of Donie and east of Lake Limestone. Continuing north out of the oil and gas fields the alignment would realign with the electrical transmission line ROW south of Teague. The proposed route would curve to pass along the east side of Browns Lake and remain adjacent to the utility to the Freestone/Navarro county line.

The Base Alignment would generally follow the utility line with the exception of bypassing west of Donie, through the oil and gas fields. In this area the proposed route strives to maximize the length adjacent to the utility line while minimizing impacts to the oil and gas fields.

4.3.2 Middle Alternative 1 (MD-1) – *West of Utility Corridor*

The MD-1 alignment alternative begins west of Cottonwood where it breaks from the Base Alignment to cross over to the west side of the electrical utility (See Appendix A, Figure A-8). MD-1 would continue to parallel the utility on the west side until it reconnects with the Base Alignment where it crosses the utility line ten miles south of Jewett. This alternative focuses on studying an alignment on the west rather than the east side of the existing electrical transmission line through this area.

4.3.3 Middle Alternative 2 (MD-2) – *West of Browns Lake*

The MD-2 alignment alternative would follow the Base Alignment until north of the oil and gas fields where it diverges from the base alignment to pass west around Browns Lake (See Appendix A, Figure A-9). This alternative evaluates a more direct alignment geometry rather than following the electrical transmission line as it makes multiple turns between Jewett and Wortham. The alignment reconnects with Base Alignment east of Wortham.

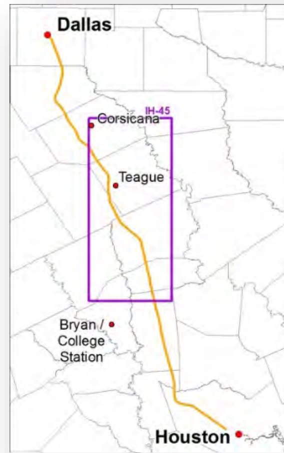
4.3.4 Middle Alternative 3 (MD-3) – *West of Lake Limestone*

The MD-3 alignment alternative follows the Base Alignment until it crosses the electrical transmission line approximately half a mile south of Simms Lake (See Appendix A, Figure A-10). This alignment alternative studies a route west around Lake Limestone toward Groesbeck to mitigate issues associated with passing through the dense oil and gas well fields, and to avoid passing through the mining sites north of Jewett. After the alternative passes west of Lake Limestone it rejoins the Base Alignment near Wortham.

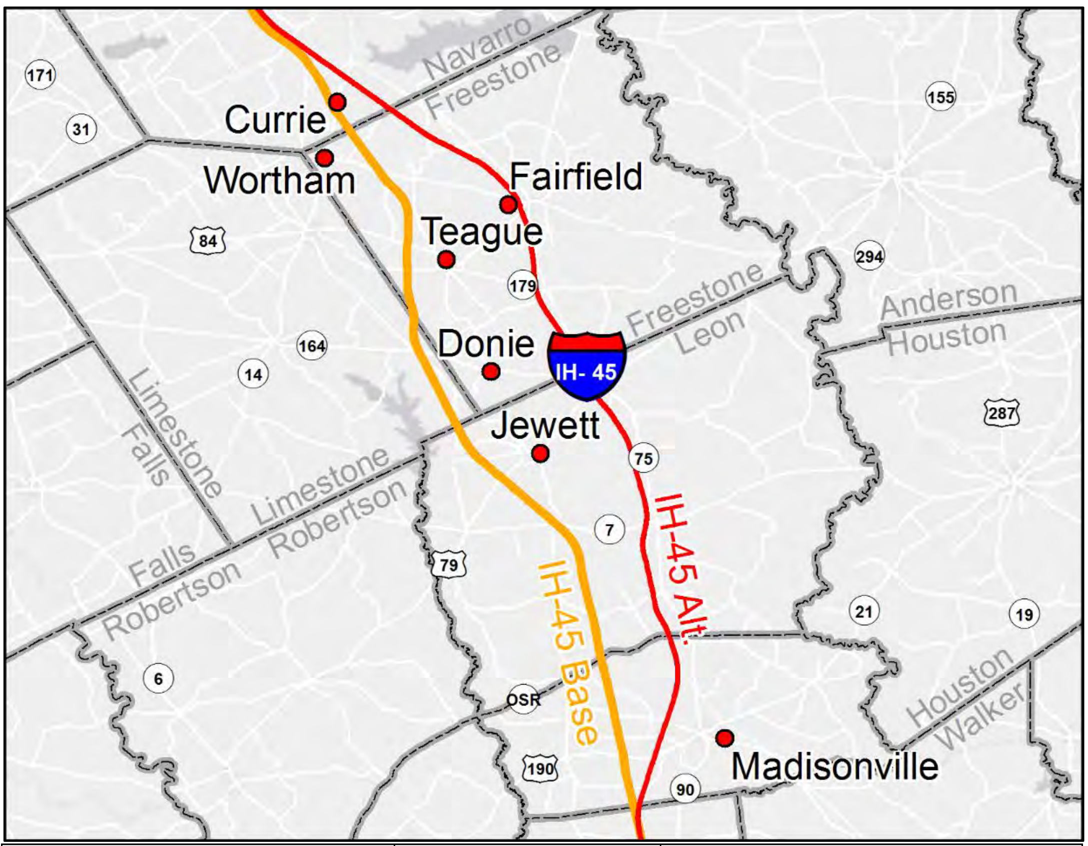
4.3.5 Middle Alternative 4 (MD-4) – *East of Teague*

The MD-4 alignment alternative begins west of Cottonwood where it breaks from the Base Alignment to cross over to the west side of the electrical transmission line (See Appendix A, Figure A-11). MD-4 would continue to parallel the electrical utility along the west side until south of Concord. MD-4 continues towards the town of Jewett. After passing west of Jewett, the alignment continues north through the oil and gas fields near Donie. Past the oil and gas fields, the alignment curves around the north side of Teague to reconnect to the Base Alignment.

4.4 IH-45



The Interstate Highway 45 (IH-45) corridor was an alternative corridor studied during the *Step 1 Screening of Alternatives Report* effort. It was determined to be an undesirable alternative for multiple reasons, namely the tight curvature required to follow the highway ROW, impacts that would occur near developed areas along the highway, and expected constructability concerns associated with construction adjacent to an active highway. Although the IH-45 corridor alternative was eliminated by the Step 1 Screening process, use of the IH-45 corridor was reconsidered in the Step 2 Screening because of the numerous comments received through the stakeholder and public engagement efforts regarding its use. The reintroduction of IH-45 allowed the Step 2 Screening effort to evaluate potential opportunities to eliminate risks associated with construction through dense gas well fields and former mining areas and to minimize private property impacts.



Name	Abbreviation	Description
IH-45 Base	IH-45 Base	Utility Corridor
IH-45 Alternative	IH-45 Alt	IH-45

Figure 14 – IH-45 Alignment Alternatives

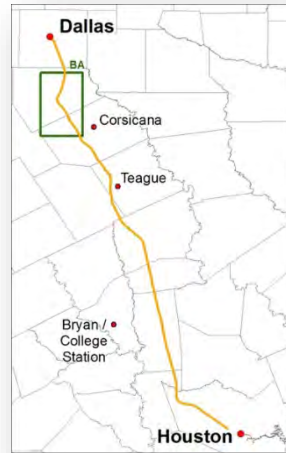
4.4.1 IH-45 Base – *Utility Corridor*

The Base Alignment within the IH-45 Alternative Group begins north of Bedias and follows the electrical transmission line north. Just south of Concord, the Base Alignment separates from the utility line ROW to pass through oil and gas fields west of Donie and east of Lake Limestone. Continuing north out of the oil and gas fields, the alignment realigns with the electrical utility ROW to continue north to Dallas.

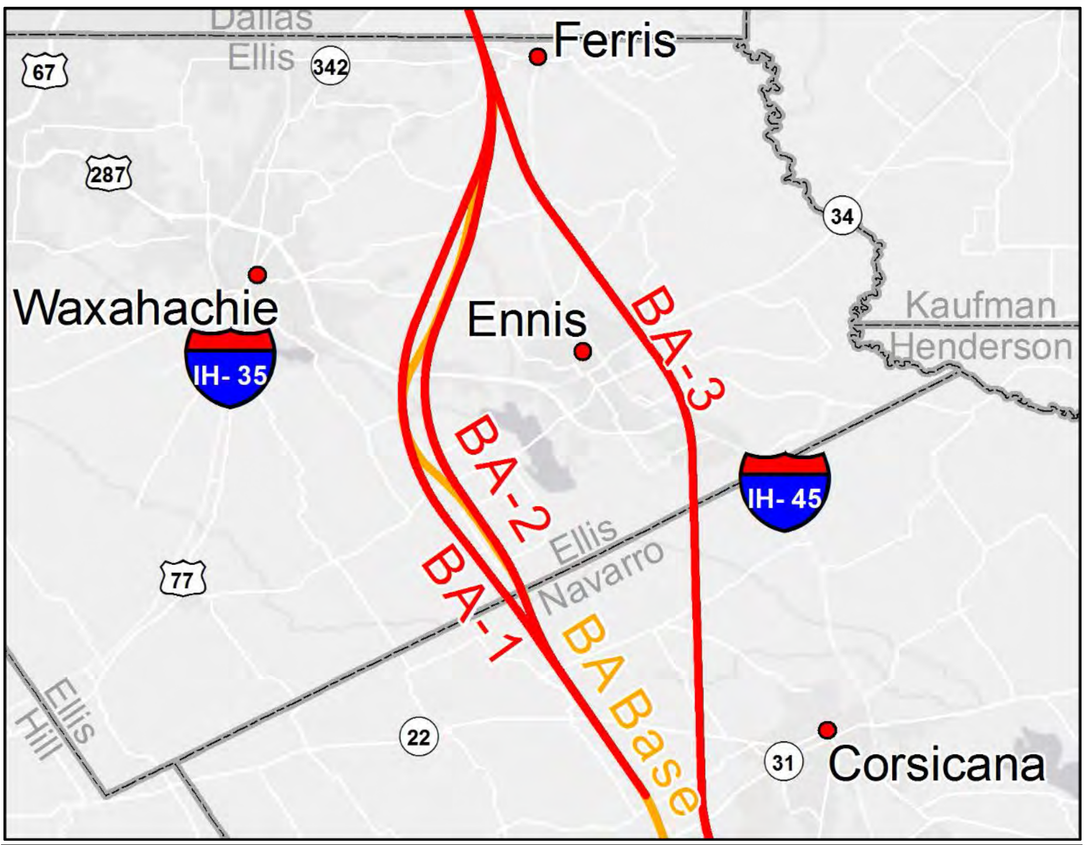
4.4.2 IH-45 Alternative – *IH-45*

The IH-45 Alt alignment alternative would follow the Base Alignment until it separates just north of Bedias (See Appendix A, Figure A-12). At this point the alignment alternative runs northeast and aligns with the IH-45 corridor. The alignment would follow the IH-45 corridor from north of Madisonville to six miles past Fairfield before rejoining the Base Alignment.

4.5 Bardwell



The Bardwell Alternative Group sits within Freestone, Navarro, and Ellis counties between Wortham and Ferris. In this segment of the corridor the alignment has multiple curves as it follows the existing electrical transmission line, which makes sharp turns in direction. Given the need to follow HSR alignment design criteria with high radius curves, the Base Alignment is often removed from the electrical transmission line. Three alternatives were developed to improve the geometric design and avoid environmentally sensitive areas. Two of these alternatives pass to the west of Bardwell Lake, and one passes to the east.



Name	Abbreviation	Description
Bardwell Base	BA Base	West Utility Corridor
Bardwell Alternative 1	BA-1	Far West Utility Corridor
Bardwell Alternative 2	BA-2	West of Bardwell Lake
Bardwell Alternative 3	BA-3	East of Ennis

Figure 15 – Bardwell Alignment Alternatives

4.5.1 Bardwell Base (BA Base) – *West of Utility Corridor*

The Base Alignment within the Bardwell Alternative Group begins near Wortham on the western side of the Utility Corridor. Running north, it closely follows the electrical utility ROW, requiring multiple curves. The horizontal offset (distance between the Utility Corridor and rail alignment) near Purdon was increased to reduce areas where the alignment would run parallel to streams. The alignment continues alongside the Utility Corridor, curving northeast at Bardwell around Bardwell Lake and multiple utility lines. At Palmer, the alignment deviates from the utility line and curves to pass west of Ferris and avoid properties in Red Oak. In this segment, the Base Alignment maximizes the length adjacent to the utility line corridor; however, due to frequent turns in the electrical transmission line the Base Alignment would have numerous curves with speed restrictions.

4.5.2 Bardwell Alternative 1 (BA-1) – *Far West of Utility Corridor*

The BA-1 alignment alternative follows the Base Alignment north until Barry (See Appendix A, Figure A-13). While the Base Alignment has multiple curves to stay adjacent to the utility line, the BA-1 alignment alternative employs a more direct route to curve west of Bardwell Lake, staying north and west of the electrical transmission line, and rejoins the Base Alignment north of Palmer.

4.5.3 Bardwell Alternative 2 (BA-2) – *West of Bardwell Lake*

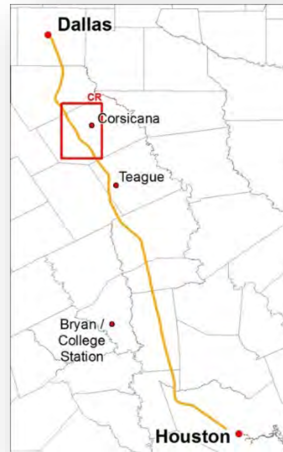
The BA-2 alignment alternative follows the Base Alignment until Rankin (See Appendix A, Figure A-14). It then crosses the electrical transmission line near Rankin to follow along its eastern side. The alignment curves northeast at Bardwell to avoid multiple utility lines, but stays west of Bardwell Lake. The route would continue on the eastern side of the Utility Corridor until Ferris where it would curve to rejoin the Base Alignment.

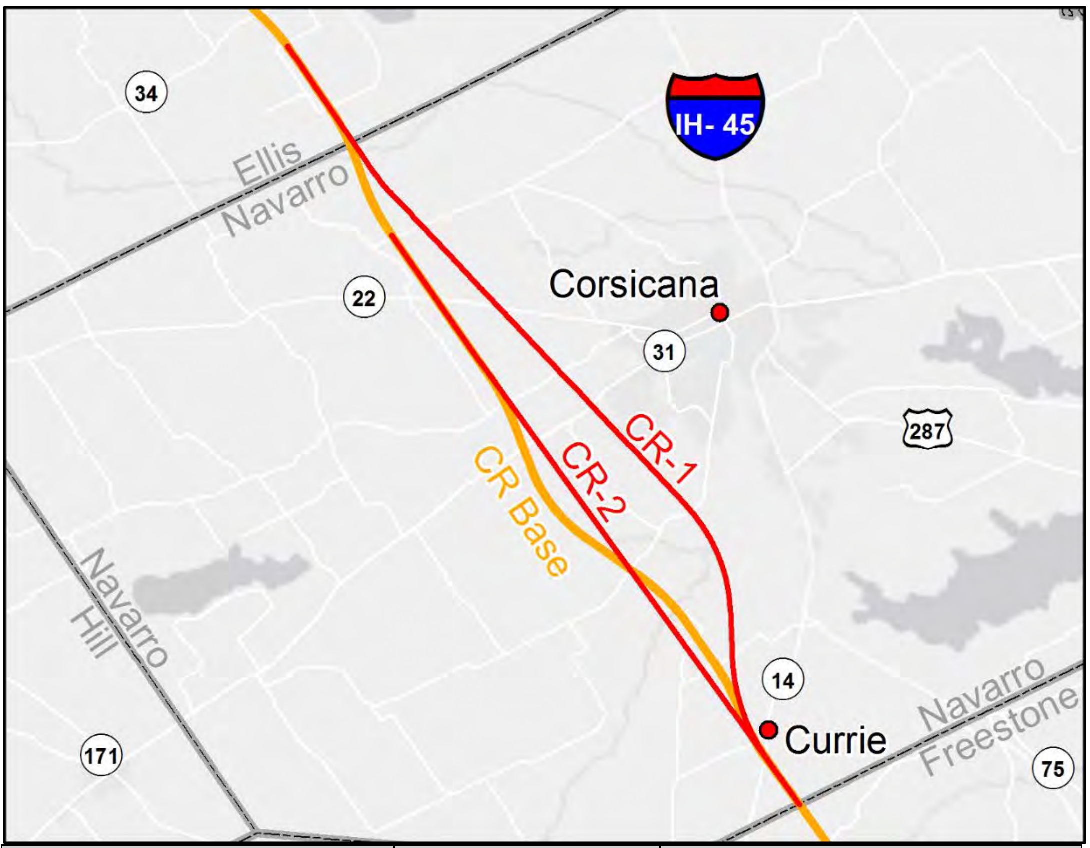
4.5.4 Bardwell Alternative 3 (BA-3) – *East of Ennis*

The BA-3 alignment alternative provides a long greenfield alignment to the east of Bardwell Lake and Ennis (See Appendix A, Figure A-15). The alignment would diverge from the Base Alignment, crossing the electrical transmission line northeast of Pursley. The alignment passes east of Oak Valley, crossing IH-45 between Ennis and Alma. At Ennis, the alignment curves northwest, passing east of Palmer, to rejoin the Base Alignment near Ferris.

4.6 Corsicana

The Corsicana Alternative Group is within Freestone, Navarro, and Ellis counties and extends between approximately Wortham and Rankin. In this section of the Base Alignment, there are geometric concerns as well as environmentally sensitive areas and large floodplains. As in the Bardwell geographic area, in this segment of the corridor the alignment has multiple curves as it follows the existing electrical transmission line, which makes sharp turns in direction. Given the need to follow HSR alignment design criteria with high radius curves, the Base Alignment is often removed from the electrical transmission line. Two alternatives were developed to address the potential impacts identified.





Name	Abbreviation	Description
Corsicana Base	CR Base	West of Utility Corridor
Corsicana Alternative 1	CR-1	Oak Valley
Corsicana Alternative 2	CR-2	Central Utility Corridor

Figure 16 – Corsicana Alignment Alternatives

4.6.1 Corsicana Base (CR Base) – *West of Utility Corridor*

The Base Alignment through the Corsicana Alternative Group starts on the western side of the utility corridor near Wortham, at the same location as the BA Base. Running north, the CR Base alignment alternative follows the transmission lines on the western side passing east of Oak Valley and West of Blooming Grove. Multiple curves are required to maintain adjacency to the transmission lines.

4.6.2 Corsicana Alternative 1 (CR-1) – *Oak Valley*

The CR-1 alignment alternative matches the Base Alignment until Currie where it curves northeast crossing the electrical utility ROW (See Appendix A, Figure A-16). The alignment crosses the floodplain at a narrow section just north of Richland, and curves northwest. The alignment passes south of Oak Valley and northeast of Barry crossing the Utility Corridor and rejoining the Base Alignment at Rankin.

4.6.3 Corsicana Alternative 2 (CR-2) – *Central Utility Corridor*

The CR-2 alignment alternative follows the Base Alignment until Currie (See Appendix A, Figure A-17). Instead of curving to follow the Utility Corridor, the tangent extends across the electrical utility ROW north of Pursley and rejoins the Base Alignment south of Barry.

5 Phase 1 Analysis

The Phase 1 analysis method was developed to quantitatively evaluate the various alignment alternatives considered using a Geographic Information Systems (GIS) based analysis of environmental areas of concern and engineering considerations. In each Alternative Group, all alignment alternatives were developed to a sufficient and consistent level of conceptual engineering and planning detail to enable this comparative assessment of competing alignments. The Phase 1 analysis was intended to (1) identify those alignments that should be advanced to the Phase 2 analysis because they meet the engineering and environmental requirements of the Project's Purpose and Need, and (2) eliminate from consideration those alignments that do not meet the engineering and environmental requirements of the Project's Purpose and Need. The alignment alternatives in each Alternative Group that meet the engineering and environmental requirements were then passed to a Phase 2 analysis to evaluate project delivery requirements of the Project's Purpose and Need.

Evaluation categories were selected for the Phase 1 analysis that covered a broad range of quantifiable engineering and environmental data as described in this section. Engineering judgment, corridor understanding, and prior experience with passenger rail and heavy infrastructure projects were used in establishing the list of categories and data sets for inclusion within each category.

5.1 Evaluation Method

A broad array of both quantitative and qualitative evaluation criteria were considered in the Phase 1 comparison of alignment alternatives covering engineering, hydrology, and environmental considerations. Evaluation Criteria were grouped into Engineering and Environmental Considerations and categorized into Evaluation Categories. Based on the results of the analysis, a "stoplight chart" value of red, yellow, or green was assigned for each category of criteria for each alignment alternative. Numeric values of 1, 2, and 3 were also used to represent the red, yellow, and green values, respectively. A score of 1 (red) indicates an alternative rated poorly, while a score of 3 (green) indicates it scored well. An overall rating was made for each alternative within each Evaluation Category as described in the section below. The evaluation method accounts for variability in the relative importance of potential evaluation criteria and focuses on criteria that are most relevant to the reasonableness of the alternatives.

The "stoplight chart" approach was used to be consistent with the alternative corridor screening evaluations documented in the *Step 1 Screening of Alternatives Report* and the termini alternatives evaluation documented in the *Last Mile Analysis Report*. This is standard practice when the multiple criteria cannot readily be summed without a complicated weighting strategy.

The Evaluation Categories of Evaluation Criteria used in the comparative analysis of competing alignment alternatives are outlined in the following section.

5.2 Evaluation Criteria

The categories of Evaluation Criteria selected for the Phase 1 comparative assessments are identified below. Key considerations used in the evaluation of each alignment alternative are provided, along with general guidelines for how the alternatives were scored with respect to that category. Engineering and environmental data used to establish the numeric ratings for each category can be found in Appendix B.

5.2.1 Evaluation Group A: Engineering Considerations

This Evaluation Group contains categories of Evaluation Criteria that constitute the major infrastructure elements of the Project or that directly affect the design or construction complexity of these elements. Increasing complexity or magnitude of infrastructure requirements would translate directly to extended delivery schedules and increased Project costs. Given the magnitude of the proposed Project, even slight variations in engineering complexity would translate to significant additional capital cost and risk. Numeric values were assigned based on the data included in Appendix B to ensure that factors were not unduly weighted in the overall assessment.

The measured Evaluation Criteria for each alignment alternative were scored relative to the other alignment alternatives within each Alternative Group. Scoring thresholds were established as either a percentage deviation from the measured average, or as a count of each instance. A detailed explanation of the analysis method used is described in each of the categories below.

5.2.1.1 Alignment Length

The length of each alignment alternative is a key metric that has cost, schedule, and travel time implications. The length of each alignment alternative and the length adjacent to the existing utility line were the two data points included in this category.

<u>Alignment Length</u>: The total length of the alignment alternative measured in miles from common points established within each Alternative Group and compared to the Base Alignment alternative. The common start point for a particular Alternative Group was defined as the southernmost location where any alignment alternative deviates from the Base Alignment alternative. Similarly the common end point is the northernmost location within an Alternative Group where an alignment alternative joins the Base Alignment. Each additional mile (especially when diverging from the electrical utility ROW) would likely result in additional cost and additional property impacts. A shorter alignment results in reduced travel time and less infrastructure maintenance. It can be assumed that a shorter alignment length would require purchase of less ROW and that the construction duration would be shorter. The rating for this evaluation criterion was 1, 2, or 3 based on the alignment length compared to other alignment alternatives in the same Alternative Group. Given that all alignment alternatives in a given Alternative Group start and end at common points along the Base Alignment, the variation in alignment length was minimal. At the expected cost per mile of a HSR system, a 5% deviation from the Alternative Group average was considered a meaningful variation between

alternatives for the purposes of scoring. Hence, an alignment within 5% of the Alternative Group average length was given a score of 2. A score of 1 or 3 respectively was given if the alignment length was 5% longer or shorter than the Alternative Group average.

Length adjacent to the existing utility line: Alignment alternatives adjacent to or generally following the high-voltage electrical transmission line were expected to have fewer property impacts, fewer environment impacts, and reduced property rights acquisition costs and risks. More adjacency scored better given that it achieved the goal of adjacency to the existing transmission line. The measured length adjacent to the existing electrical utility ROW varied significantly within an Alternative Group. An alignment within 15% of the Alternative Group average was given a score of 2. A score of 1 or 3 respectively was given if the adjacent length was 15% shorter or longer than the Alternative Group average.

5.2.1.2 Alignment Geometry

Each alignment alternative was analyzed to compare the key geometry metrics. The data sets included in this category were number of curves, speed restrictions due to geometry, and maximum applied superelevation. Curves with tighter radii and higher superelevation would be more difficult to construct, would require more maintenance, and could affect operating schedules due to speed restrictions depending on the location of the curves. Generally speaking, even if alignment curves meet the required geometry to support high speed operations, simpler geometry is better; fewer curves generally translate to shorter alignment length, less complex structures, less wear on the track, simplified maintenance, a smoother ride, and reduced noise.

Superelevation: The maximum applied superelevation on any curve of the alignment alternative. Where a maximum of five inches of superelevation was required on any curve the alignment was given a score of 3. Alignments with superelevation values between five and six inches scored a 2 as an upper limit of reasonable values. Alignments with superelevation in excess of six inches were given a score of 1.

Total number of curves: The number of bearing changes of the alignment. A 20% deviation from the Alternative Group average was determined to allow for the low number of curves tallied. An alignment within 20% of the Alternative Group average scored a 2, while a score of 1 or 3 respectively was given if the alternative had 20% more or fewer curves than the Alternative Group average.

Curves with speed restrictions: Curves that would not permit operations at the design speed. A score of 3 was given for alignments with no speed-restricting curves. A score of 1 was given for one or more speed restricting curves.

5.2.1.3 Viaduct Length and Major Structures

It is important to note that the shortest route is not always the preferred alignment. High viaduct bridges are more expensive to construct than low embankment sections and pose greater safety, constructability, and engineering challenges; therefore, the length of each type of typical infrastructure section was also compared. Additionally, large and/or complex structures for crossing major highways and interchanges, rivers, rail lines, reservoirs, and other major physical barriers were analyzed for vertical clearance, possible viaduct pier locations, maximum allowable span length, depth of viaduct bridge thickness, and constructability. The greater the number, size, height, and complexity of the major structures associated with any alignment alternative, the greater the costs and impacts on construction duration and constructability. The evaluation criteria were rated 1, 2, or 3 depending on relative viaduct length and the variation of number and complexity of major structures for each alignment alternative in the same Alternative Group.

<u>Total viaduct length</u>: The viaduct lengths for each alignment alternative measured from concept vertical alignments developed. The start and end of each structure was measured between the points where the vertical alignment exceeds 25 feet above ground level. Fewer miles of viaduct scored better in the evaluation. Given that the cost of an alternative would vary significantly with only a relatively small increase or decrease in viaduct length, a 5% deviation from the Alternative Group average was used. An alignment within 5% of the Alternative Group average scored 2. A score of 1 or 3 respectively was given if the length of viaduct was 5% longer or shorter than the Alternative Group average.

<u>Complex structures</u>: Complex structures were defined for the analysis as significant deviations from standard viaduct structure lengths or heights, or constrained locations where the cumulative effect of adjacent constraints would introduce complexities to the construction or delivery schedule of the works. Highly skewed crossings of the alignment over a major highway or railroad would increase the span length, requiring a more complex structural solution. Low skew angle crossings that pass over multiple adjacent constraints (such as a major highway adjacent to a railroad) would require careful staging, scheduling, and traffic mitigation measures. Alternatives with fewer complex structures scored better in the evaluation. A score of 3 was given to alternatives with zero complex structures. Scores of 2 and 1 respectively were given for alternatives with one or more complex structures. While the variation in the number of complex structures between competing alternatives was small, each additional complex structure would translate to significant additional construction cost, design complexity, schedule risk, and increased permitting and third-party coordination requirements.

5.2.1.4 Crossings

The major and minor crossings of utilities, railways, and roadways were quantified. Roadway crossings do not require a major structure, but would require road closure or re-profiling of the road above the HSR line to separate roadway traffic from HSR operations. Railway crossings would require a HSR viaduct structure to separate existing railway operations from HSR operations. Utility crossings would potentially require the modification of utility lines or structures to carry railroad loading outside the influence line of the utility. Alignment alternatives with fewer crossings would be more desirable due to reduced cost, construction duration, maintenance, and third-party coordination. The evaluation criteria was rated 1, 2, or 3 depending on the number of crossings compared to the alignment alternatives in the same Alternative Group.

Major road crossings: The number of major highway crossings. Major roads were defined as Interstate Highways, U.S. Highways or larger State Highways. Each crossing would likely add significant costs to the Project; accordingly, alternatives with fewer crossings scored better in the evaluation. A score of 3 was given to alternatives with zero major road crossings. Scores of 2 and 1 were respectively given for alternatives with one or more crossings.

Moderate road crossings: The number of moderate sized roadway crossings, defined as most State Highways and some large county roads. The cost of grade separating a moderate sized road would be less significant than a major road in evaluating the alignment alternatives. A 10% deviation from the Alternative Group average scored 2. A score of 1 or 3 respectively was given if the alternative had 10% more or fewer crossings than the Alternative Group average.

Minor road crossings: The number of minor road crossings, defined as local roads and most county roads. The cost of grade separating or diverting a minor road would be less significant than a moderate road crossing in evaluating the alignment alternatives. A 15% deviation from the Alternative Group average scored 2. A score of 1 or 3 respectively was given if the alternative had 15% more or fewer crossings than the Alternative Group average.

Freight crossings: The number of locations where the proposed alignment crosses over an existing freight railroad track. There are few instances of these crossings, but each instance would require careful coordination with the operating freight railroad and present significant additional schedule risk. As such, a score of 3 was given to alternatives with zero railroad crossings. Scores of 2 and 1 were respectively given for alternatives with one or more crossings.

Utility crossings: The number of utility line crossings. Each crossing would potentially require the utility line to be horizontally or vertically realigned, or would require unique treatment of the HSR infrastructure. The cost and construction schedule of each crossing would vary depending on the length of realignment, the number of transmission towers impacted, and whether additional ROW would be required. A 10% deviation from the Alternative Group average allowed for differentiation of alternatives based on counts for each alternative. An alignment within 10% of the Alternative Group average was given a score of 2. A score of 1 or 3 respectively was given if the alternative had 15% more or fewer crossings than the Alternative Group average.

5.2.1.5 Hydrology

All of the identified alignment alternatives would not only require crossing numerous utilities, railways, and roadways, but also major and minor drainage features in the Brazos, Trinity, and San Jacinto river basins. The crossings of these major hydrologic drainage features varied among the alignments, depending on the crossing location within the watershed. As such, drainage crossing requirements were estimated for each of the alignment alternatives after crossings of major streams, confluences, and wide floodplain areas were minimized as much as feasible through an iterative approach to alignment development.

The goal of the hydrology analysis for alternatives screening was to assess the larger watershed-wide drainage features that each alignment would encounter. In order to provide hydrologic input to the screening of a larger number of alternatives ahead of performing more detailed analysis, representative proxies were found for the expected drainage feature accommodations and impacts for each alternative. Several sources of readily available input data from the Federal Emergency Management Agency (FEMA) and the United States Geological Survey (USGS) were used to make the hydrology assessment.

In order to evaluate and compare alignment alternatives, a set of hydrology criteria was used to quantify potential significance associated with stream and floodplain crossings which could have an impact on the design and construction of each alternative. The hydrology criteria were organized into two major classifications, or "tiers", based on the anticipated significance of the crossing, and each tier utilized unique data to define potential hydrologic features. Each tier was further broken down into two classifications in order to further refine significance of drainage features along alignment alternatives.

Tier 1 Hydrologic Features – FEMA Crossings

The first classification of hydrologic features, Tier 1 crossings, included any FEMA inventoried stream crossing that may be subject to FEMA regulations regarding floodplain and/or floodway impacts and permitting. Crossings of these Special Flood Hazard Areas (SFHA) would require permits from FEMA. Alignments would typically be required to minimize any fill within the floodplain. Detailed design would be required to assess any potential impacts to regulatory flood elevations.

The Tier 1 classification was broken into two categories, 1A and 1B, to provide additional detail on the significance of the anticipated crossing. Tier 1A crossings include FEMA studied streams where a hydraulic analysis has been performed to produce Base Flood Elevations (BFE) and detailed floodplain extents (Zone AE).

Tier 1B crossings do not have an available detailed hydraulic analysis through previous study efforts, and the 100-year (1% AEP) floodplain extents (Zone A) were determined through approximations. These approximations served as a good representation of likely floodplain limits, which would likely require viaduct construction to minimize floodplain impacts.

Data utilized for the Tier 1 classification consisted of National Flood Hazard Layer (NFHL) GIS data, which is maintained by FEMA. The NFHL data incorporates all Flood Insurance Rate Map (FIRM) databases published by the FEMA, and any Letters of Map Revision (LOMRs) that have been issued against those databases since their publication date. FEMA data dated January 2015 was utilized for this assessment.

The FIRM databases depict flood risk information and supporting data used to develop the risk data. The primary risk classifications used are the 1-percent-annual-chance flood event, the 0.2-percent-annual-chance flood event, and areas of minimal flood risk. The FIRM databases are derived from Flood Insurance Studies (FISs), previously published FIRMs, flood hazard analyses performed in support of the FISs and FIRMs, and new mapping data, where available. Where the NFHL data was not available, it was supplemented with FEMA Q3 data, a previously created product produced by FEMA to digitize FIRMs.

For the purposes of this analysis, the NFHL and Q3 data provides a good representation of regulatory areas which may require additional infrastructure to avoid impacts, and where additional coordination with local municipalities, counties, and FEMA will likely be required.

Tier 2 Hydrologic Features – Other Crossings

The Tier 2 crossings include all other crossings that were identified using the USGS National Hydrography Dataset (NHD) and were not included within FEMA inventories at the time of the assessment. These crossings may or may not be subject to the more stringent FEMA permitting requirements that Tier 1 crossings fall under; however, some of these crossings would likely fall under them.

The Tier 2 classification was broken into two categories, 2A and 2B, to provide additional detail on the significance of the anticipated crossing. Within this Tier 2 classification, the Tier 2A crossings are those which were identified as a potentially large crossing and would likely require bridge spans or bridge class culverts.

Tier 2B crossings were identified as those less significant drainage features which alignment alternatives would cross. These crossings would likely be accommodated through smaller cross-drainage infrastructure such as culverts, or possibly through capture and conveyance within ROW ditches to larger crossings. In some cases, these smaller crossings represent drainage features which are within the floodplain associated with a larger stream. In these instances, the smaller crossing would most likely be accommodated through the span identified for the larger stream's floodplain.

While available FEMA data generally provides a better representation of flood risk and potential significance of hydrologic crossings by the railway alignment, the FEMA data may only exist for larger streams and does not cover all of the alignments alternatives. The NHD data was used to supplement the FEMA data and help define the Tier 2 classification of hydrologic drainage features. The NHD represents the drainage network with features such as rivers, streams, canals, and other smaller hydrologic features, which may not be inventoried and mapped by FEMA.

The NHD is based on USGS 1:24,000-scale printed topographic maps and represents a stream network collected using stereo imagery, which is also field checked.

Analysis Method

To gauge the hydrologic impacts associated with each alignment alternative, the analysis considers several drainage characteristics that would be encountered by alignment alternatives. For each alternative, these included total number of stream crossings, stream length within the alternative, floodplain length along the alignment, and floodplain area within the alternative.

The total number of stream crossings was determined by intersecting the FEMA and NHD base data with each alignment alternative and determining the total number of unique crossings. The total floodplain length was calculated by intersecting FEMA floodplains with each alignment alternative and determining the total length of floodplain that may need to be spanned.

The stream length and floodplain area within the alternative were assessed to provide a proxy of impacts within a buffered area of the alignment centerline, corresponding to the 350-foot buffer used in the environmental analysis. This analysis allowed for the identification of potential impacts that would be associated with a construction operation for a project of this scale, which could potentially impact hydrologic features within a wider area beyond the footprint of defined typical embankment sections for construction access roads and other ancillary works.

Each of these hydrologic impact characteristics were further broken down by category, including FEMA studied streams and floodplains, FEMA approximate floodplains for unstudied streams, major streams (non-regulatory by FEMA), and minor streams. Each category was given a weighting factor in order to differentiate between the levels of significance of each crossing.

The total impacts for each hydrologic characteristic were totaled and a score was given based on the weighting factors. Scores were then normalized for each alternative by determining where the estimated impact for any particular alternative fell relative to a one standard deviation of the average score. Alternatives for which the scores were higher than one standard deviation above the average were given a score of 1 (indicating greatest expected impact to hydrologic features). Alternatives with scores less than minus one standard deviation of the average were given a score of 3 (indicating least expected impacts to hydrologic features). Scores within one standard deviation of the average were given a score of 2 (indicating moderate expected impacts to hydrologic features).

All of the normalized scores for each hydrologic characteristic criteria were averaged to produce a final score for each alternative.

5.2.2 Evaluation Group B: Environmental Considerations

To help evaluate and compare alignment alternatives, a set of environmental evaluation criteria was developed to quantify potential impacts resulting from each alignment alternative to environmental, community, and natural resources. The environmental criteria were organized into five categories relevant to the NEPA process and regulatory authorities with anticipated Project involvement (e.g., United States Army Corps of Engineers, United States Fish and Wildlife Service): Streams, Waterbodies, and Wetlands; Natural Resources and Land Cover; Cultural Resources; Environmental Justice; and Hazardous Sites. Readily available public GIS datasets were the primary source of information used for the environmental analysis presented in the report.

The environmental analysis of each alternative included a two-step technical screening process. The first step involved a best professional judgment review of the alignment corridor informed by professional expertise, knowledge of existing conditions, and aerial photography to identify potential environmental areas of concern that might otherwise be missed by software analysis. A summary table listing all areas of concern identified for all alignments is included in Appendix D.

The second step of the environmental screening analysis included using a spatial GIS model comprised of publicly available GIS datasets accessed from federal, state, local, and private entities, which correspond to the environmental criteria categories referenced above. The model established a 350-foot-wide buffer (175 feet on each side of the alignment alternative centerline) along the length of the each alignment between the common analysis end points for each Alternative Group. The 350-foot buffer width was established in and continued from previous studies (See *Step 1 Screening of Alternatives Report*).

The GIS model recorded a "hit" or data point each time the buffer intersected with a dataset. This process was repeated for all datasets and alignment alternatives. Depending on the type of dataset (point, line, or polygon), one or multiple data points were collected from each dataset. This information was then summed or counted based on the unit of measure appropriate for each particular dataset (i.e., feet, acres, percent, or count) and recorded in tabular format (See Appendix B). ESRI® ArcGIS software was used to analyze all datasets.

Raw data from the GIS model for each dataset was organized by parameter and grouped for each environmental criteria category. This information was then tabulated by Alternative Groups. The raw data for each parameter (i.e., feet, acres, percent, or count) were scored from 1 to 3. Parameters with no data points or "hits" (data value = 0) were assigned a 3. The alternative with the highest raw data score (greatest impact) for each specific parameter was scored a 1, while the alternative with the lowest raw data score (least impact) for each parameter was scored a 3. The remaining alternatives for each parameter with intermediate scores were assigned a value of 2. Ties were considered to be present for alternatives in any parameter whose raw data values did not differ more than 5% from highest or lowest score. Tied alternatives were given the same score. Any value that was tied with the highest and lowest score was assigned a 2. Lower scores are associated with greater environmental impacts.

All the scores for each parameter within each category were averaged to produce a final score for each alignment alternative in each category. The resulting averaged values ranged from 1.00 - 3.00. These values were input into the final Phase 1 Table for the environmental analysis and summary tables for Alternative Groups. Appendix B contains a complete list of raw data and calculated values presented in this report.

Given the overall scale of the Project, even slight variations in the overall environmental score could present significant additional stakeholder concerns, permitting requirements, regulatory approval risks, and mitigation costs. Additionally, impact to certain individual environmental constraints could present such risks that while they may not make the alternative fatally flawed, they could make project delivery impractical. Any environmental constraint which could render project delivery impracticable was identified using professional judgment, and called out prior to scoring. These constraints, in combination with the quantitative GIS model data, were considered in the overall evaluation of feasibility for each alternative, and professional judgment was used in the selection of those advanced to Phase 2.

5.2.2.1 Streams, Waterbodies, Wetlands

This evaluation category includes streams, wetlands, and waterbodies (impoundments) that could be regulated by the U.S. Army Corps of Engineers (USACE) under Section 404 of the Clean Water Act or Section 10 of the Rivers and

Harbors Act. The USACE would require compensatory mitigation for unavoidable impacts to streams, wetlands, and waterbodies associated with each alternative and would evaluate these impacts in deciding whether the Least Environmentally Damaging Practicable Alternative (LEDPA) was chosen.

The Streams, Wetlands, and Waterbodies category includes datasets commonly used to identify potential waters of the U.S. that would be regulated by the USACE. Specifically, streams and waterbodies derived from the USGS National Hydrography Dataset (NHD), FEMA mapped streams, and wetland boundaries derived from the U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI). In addition, Natural Resources Conservation Service (NRCS) soils data were used to identify hydric soils, which commonly support wetland habitats and are a factor in wetland delineations performed in accordance with USACE methods. Individual scoring parameters are further explained below.

- Stream Crossings – count and linear feet of NHD streams.
- Parallel Streams – linear feet of NHD streams that run parallel to the alignment for a distance of greater than 300 feet. A smaller 100-foot-wide buffer (50 feet to either side of the alignment) was used to identify stream segments parallel to the alignment centerline. Parallel stream segments would likely require realignment or channelization, which is generally viewed unfavorably by the USACE and would likely require mitigation.
- Waterbody Crossings – acres of NHD ponds, impoundments, or reservoirs.
- Forested/Scrub Shrub Wetlands – acres of NWI forested/scrub shrub wetlands.
- Emergent Wetlands – acres of NWI emergent wetlands.
- Hydric Soils – acres of NRCS hydric soils. The hydric soils data set was included as a supplement to the NWI dataset to help capture areas with potential wetland habitat.

5.2.2.2 Natural Resources and Land Cover

This evaluation category includes potentially protected or high value lands, habitats, and cover types that could trigger additional consideration under NEPA and/or additional regulatory agency coordination or permitting. Examples could be state or federally owned lands, or lands reported to contain federally listed threatened or endangered species or their habitats.

The Natural Resources and Land Cover category includes datasets commonly used to identify protected lands, including threatened or endangered species habitat and occurrence data, property boundaries for federal, state, and local parklands, as well as cover type data for farmland and developed areas. Specific datasets used in the model include USFWS critical habitat and federal wildlife refuge boundaries, Texas Parks and Wildlife Department (TPWD) element occurrence reports and wildlife management areas, Texas Natural Resources Information System (TNRIS) boundaries for state and local parks, U.S. Forest Service (USFS) administrative boundaries for National Forests and Grasslands, USACE mitigation bank point locations, U.S. Department of Agriculture (USDA) prime farm land soils, and the National Land Cover Dataset (NLCD) cover types for developed areas. Individual scoring parameters are further explained below.

- Federal and State Threatened and Endangered (T & E) Species Element Occurrence Areas – acres of TPWD reported element occurrence areas for federally listed threatened or endangered species;
- National, State, County, and City Parks and Forests – acres of federal, state, county, and municipal parklands, federal wildlife refuges, TPWD wildlife management areas, and USACE mitigation banks (reported as a count when present).
- Prime Farmland – acres of USDA prime farm land soil map units.
- Developed Land – acres of NLCD developed cover types including high, medium, and low intensity.

5.2.2.3 Cultural Resources

This evaluation category includes documented cultural resource sites, including archaeological sites, historical structures, and cemeteries, recorded by the Texas Historical Commission (THC) at the time of this report and areas with a high probability of containing cultural resource sites. An impact to any one of these sites could require coordination with the State Historic Preservation Officer and/or consultation under Section 106 of the National Historic Preservation Act, as well as require investigation that could delay Project development.

The Cultural Resources category includes datasets commonly used to identify previously recorded archaeological sites and cemeteries. Specifically, a review of the archaeological records available on the THC Texas Archaeological Sites Atlas (TASA) was conducted between December 2014 and March 2015 to determine if any previously recorded archaeological sites or historic properties listed in the National Register of Historic Places (NRHP), State Antiquities Landmarks (SAL), and Recorded Texas Historic Landmarks (RTHL) were located within or adjacent to the buffer area. Cemeteries data were obtained from the THC. Individual scoring parameters are further explained below.

- Cemeteries – count of THC registered cemeteries.
- High Probability Areas for Archaeological/Cultural Resources – acres of high probability areas for potential archaeological sites based on professional judgment regarding major streams, upland terraces, previously documented archaeological sites, historic aerials, and USGS topographic maps, and geologic formations along each alignment alternative.
- NRHP Sites – count of NRHP structures and historic districts.
- Historical Markers – count of THC Historical Markers.
- Archaeological Sites – count of previously recorded archaeological sites (linear, polygons, and site centroids). A GIS 100’ radius buffer was assigned to each documented archaeological site centroid not having boundary extents defined during field investigations. These sites are typically documented from surface inspection only making the vertical extents of the site unclear and requiring further archaeological investigations.

5.2.2.4 Environmental Justice

This category includes minority and low income population data from U.S. Census Blocks and Block Groups. While not a measure of environmental justice, this category also considered the location of schools, churches, and hospitals along the proposed alignment alternatives due to the potential social impacts of affecting these facilities.

The Environmental Justice category includes datasets commonly used to estimate population demographics, specifically as they relate to minority or low income populations. The principal datasets used in this analysis were the U.S. Census Bureau 2010 decennial census blocks for minority populations and the U.S. Census Bureau American Community Survey (ACS) 2009-2013 block groups for low income populations. In every case, the smallest geographic area for which data were available was used for this assessment. The data for schools, churches, and hospitals were gathered from the ESRI® ArcGIS Gazetteer Dataset. Individual scoring parameters are further explained below.

- Minority Populations (%) – percentage of persons belonging to an ethnic minority based on the total population within the block.
- Low Income Families (%) – percentage of families or households with incomes below the poverty level based on the total population within the block group.
- Minority Populations – count of persons belonging to an ethnic minority based on the total population within the blocks that are in each alignment alternative buffer.
- Low Income Families – count of block groups with families or households with incomes at or below the poverty level based on the total population within the block groups that are in each alignment alternative buffer.
- Minority Impacts Compared to County Level Data – count of blocks with disproportionate minority populations for each alignment. Calculated as the percentage of minority persons in the block divided by the county-wide percentage of minorities. Values of one or greater indicates a potential disproportionate impact on minority persons for the specific block. The blocks with values higher than one were totaled to yield the final value used for the evaluation.
- Low Income Family Impacts Compared to County Level Data – count of block groups with a disproportionate number of families or households with incomes at or below the poverty level for each alignment alternative. Calculated by dividing the percentage of families in poverty in the block group by the county-wide percentage of families in poverty. Values of one or greater indicates a potential disproportionate impact on families living in poverty for the specific block group. The block groups with values higher than one were totaled to yield the final value used for the evaluation.
- Schools, Churches, and Hospitals – count of public and private schools, churches, and hospitals.

5.2.2.5 Hazardous Sites

This category included regulated hazardous materials sites, such as landfills and superfund sites, according to available state and federal records reviewed at the time of the report. Alternatives impacting a regulated site could require environmental remediation for contaminated soils and/or groundwater encountered during construction with associated risks to workers and the public, as well as delays, and higher costs.

The Hazardous Sites category included datasets commonly reviewed for Phase I Environmental Site Assessment Process (ASTM International Standard E-1527-13, Standard Practice for Environmental Site Assessments, 2013) to identify the presence or likely presence of regulated materials sites along the proposed alignment that could pose environmental concerns. Federal and state records were obtained directly from the U.S. Environmental Protection Agency (USEPA) and Texas Commission on Environmental Quality (TCEQ), as available. Specific datasets reviewed in this analysis include USEPA registered facilities, brownfield sites, and voluntary cleanup sites, TCEQ and USEPA Superfund Sites and radioactive sites, and TCEQ registered municipal solid waste facilities (closed and active), public supply water wells, petroleum storage tanks, and municipal setting designation sites for groundwater restrictions.

- Municipal Setting Designations (MSDs) – count of TCEQ-registered sites with institutional controls in place to address contaminated groundwater.
- Petroleum Storage Tanks – count of TCEQ-registered petroleum storage tanks.
- Water Supply Wells – count of TCEQ registered public water supply wells.
- Municipal Solid Waste (MSW) Facilities– count of TCEQ registered operational and closed MSW facilities (landfills).
- USEPA Facilities – count of USEPA-registered facilities that generate, use, or store hazardous waste.
- Cleanup Sites – count of USEPA and TCEQ registered Superfund, brownfield and voluntary cleanup sites.
- Radioactive Sites – count of USEPA and TCEQ registered radioactive sites.

5.3 Phase 1 Analysis Results

The results of the Phase 1 analysis within each Alternative Group are presented in this section.

5.3.1 Downtown Houston (DH)

The following section describes the results of the Downtown Houston alignment alternatives Phase 1 analysis. For a summary of the Phase 1 analysis results refer to Section 7.1. For a detailed table summarizing all data used in the analysis, refer to Appendix B.

5.3.1.1 Downtown Houston Alternative 1 (DH-1) – *Downtown Amtrak*

Engineering

The total length of the DH-1 alignment alternative would be approximately 5.9 miles with none of that located adjacent to the existing utility line. DH-1 would contain a total of three curves requiring a maximum superelevation of six inches. There were no materially relevant speed restrictions for this alignment. This alignment ranks low in terms of geometry.

The entire length of DH-1 alignment alternative would be constructed on viaduct due to its location between the existing freight ROW and adjacent properties. A major structure would be required when crossing over the IH-610 and IH-10 interchange. After the alignment crosses IH-10 it would continue to stay on viaduct along the existing freight ROW to minimize impacts to freight operations and adjacent properties.

The DH-1 alignment alternative would require a total of 27 crossings. It would require the most freight crossings compared to the other Downtown Houston alternative. This alignment ranks the lowest in terms of total crossings.

The DH-1 alignment alternative has minimal hydrology impacts. The DH-1 alignment alternative impacts 5 acres of a Tier 1A FEMA Zone AE floodplain.

Environmental

The high level review along DH-1 identified six environmental areas of concern (See Appendix D, Figure D-1): A National Historic District called Heights Boulevard Esplanade, the U.S. Healthworks Hospital on Hempstead Highway, the Houston and Texas Central Railroad archaeology site, and Cottage Grove Park are within the buffer alignment. The former Jefferson Davis Hospital brownfield site and the Smith Industries brownfield site are located in proximity to the alignment buffer.

The results of the analysis showed the DH-1 alignment alternative would have the greatest impact with regard to the minorities across all environmental justice categories. In addition, DH-1 would have the greatest impact to USEPA registered facilities, hydric soils, and prime farm land.

DH-1 would have the least impact to low income families, high probability areas for cultural resources, streams, waterbodies, and park lands.

Summary Table – Downtown Houston Alternative 1 (DH-1)

The following table summarizes the key impacts and ratings for the Downtown Houston Alternative 1 (DH-1) alignment alternative. For rating details, refer to the tables in Appendix B.

Table 3 – Downtown Houston Alternative 1 (DH-1) Summary Table

Evaluation Categories	**Key Issues/Impacts**	**Rating**
Engineering		
Alignment Length	• Total length of 5.9 mi • Alignment not adjacent to transmission lines	2.50
Alignment Geometry	• Maximum superelevation of 6” • 3 total curves	2.50
Viaduct Length and Major Structures	• 5.9 mi of viaduct • 2 complex structures (crossing IH-610, IH-10)	2.00
Crossings	• 27 total crossings • 2 major roadway crossings • 4 freight line crossings • 3 utility line crossings	1.20
Hydrology	• Lower impacts compared to other alignments	3.00
Environmental		
Streams, Waterbodies, Wetlands	• Greatest impact to hydric soils	2.71
Natural Resources and Land Cover	• Greatest impact to prime farm land	2.50
Cultural Resources	• Substantial impact to NRHP Sites and Archaeological Sites	2.20
Environmental Justice	• Greatest impacts to minorities across all environmental justice categories. • Substantial impact to schools, churches, and hospitals	1.86
Hazardous Sites	• Greatest impact to USEPA facilities • Substantial impact to petroleum storage tanks	2.43

5.3.1.2 Downtown Houston Alternative 2 (DH-2) – *Downtown IH-10*

Engineering

The total length of the DH-2 alignment alternative would be approximately 6.7 miles with none of that located adjacent to the existing utility line. The DH-2 alignment alternative would contain a total of 11 curves requiring a maximum superelevation of six inches. There were no materially relevant speed restrictions for this alignment. This alignment ranks low in terms of geometry.

The entire length of the DH-2 alignment alternative would be constructed on viaduct due to its location down the center of IH-10 and parallel to the IH-10 structure. A major structure would be required when crossing over IH-610 and crossing into the center of

IH-10. Although not identified in the Step 1 Screening, a major structure would be required to cross the eastbound lanes of IH-10 to align with the median, and to cross the westbound lanes to run along the northern side of IH-10 approaching Downtown, and also to crossover the IH-10/IH-45 interchange ramps. After passing the IH-10/IH-45 interchange ramps, the alignment would continue to stay on viaduct crossing over the White Oaks Bayou and would terminate at the Hardy Yards site. This alignment ranks low in terms of combined viaduct length and major structures.

The DH-2 alignment alternative would require a total of 26 crossings. This alignment would have the greatest amount of major interstate road crossings compared to the other Downtown Houston alternative. This alignment ranks low in terms of total crossings.

The DH-2 alignment alternative would require a total of 3 stream crossings, would cross 3 miles of floodplain, and could affect 0.9 miles of streams and 120 acres of floodplain within the corridor.

When compared to the other alternative, the DH-2 alignment alternative would have the greatest number of stream crossings, the greatest amount of length of floodplain crossings, the greatest amount of stream length within the corridor, and the greatest amount of floodplain area within the corridor.

The DH-2 alignment alternative would result in three additional crossings over White Oak Bayou, a major FEMA regulatory stream, and would follow its floodway.

Environmental

The high-level review along DH-2 identified nine environmental areas of concern (See Appendix D, Figure D-1). A National Historic District called Heights Boulevard Esplanade, the U.S. Healthworks Hospital on Hempstead Highway, Houston and Texas Central Railroad, Cottage Grove Park, Stude Park, White Oak Park, and Hogg Park are all within the alignment buffer. .The Smith Industries brownfield site and the America Works Clinic, which is near the intersection of Heights Boulevard and the Katy Freeway (IH-10), are located in proximity to the alignment buffer.

The results of the analysis showed that the DH-2 alignment alternative would have the greatest impact with regard to parklands, developed lands, stream crossings (count and linear feet), parallel streams, and waterbody crossings. Additionally, DH-2 would have the greatest impact to high probability areas for cultural resources and low income families across all environmental justice categories.

DH-2 would have the least impact to hydric soils, prime farm land, minority populations and USEPA facilities.

Summary Table – Downtown Houston Alternative 2 (DH-2)

Table 4 summarizes the key impacts and ratings for the Downtown Houston Alternative 2 (DH-2) alignment alternative. For rating details, refer to Appendix B.

Table 4 – Downtown Houston Alternative 2 (DH-2) Summary Table

Evaluation Categories	**Key Issues/Impacts**	**Rating**
Engineering		
Alignment Length	• Total length of 6.7 mi • Alignment not adjacent to transmission lines	1.50
Alignment Geometry	• Maximum superelevation of 6” • 11 total curves	1.50
Viaduct Length and Major Structures	• 6.7 mi of viaduct • 3 complex structures (crossing IH 610, IH-10, Bayou)	1.00
Crossings	• 26 total crossings • 6 major roadway crossings • 3 freight line crossings • 3 utility line crossings	1.60
Hydrology	• Greatest impacts compared to other alignments • 3 additional crossings over White Oak Bayou • Significant length of alignment within White Oak Bayou Floodway	1.00
Environmental		
Streams, Waterbodies, Wetlands	• Greatest impacts to stream crossings, parallel steams, and waterbody crossings	1.86
Natural Resources and Land Cover	• Greatest impact to parklands and developed acres	2.00
Cultural Resources	• Greatest impact to high probability of archaeology/cultural resources • Substantial impact to NRHP sites and Archaeological Sites	1.80
Environmental Justice	• Greatest impacts to low income families across all environmental justice categories. • Substantial impact to schools, churches, and hospitals	1.86
Hazardous Sites	• Substantial impact to petroleum storage tanks	2.71

5.3.1.3 Downtown Houston Results Summary

Based on the Phase 1 analysis and supported by the prior study of the Last Mile Alternatives, DH-1 and DH-2 are eliminated from further consideration as unreasonable alternatives. For more information, see Section 7.1.

5.3.2 Hockley (HC)

The following section describes the results of the Hockley alignment alternatives Phase 1 analysis. For a summary of the Phase 1 analysis results refer to Section 7.2. For a detailed table summarizing all data used in the analysis, refer to Appendix B.

5.3.2.1 Hockley Base (HC Base) – *Hegar Road*

Engineering

The total length of the HC Base alignment alternative would be approximately 25.6 miles, of which five miles is located adjacent to the existing electrical utility line. The alignment would contain a total of three curves requiring a maximum superelevation of six inches to support the optimum design speed of 205 mph. This alignment ranks the highest in terms of geometry and contains no speed restrictions.

The total viaduct length of the HC Base alignment alternative would be approximately 10.1 miles. This alignment would require an average amount of viaduct compared to the other Hockley alternatives. The majority of viaduct for this alignment would be located at SH 99, US 290, and existing freight line crossing located east of Hockley. The alignment would continue on viaduct structure after crossing US 290 along Hegar Road to minimize impacts to adjacent residential properties. This alignment ranks low in terms of combined viaduct length and major structures required.

The HC Base alignment alternative would require a total of 30 crossings. This alignment would have the same number of total major and moderate-size road crossings; however, this alignment would require a moderate number of utility crossings compared to the other Hockley alternatives. This alignment ranks in the middle in the crossings category.

The Hockley Base alignment would require a total of 34 stream crossings, would cross 3.2 miles of floodplain, and could affect 4.4 miles of streams and 133 acres of floodplain within the corridor.

When compared to the other alternatives, the HC Base alignment alternative would have a moderate number of stream crossings, a moderate amount of floodplain crossings, the greatest stream length within the corridor, and a moderate amount of floodplain area within the corridor.

The HC Base alignment alternative would be located within Spring Creek's floodway for approximately one mile.

Environmental

The high-level review indicated that there is one environmental constraint specific to the alignment, which is Saint Aidan's Episcopal Church south of US 290.

The results of the analysis showed the HC Base alignment alternative would have the greatest impact in terms of number and linear feet of stream crossings and number of parallel streams.

Summary Table – Hockley Base (HC Base)

The following table summarizes the key impacts and ratings for the HC Base alignment alternative. For rating details, refer to the tables in Appendix B.

Table 5 – Hockley Base (HC Base) Summary Table

Evaluation Categories	**Key Issues/Impacts**	**Rating**
Engineering		
Alignment Length	• Total length of 25.6 mi • 5 mi of alignment adjacent to transmission lines	2.00
Alignment Geometry	• Maximum superelevation of 6” • 3 total curves • No speed restrictions	2.67
Viaduct Length and Major Structures	• 10.1 mi of viaduct • 2 complex structures (crossing SH 99, US 290 and freight line)	1.00
Crossings	• 30 total crossings • 2 major roadway crossings • 1 freight line crossing • 5 utility line crossings	1.80
Hydrology	• Greatest stream length within corridor • Within Spring Creek’s floodway for 1 mile	1.75
Environmental		
Streams, Waterbodies, Wetlands	• Greatest impacts to stream crossings and parallel streams • Substantial impact to waterbody crossings • Moderate impact to forested/scrub-shrub wetlands	1.71
Natural Resources and Land Cover	• Substantial impact to developed acres • Moderate impact to prime farmland	2.25
Cultural Resources	• Substantial impact to high probability of archeology/cultural resources	2.60
Environmental Justice	• Substantial impacts to low income families by percent and when compared to county level data • Moderate impact to low income families by count	2.29
Hazardous Sites	• No impacts	3.00

5.3.2.2 Hockley Alternative 1 (HC-1) – *East of Hegar Road*

Engineering

The total length of the HC-1 alignment alternative would be approximately 25.1 miles with 16.7 miles of track located adjacent to the existing utility line. This alignment would contain the greatest length adjacent to the existing utility line. The HC-1 alignment alternative would also contain a total of three curves requiring a maximum superelevation of six inches. However, two of the three curves do not support the optimum design speed of 205 mph. The tight curvature would be required to stay on the east side of the utility line, causing speed reductions to 160 mph. This alignment ranks low in terms of geometry and contains speed restrictions.

The total viaduct length of the HC-1 alignment alternative would be approximately 13.3 miles. This alignment would require the most amount of viaduct compared to the other Hockley alternatives. The majority of viaduct for this alignment would be located at SH 99, US 290 and existing freight line crossing located east of Hockley. The alignment would continue on viaduct structure after US 290 to minimize impacts to adjacent residential properties. This alignment ranks low in terms of combined viaduct length and major structures required.

The HC-1 alignment alternative would require a total number of 29 crossings. This alignment would have the same number of major and moderate road size crossings; however, it would have the least number of utility crossings compared to the other Hockley alternatives. This alignment ranks the highest in the crossings category.

The HC-1 alignment alternative would require a total of 27 stream crossings, would cross 3.8 miles of floodplain, and could affect 2.8 miles of streams and 158 acres of floodplain within the corridor.

When compared to the other alternatives, the HC-1 alignment alternative would have a moderate number of stream crossings, the greatest length of floodplain crossings, a moderate stream length within the corridor, and the greatest amount of floodplain area within the corridor.

The HC-1 alignment alternative would be located within Threemile Creek's floodway for approximately one mile.

Environmental

The high-level review along HC-1 identified four environmental areas of concern along the alignment (See Appendix D, Figure D-2). Hegar Cemetery is documented by the THC along the alignment just north of Magnolia Road. Zube Park is located between US 290 and FM 2920. The solid waste site for CDR Industries is located northeast of Hockley, TX on FM 2920. Available information from the TCEQ indicates the facility's permit was withdrawn. Saint Aidan's Episcopal Church is located south of US 290.

The results of the analysis showed that the HC-1 alignment alternative would have the greatest impact with regard to cemeteries, parkland (Zube Park), and water supply wells.

HC-1 would have the lowest impact with regard to acres of forested wetlands and prime farmland.

Summary Table – Hockley Alternative 1 (HC-1)

The following table summarizes the key impacts and ratings for the Hockley Alternative 1 (HC-1) alignment. For rating details, refer to the tables in Appendix B.

Table 6 – Hockley Alternative 1 (HC-1) Summary Table

Evaluation Categories	**Key Issues/Impacts**	**Rating**
Engineering		
Alignment Length	• Total length of 25.1 mi • 16.7 mi of alignment adjacent to transmission lines	2.50
Alignment Geometry	• Maximum superelevation of 6” • 3 total curves • 2 curves contain 160 mph speed restrictions	2.00
Viaduct Length and Major Structures	• 13.3 mi of viaduct • 2 complex structures (crossing SH 99, US 290 and freight line)	1.00
Crossings	• 29 total crossings (least amount of utility crossings) • 2 major roadway crossings • 1 freight line crossing • 3 utility line crossings	2.00
Hydrology	• Greatest length of floodplain crossings • Greatest floodplain area within corridor • Within Threemile Creek’s floodway for one mile	1.50
Environmental		
Streams, Waterbodies, Wetlands	• Substantial impacts to emergent wetlands and hydric soils • Moderate impacts to stream crossings and parallel streams	2.00
Natural Resources and Land Cover	• Greatest impact to parklands • Moderate impact to developed acres	2.25
Cultural Resources	• Greatest impact to cemeteries • Substantial impacts to high probability of archeology/cultural resources	2.20
Environmental Justice	• Substantial impact to minority populations by count • Substantial impacts to low income families by count, percent, and when compared to county level data • Moderate impact to minority populations by percent	1.71
Hazardous Sites	• Greatest impact to water supply wells • Substantial impact to USEPA facilities	2.43

5.3.2.3 Hockley Alternative 2 (HC-2) – *West of Hegar Road*

Engineering

The total length of the HC-2 alignment alternative would be approximately 25.8 miles, of which four miles is located adjacent to the existing utility line. The alignment would contain a total of five curves requiring a maximum superelevation of six inches for the optimum design speed of 205 mph. This alignment ranks in the middle in terms of geometry and contains no speed restrictions.

The total viaduct length of the HC-2 alignment alternative would be approximately 6.5 miles. This alignment would require a relatively small amount of viaduct when compared to the other Hockley alternatives. The majority of viaduct length required for this alignment would be located at SH 99, US 290 and existing freight line crossing located east of Hockley. (This particular crossing would be complicated as discussed in the Phase 2 analysis as discussed in Section 6.4.1.) After passing US 290, the alignment would begin to transition from viaduct to embankment for a majority of its length. This alignment ranks in the middle in terms of viaduct length, but does require two major structures.

The HC-2 alignment alternative would require a total of 29 crossings. This alignment would have the same number of major and moderate road crossings and a moderate number of utility crossings compared to the other Hockley alternatives. This alignment ranks in the middle in the crossings category.

The HC-2 alignment alternative would require a total of 32 stream crossings, would cross 2.7 miles of floodplain, and could affect 3.5 miles of streams and 118 acres of floodplain within the corridor.

When compared to the other alternatives, the HC-2 alignment alternative would have a moderate number of stream crossings, a moderate length of floodplain crossings, a moderate stream length within the corridor, and a moderate amount of floodplain area within the corridor.

Environmental

The high-level review indicated that there is one area of concern specific to the alignment, which is Saint Aidan's Episcopal Church south of US 290 (See Appendix D, Figure D-2).

The results of the analysis showed HC-2 would have the greatest impact to prime farm land.

HC-2 would have the lowest impact with regard to developed acres.

Summary Table – Hockley Alternative 2 (HC-2)

The following table summarizes the key impacts and ratings for the Hockley Alternative 2 (HC-2) alignment. For rating details, refer to the tables in Appendix B.

Table 7 – Hockley Alternative 2 (HC-2) Summary Table

Evaluation Categories	Key Issues/Impacts	Rating
Engineering		
Alignment Length	• Total length of 25.8 mi • 4.0 mi of alignment adjacent to transmission lines	1.50
Alignment Geometry	• Maximum superelevation of 6” • 5 total curves • No speed restrictions	2.33
Viaduct Length and Major Structures	• 6.5 mi of viaduct • 2 complex structures (crossing SH 99, US 290 and freight line)	2.00
Crossings	• 29 total crossings • 2 major roadway crossings • 1 freight line crossing • 5 utility line crossings	1.80
Hydrology	• Moderate impacts compared to other alignments	2.00
Environmental		
Streams, Waterbodies, Wetlands	• Substantial impacts to water crossings and wetlands • Moderate impacts to stream crossings and parallel streams	1.71
Natural Resources and Land Cover	• Greatest impact to prime farmland	2.50
Cultural Resources	• Moderate impact to high probability of archeology/cultural resources	2.80
Environmental Justice	• Substantial impacts to low income families by percent and when compared to county level data • Moderate impact to low income families by count	2.29
Hazardous Sites	• No impacts	3.00

5.3.2.4 Hockley Alternative 3 (HC-3) – *Kickapoo Road*

Engineering

The total length of the HC-3 alignment alternative would be approximately 27.0 miles, of which approximately 1.1 miles would be located adjacent to the existing electrical utility line. The HC-3 alignment alternative was given a low ranking, because of its limited adjacency to the utility line compared to other Hockley alternatives. The alignment would contain a total of five curves requiring a maximum superelevation of seven inches for the optimum design speed of 205 mph. This alignment ranks low in terms of geometry but contains no speed restriction.

The total viaduct length of the HC-3 alignment alternative would be approximately 5.3 miles. This alignment would require a small amount of viaduct compared to the other Hockley alternatives. The majority of viaduct length would be required for the crossing SH 99, US 290, and the existing freight line to the west of Hockley. The freight line and US 290 crossings are widely spaced apart along this alignment and a major structure would not be required to cross them. After the alignment passes US 290 it would begin to transition from viaduct to embankment for a majority of its length. This alignment ranks high in terms of least amount of viaduct length and should only require one major structure at SH 99.

The HC-3 alignment alternative would require a total of 31 crossings. This alignment would have the same number of major and moderate road crossings and the greatest number of utility crossings compared to the other Hockley alternatives. This alignment ranks the lowest in the crossings category.

The HC-3 alignment alternative would require a total of 21 stream crossings, would cross 2.7 miles of floodplain, and could affect 2.5 miles of streams and 122 acres of floodplain within the corridor.

When compared to the other alternatives, the HC-3 alignment alternative would have the least number of stream crossings, a moderate length of floodplain crossings, the least stream length within the corridor, and a moderate amount of floodplain area within the corridor.

Environmental

The high-level review of HC-3 identified three areas of concern: a planned housing development, Kickapoo Preserve, is planned to be developed west of Kickapoo Road just north of the Waller/Harris county line; Saint Aidan’s Episcopal Church is located south of US 290; and Daikon-Goodman Industrial Site is located east of Kickapoo Road near US 290 (See Appendix D, Figure D-2).

The results of the analysis showed the HC-3 alignment alternative would have the greatest impact to minority populations when compared to county level data.

HC-3 would have the least impact with regard to number and linear feet of stream crossings, and number of parallel streams.

Summary Table – Hockley Alternative 3 (HC-3)

The following table summarizes the key impacts and ratings for the Hockley Alternative 3 (HC-3) alignment. For rating details, refer to the tables in Appendix B.

Table 8 – Hockley Alternative 3 (HC-3) Summary Table

Evaluation Categories	**Key Issues/Impacts**	**Rating**
Engineering		
Alignment Length	• Total length of 27.0 mi • 1.1 mi of alignment adjacent to transmission lines	1.50
Alignment Geometry	• Maximum superelevation of 7" • 5 total curves • No speed restrictions	2.00
Viaduct Length and Major Structures	• 5.3 mi of viaduct • 1 complex structure (crossing SH 99)	2.50
Crossings	• 31 total crossings • 2 major roadway crossings • 1 freight line crossing • 6 utility line crossings	1.60
Hydrology	• Least number of stream crossings • Least stream length within corridor	2.50
Environmental		
Streams, Waterbodies, Wetlands	• Substantial impacts to forested/scrub-shrub wetlands and hydric soils • Moderate impact to waterbody crossings	2.29
Natural Resources and Land Cover	• Substantial impact to developed areas • Moderate impacts to prime farmland and parklands	2.00
Cultural Resources	• Least impact to high probability of archaeology/cultural resources	3.00
Environmental Justice	• Greatest impact to minority families when compared to county level data • Substantial impacts to low income families by count, percent, and when compared to county level data • Moderate impacts to minority populations by percent and count	1.57
Hazardous Sites	• Substantial impact to USEPA facilities	2.71

5.3.2.5 Hockley Alternative 4 (HC-4) – *West of Kickapoo Road*

Engineering

The total length of the HC-4 alignment alternative would be approximately 28.1 miles with none located adjacent to the existing utility line. The HC-4 alignment alternative would have the lowest ranking in terms of adjacency to the electrical utility line compared to other Hockley alternatives. The alignment would contain a total of seven curves requiring a maximum superelevation of six inches for the optimum design speed of 205 mph. This alignment ranks low in terms of geometry, but contains no speed restrictions.

The total viaduct length of the HC-4 alignment alternative would be approximately 6.1 miles. This alignment would require a small amount of viaduct compared to the other Hockley alternatives. The majority of viaduct length would be required to cross SH 99 east of Hockley, US 290, and the existing freight line located west of Hockley. The freight line and US 290 are widely spaced apart along this alignment and a major structure would not be required to cross them. After passing US 290, the alignment would begin to transition from viaduct to embankment for a majority of its length. This alignment ranks high in terms of the least amount of viaduct length and should only require one major structure at SH 99.

The HC-4 alignment alternative would require a total of 27 crossings. This alignment would have the least number of total road crossings compared to the other Hockley alternatives; however, this alignment would require the greatest number of utility crossings. This alignment ranks in the middle in the crossings category.

The HC-4 alignment alternative would require a total of 31 stream crossings, would cross 2.4 miles of floodplain, and could affect 2.6 miles of streams and 102 acres of floodplain within the corridor.

When compared to the other alternatives, the HC-4 alignment alternative would have a moderate number of stream crossings, the least length of floodplain crossings, a moderate stream length within the corridor, and the least amount of floodplain area within the corridor.

Environmental

The high-level review indicated that there is one area of concern specific to the alignment, which is Saint Aidan's Episcopal Church south of US 290 (See Appendix D, Figure D-2).

The results of the analysis showed the HC-4 would have the greatest impact on archaeological sites and minority populations by percent.

HC-4 would have the least impact with regard to percentage of low income families by percent.

Summary Table – Hockley Alternative 4 (HC-4)

The following table summarizes the key impacts and ratings for the Hockley Alternative 4 (HC-4) alignment. For rating details, refer to the tables in Appendix B.

Table 9 – Hockley Alternative 4 (HC-4) Summary Table

Evaluation Categories	**Key Issues/Impacts**	**Rating**
Engineering		
Alignment Length	• Total length of 28.1 mi • 0 mi of alignment adjacent to transmission lines	1.00
Alignment Geometry	• Maximum superelevation of 6” • 7 total curves • No speed restrictions	2.00
Viaduct Length and Major Structures	• 6.1 mi of viaduct • No complex structures	2.50
Crossings	• 27 total crossings (least amount of local road crossings) • 2 major roadway crossings • 1 freight line crossing • 6 utility line crossings	1.80
Hydrology	• Least length of floodplain crossings • Least floodplain area within corridor	2.50
Environmental		
Streams, Waterbodies, Wetlands	• Moderate impacts to stream crossings, parallel streams and forested/scrub-shrub wetlands	2.43
Natural Resources and Land Cover	• Moderate impacts to prime farmland and developed acres	2.50
Cultural Resources	• Substantial impact to archaeological sites	2.60
Environmental Justice	• Greatest impact to minority populations by percent • Substantial impacts to minority populations by count and low income families when compared to county level data • Moderate impact to minority populations when compared to county level data	2.00
Hazardous Sites	• No impacts	3.00

5.3.2.6 Hockley Results Summary

Based on the Phase 1 analysis HC Base, HC-1, and HC-3 are eliminated from further consideration as unreasonable alternatives. HC-2, and HC-4 were proposed to advance to the Phase 2 analysis. For more information, see Section 7.2.

5.3.3 Middle (MD)

The following section describes the results of the Middle alignment alternatives Phase 1 analysis. For a summary of the Phase 1 analysis results refer to Section 7.3. For a detailed table summarizing all data used in the analysis, refer to Appendix B.

5.3.3.1 Middle Base (MD Base) – *East of Utility Corridor*

Engineering

The total length of the MD Base alignment alternative would be approximately 74.4 miles with 47.5 miles located adjacent to the existing utility line. The alignment would contain a total of 18 curves requiring a maximum superelevation of five inches for the optimum design speed of 205 mph. This alignment ranks the lowest in terms of geometry given the large number of curves. It would have five more curves than the next closest alternative.

The total viaduct length of the MD Base alignment alternative would be approximately 32.6 miles. This alignment would require slightly more viaduct compared to the other MD alternatives. The majority of viaduct would be located in the oil and gas fields between Jewett and Teague. This alignment ranks the lowest in terms of viaduct length; however, no complex structure is needed along its length.

The MD Base alignment alternative would require a total of 57 crossings. This alignment would have the least amount of road crossings. With nine utility line crossings, this alignment would be similar to the other options. In terms of total crossings, this alignment is consistent with the other options.

The MD Base alignment alternative would require a total of 135 stream crossings, would cross 12.4 miles of floodplain, and could affect 15 miles of streams and 520 acres of floodplain within the corridor.

When compared to the other alternatives, the MD Base alignment alternative would have a moderate number of stream crossings, a moderate length of floodplain crossings, a moderate stream length within the corridor, and a moderate amount of floodplain area within the corridor.

The MD Base alignment alternative would parallel Spring Creek's floodplain for two miles, would parallel Big Elm Creek's floodplain for one mile, and would have a two mile long crossing over Lake Limestone.

Environmental

The high-level review along the MD Base alignment alternative identified four areas of concern along the alignment: the Union Church, Ten Mile Cemetery, and bald eagle (*Haliaeetus leucocephalus*) and interior least tern (*Sterna antillarum athalassos*) sightings east of Lake Limestone (See Appendix D, Figure D-3).

The results of the analysis show that the MD Base alignment alternative would have the greatest potential for impact to minority populations and archaeological sites.

The MD Base alignment alternative would have the lowest potential for impact to low income families.

Summary Table – Middle Base (MD Base)

The following table summarizes the key impacts and ratings for the MD Base alignment. For rating details, refer to the tables in Appendix B.

Table 10 – Middle Base (MD Base) Summary Table

Evaluation Categories	Key Issues/Impacts	Rating
Engineering		
Alignment Length	• Total length of 74.4 mi • 47.5 mi of alignment adjacent to transmission lines	2.50
Alignment Geometry	• Maximum superelevation of 5” • 18 total curves • No speed restrictions	2.33
Viaduct Length and Major Structures	• 32.6 mi of viaduct • No complex structures	2.00
Crossings	• 57 total crossings • 0 major roadway crossings • 3 freight line crossings • 9 utility line crossings	2.20
Hydrology	• Moderate impacts compared to other alignments • Follows Spring Creek’s floodplain for 2 miles • Follows Big Elm Creek’s floodplain for 1 mile • 2 mile long crossing over Lake Limestone	2.00
Environmental		
Streams, Waterbodies, Wetlands	• Moderate impacts to stream crossings (linear feet), parallel streams, waterbody crossings, and wetlands	2.29
Natural Resources and Land Cover	• Substantial impact to threatened and endangered species element occurrence • Moderate impacts to prime farmland and developed acres	2.00
Cultural Resources	• Greatest impact to archaeological sites • Substantial impact to high probability areas/cultural resources	2.20
Environmental Justice	• Greatest impact to minority populations by percent • Substantial impact to minority populations by count • Substantial impact to schools, churches, and hospitals • Moderate impact to minority populations when compared to county level data	2.00
Hazardous Sites	• Moderate impact to USEPA facilities	2.86

5.3.3.2 Middle Alternative 1 (MD-1) – *West of Utility Corridor*

Engineering

The total length of the MD-1 alignment alternative would be approximately 74.5 miles with 47.5 miles of track located adjacent to the existing electrical utility line. The alignment would contain a total of 13 curves requiring a maximum superelevation of five inches for the optimum design speed of 205 mph. This alignment ranks in the middle of the pack in terms of geometry.

The total viaduct length of the MD-1 alignment alternative would be approximately 26.1 miles. This alignment requires the second least amount of viaduct compared to the other MD alignment alternatives. Similar to the MD Base alignment alternative, the majority of viaduct would be located over the oil and gas fields between Jewett and Teague.

The MD-1 alignment alternative would require a total of 60 crossings. This alignment would have a moderate number of road crossings. With nine utility line crossings this alignment would be similar to the other options. In terms of total crossings this alignment is consistent with the other options.

The MD-1 alignment alternative would require a total of 147 stream crossings, would cross 12.8 miles of floodplain, and could affect 15.4 miles of streams and 535 acres of floodplain within the corridor.

When compared to the other alternatives, the MD-1 alignment alternative would have a moderate number of stream crossings, a moderate length of floodplain crossings, a moderate stream length within the corridor, and a moderate amount of floodplain area within the corridor.

The MD-1 alignment alternative would parallel Spring Creek's floodplain for two miles, would parallel Big Elm Creek's floodplain for one mile, and would have a two-mile-long crossing over Lake Limestone.

Environmental

The high-level review along the MD-1 alignment alternative identified three environmental areas of concern along the alignment, including the Oxford Cemetery, bald eagle, and interior least tern sightings east of Lake Limestone (See Appendix D, Figure D-3).

The results of the analysis show that the MD-1 alignment alternative would have the highest impact on prime farmland and the least impact on developed acres.

Summary Table – Middle Alternative 1 (MD-1)

The following table summarizes the key impacts and ratings for the Middle Alternative 1 (MD-1) alignment. For rating details, refer to the tables in Appendix B.

Table 11 – Middle Alternative 1 (MD-1) Summary Table

Evaluation Categories	**Key Issues/Impacts**	**Rating**
Engineering		
Alignment Length	• Total length of 74.5 mi • 47.5 mi of alignment adjacent to transmission lines	2.50
Alignment Geometry	• Maximum superelevation of 5” • 13 total curves • No speed restrictions	2.67
Viaduct Length and Major Structures	• 26.1 mi of viaduct • 0 complex structures	2.50
Crossings	• 60 total crossings • 0 major roadway crossings • 3 freight line crossings • 9 utility line crossings	2.20
Hydrology	• Moderate impacts compared to other alignments • Follows Spring Creek’s floodplain for 2 miles • Follows Big Elm Creek’s floodplain for 1 mile • 2 mile long crossing over Lake Limestone	2.00
Environmental		
Streams, Waterbodies, Wetlands	• Substantial impact to stream crossings • Moderate impacts to parallel streams, waterbody crossings, and wetlands	1.86
Natural Resources and Land Cover	• Substantial impacts to threatened and endangered species occurrence and prime farmland	2.00
Cultural Resources	• Substantial impact to high probability of archeology/cultural resources • Moderate impact to archaeological sites	2.40
Environmental Justice	• Substantial impact minority populations by count • Moderate impacts to minority populations by percent and when compared to county level data • Moderate impact to low income families by count	2.29
Hazardous Sites	• Moderate impact to USEPA facilities	2.86

5.3.3.3 Middle Alternative 2 (MD-2) – *West of Browns Lake*

Engineering

The total length of the MD-2 alignment alternative would be approximately 74.0 miles with 31.1 miles located adjacent to the existing utility line. The alignment would contain a total of 12 curves requiring a maximum superelevation of four inches for the optimum design speed of 205 mph. This alignment ranks in the middle of the pack in terms of geometry.

The total viaduct length of the MD-2 alignment alternative would be approximately 30.1 miles. This alignment would require an average amount of viaduct compared to the other MD alignment alternatives. Similar to the MD Base alignment alternative, the majority of viaduct would cross the oil and gas fields between Jewett and Teague.

The MD-2 alignment alternative requires a total of 61 crossings. This alignment would have a moderate amount of road crossings. With nine utility line crossings this alignment would be consistent with the other options. In terms of total crossings the alignment ranks in the middle of the pack.

The MD-2 alignment alternative would require a total of 146 stream crossings, would cross 14.4 miles of floodplain, and could affect 15.8 miles of streams and 604 acres of floodplain within the corridor.

When compared to the other alternatives, the MD-2 alignment alternative would have the greatest number of stream crossings, a moderate length of floodplain crossings, the greatest stream length within the corridor, and a moderate amount of floodplain area within the corridor.

The MD-2 alignment alternative would parallel Spring Creek’s floodplain for two miles, would parallel Big Elm Creek’s floodplain for one mile, would parallel Patton Creek’s floodplain for one mile, and would have a two-mile-long crossing over Lake Limestone.

Environmental

The high-level review along the MD-2 alignment alternative identified four environmental areas of concern, including bald eagle, and interior least tern sightings east of Lake Limestone, the Union Church, and Ten Mile Cemetery (See Appendix D, Figure D-3).

The results of the analysis show that MD-2 would have the greatest impact to minority populations when compared to county level data and number of parallel stream crossings.

The results of the analysis show that MD-2 would have the least number of water body crossings and the least number of minority populations.

Summary Table – Middle Alternative 2 (MD-2)

The following table summarizes the key impacts and ratings for the Middle Alternative 2 (MD-2) alignment. For rating details, refer to the tables in Appendix B.

Table 12 – Middle Alternative 2 (MD-2) Summary Table

Evaluation Categories	Key Issues/Impacts	Rating
Engineering		
Alignment Length	• Total length of 74.0 mi • 31.1 mi of alignment adjacent to transmission lines	2.00
Alignment Geometry	• Maximum superelevation of 4” • 12 total curves • No speed restrictions	2.67
Viaduct Length and Major Structures	• 30.1 mi of viaduct • 0 complex structures	2.00
Crossings	• 61 total crossings • 0 major roadway crossings • 3 freight line crossings • 9 utility line crossings	2.20
Hydrology	• Greatest number of stream crossings • Greatest stream length within corridor • Follows Spring Creek’s floodplain for 2 miles • Follows Big Elm Creek’s floodplain for 1 mile • Follows Patton Creek’s floodplain for 1 mile • 2 mile long crossing over Lake Limestone	1.50
Environmental		
Streams, Waterbodies, Wetlands	• Greatest impact to parallel streams • Substantial impact to stream crossings • Moderate impact to wetlands	1.86
Natural Resources and Land Cover	• Substantial impact to threatened and endangered species occurrence • Moderate impact to developed acres	2.25
Cultural Resources	• Substantial impact to high probability of archeology/cultural resources • Moderate impact to archaeological sites	2.40
Environmental Justice	• Greatest impact to minority populations when compared to county level data • Substantial impact to schools, churches, and hospitals • Moderate impact to low income families by count	2.29
Hazardous Sites	• Moderate impact to USEPA facilities	2.86

5.3.3.4 Middle Alternative 3 (MD-3) – *West of Lake Limestone*

Engineering

The total length of the MD-3 alignment alternative would be approximately 79.8 miles with approximately 23.1 miles located adjacent to the existing utility line. The alignment would contain a total of ten curves requiring a maximum superelevation of four inches for the optimum design speed of 205 mph. This alignment ranks in the average in terms of track geometry, but would be the worst in terms of alignment length.

The total viaduct length of the MD-3 alignment alternative would be approximately 31.4 miles. This alignment would require an average amount of viaduct compared to the other MD alignment alternatives. For this alignment alternative, the majority of viaduct would be required to cross flood plains around both the Navasota River and Lake Limestone.

The MD-3 alignment alternative would require a total of 76 crossings. This alignment would have the most road crossings; however, the alignment would have only eight utility crossings, the least of the alternatives. In terms of total crossings, the alignment ranks in the middle of the pack.

The MD-3 alignment alternative would require a total of 132 stream crossings, would cross 13.4 miles of floodplain, and could affect 14.4 miles of streams and 570 acres of floodplain within the corridor.

When compared to the other alternatives, the MD-3 alignment alternative would have a moderate number of stream crossings, a moderate length of floodplain crossings, a moderate stream length within the corridor, and a moderate amount of floodplain area within the corridor.

The MD-3 alignment alternative would cross over the Navasota River and would cross Lake Limestone twice.

Environmental

The high-level review of along the MD-3 alignment alternative identified four environmental areas of concern along the alignment, including the Union Church, Ten Mile Cemetery, the Lenamon Cemetery, and the Shiloh Cemetery (See Appendix D, Figure D-3). The alignment passes within 500 feet of Webb Church and passes through an area with reported bald eagle sightings south of Lake Limestone (See Appendix D, Figure D-3).

The results of the analysis show that the MD-3 alignment alternative would have the greatest acreage of potential forested/shrub-scrub wetlands and the greatest acreage of hydric soils. MD-3 would have the potential to impact the greatest number of cemeteries and one historical marker. The alignment would have the greatest impact to low income families by count and when compared to county level data.

MD-3 would have the least acreage of potential emergent wetlands impacts. It would have the least impact to known archaeological sites and USEPA registered facilities.

Summary Table – Middle Alternative 3 (MD-3)

The following table summarizes the key impacts and ratings for the Middle Alternative 3 (MD-3) alignment. For rating details, refer to the tables in Appendix B.

Table 13 – Middle Alternative 3 (MD-3) Summary Table

Evaluation Categories	**Key Issues/Impacts**	**Rating**
Engineering		
Alignment Length	• Total length of 79.8 mi • 23.1 mi of alignment adjacent to transmission lines	1.00
Alignment Geometry	• Maximum superelevation of 4” • 10 total curves • No speed restrictions	2.67
Viaduct Length and Major Structures	• 31.4 mi of viaduct • 0 complex structures	2.00
Crossings	• 76 total crossings • 0 major roadway crossings • 3 freight line crossings • 9 utility line crossings	2.20
Hydrology	• Moderate impacts compared to other alignments • Crosses the Navasota River • Crosses Lake Limestone twice	2.00
Environmental		
Streams, Waterbodies, Wetlands	• Greatest impacts to forested/scrub-shrub wetlands and hydric soils • Moderate impacts to parallel streams and waterbody crossings	2.14
Natural Resources and Land Cover	• Moderate impacts to threatened and endangered species occurrence and developed acres	2.50
Cultural Resources	• Greatest impacts to cemeteries and historical markers • Moderate impact to high probability of archaeology/cultural resources	2.00
Environmental Justice	• Greatest impacts to low income families by count and when compared to county level data • Substantial impact to low income families by percent • Substantial impact to schools, churches, and hospitals • Moderate impacts to minority populations by count and when compared to county level data	1.57
Hazardous Sites	• Least impact to USEPA facilities	3.00

5.3.3.5 Middle Alternative 4 (MD-4) – *East of Teague*

Engineering

The total length of the MD-4 alignment alternative would be approximately 73.7 miles with approximately 32.5 miles located adjacent to the existing utility line. The alignment would contain a total of eight curves requiring a maximum superelevation of two inches for the optimum design speed of 205 mph. This alignment ranks at the top in terms of geometry with the least amount of curves, superelevation, and track length.

The total viaduct length of the MD-4 alignment alternative would be approximately 19.8 miles. This alignment would require the least amount of viaduct compared to the other MD alignment alternatives. For this alignment alternative, the majority of viaduct would be required to cross through the oil and gas fields between Jewett and Teague.

The MD-4 alignment alternative would require a total of 65 crossings. This alignment would be tied with the MD-1 alignment alternative for the second fewest road crossings. With 14 utility line crossings this alignment would have five more utility crossings than any alternative. In terms of total crossings this alignment ranks the lowest due to the numerous utility crossings.

The MD-4 alignment alternative would require a total of 136 stream crossings, would cross 8.7 miles of floodplain, and could affect 14.4 miles of streams and 366 acres of floodplain within the corridor.

When compared to the other alternatives, the MD-4 alignment alternative would have the least number of stream crossings, the least length of floodplain crossings, the least stream length within the corridor, and the least amount of floodplain area within the corridor.

The MD-4 alignment alternative would parallel Spring Creek's floodplain for two miles.

Environmental

The high-level review along the MD-4 alignment alternative identified two environmental areas of concern along the alignment: the crossing of Buffalo Creek at a location listed by the TPWD as a significant stream segment, and the Oxford Cemetery (See Appendix D, Figure D-3).

The results of the analysis show that the MD-4 alignment alternative would have the greatest amount of potential emergent wetland acreage impacts, the greatest number of USEPA registered hazardous material producing facilities, waterbody crossings, and developed acres.

MD-4 would have the least acreage of potential forested/scrub-shrub wetlands, least impact to federal and state threatened and endangered species element occurrence, low probability of archaeology/cultural resources, and the least impact to minority populations when compared to county level data.

Summary Table – Middle Alternative 4 (MD-4)

The following table summarizes the key impacts and ratings for the Middle Alternative 4 (MD-4) alignment. For rating details, refer to the tables in Appendix B.

Table 14 – Middle Alternative 4 (MD-4) Summary Table

Evaluation Categories	Key Issues/Impacts	Rating
Engineering		
Alignment Length	• Total length of 73.7 mi • 32.5 mi of alignment adjacent to transmission lines	2.00
Alignment Geometry	• Maximum superelevation of 2” • 8 total curves • No speed restrictions	3.00
Viaduct Length and Major Structures	• 19.8 mi of viaduct • 0 complex structures	3.00
Crossings	• 65 total crossings • 0 major roadway crossings • 3 freight line crossings • 14 utility line crossings	2.00
Hydrology	• Least impacts compared to other alignments • Follows Spring Creek’s floodplain for 2 miles	3.00
Environmental		
Streams, Waterbodies, Wetlands	• Greatest impacts to waterbody crossings and emergent wetlands • Moderate impact to hydric soils	2.29
Natural Resources and Land Cover	• Greatest impact to developed acres • Moderate impact to prime farmland	2.00
Cultural Resources	• Moderate impact to archaeological sites	2.80
Environmental Justice	• Substantial impact to low income families by percent • Moderate impact to minority populations by count • Moderate impacts to low income families by count and when compared to county level data	2.29
Hazardous Sites	• Greatest impact to USEPA facilities	2.71

5.3.3.6 Middle Results Summary

Based on the Phase 1 analysis MD Base, MD-2, and MD-3 are eliminated from further consideration as unreasonable alternatives. MD-1 and MD-4 were proposed to advance to the Phase 2 analysis. For more information, see Section 7.3.

5.3.4 IH-45 (IH-45)

The following section describes the results of the IH-45 alignment alternatives Phase 1 analysis. For a summary of the Phase 1 analysis results refer to Section 7.4. For a detailed table summarizing all data used in the analysis, refer to Appendix B.

5.3.4.1 IH-45 Base (IH-45 Base) – *Utility Corridor*

Engineering

The total length of the IH-45 Base alignment alternative would be approximately 107.6 miles with approximately 66.5 miles being located adjacent to the existing utility line. The alignment contains 25 curves requiring a maximum of five inches of superelevation for the design speed of 205 mph.

The total viaduct length of the IH-45 Base alignment alternative would be approximately 51.3 miles. The majority of the viaduct in this section is required to cross the oil and gas fields between Jewett and Teague.

The IH-45 Base alignment alternative would require a total amount of 103 crossings. Of these, 85 are roadway crossings. The majority of the roadway crossings are minor or local roads. This alignment would have three freight crossings and 15 utility line crossings within the extents.

The alignment would require a total of 186 stream crossings, would cross 19.7 miles of floodplain, and could affect 20.5 miles of streams and 832 acres of floodplain within the corridor.

When compared to the alternative, the IH-45 Base alignment alternative would have a moderate number of stream crossings, the least length of floodplain crossings, a moderate stream length within the corridor, and a moderate amount of floodplain area within the corridor.

Environmental

The high-level review along the IH-45 Base alignment alternative identified five environmental areas of concern, including the Union Church, Ten Mile Cemetery, and three federally listed threatened and endangered species element occurrences (See Appendix D, Figure D-4). The threatened and endangered species element occurrences include sightings of interior least tern associated with Lake Limestone and two records of bald eagle sightings: one adjacent to Lake Limestone and one associated with Richland-Chambers Reservoir.

The results of the analysis show that the IH-45 Base alignment alternative would have the greatest count and linear feet of stream crossings, parallel streams, water body crossings, and emergent wetlands. The IH-45 Base alignment alternative would have the greatest number of acres of high potential for archaeological/cultural resources, and the greatest number of cemeteries and archaeological sites. The IH-45 Base would have the greatest number of prime farm land acreage, greatest number of threatened and endangered species element occurrences, and the greatest number of public water supply wells. The IH-45 Base would also have the greatest impact to minority populations when compared to county level data.

The IH-45 Base alignment alternative would have the least impact to forested wetlands, acres of hydric soils, parkland, developed land acreage, minority populations by count and percent, low income families by count, and would have the least impact to low income families when compared to county level data. The alignment also would have the least number of USEPA registered facilities and petroleum storage tanks (PSTs).

Summary Table – IH-45 Base (IH-45 Base)

The following table summarizes the key impacts and ratings for the IH-45 Base (IH-45 Base) alignment. For rating details, refer to the tables in Appendix B.

Table 15 – IH-45 Base (IH-45 Base) Summary Table

Evaluation Categories	**Key Issues/Impacts**	**Rating**
Engineering		
Alignment Length	• Total length of 107.6 mi • 66.5 mi of alignment adjacent to transmission lines	2.50
Alignment Geometry	• Maximum superelevation of 5” • 25 total curves • No speed restrictions	2.67
Viaduct Length and Major Structures	• 51.3 mi of viaduct • 0 complex structures	2.00
Crossings	• 103 total crossings • 0 major roadway crossings • 3 freight line crossings • 15 utility line crossings	2.60
Hydrology	• Least stream length within corridor	2.25
Environmental		
Streams, Waterbodies, Wetlands	• Greatest impacts to stream crossings, parallel streams, waterbody crossings, and emergent wetlands	1.57
Natural Resources and Land Cover	• Greatest impacts to number of threatened and endangered species element occurrence and prime farmland	2.00
Cultural Resources	• Greatest impacts to high probability for archaeological/cultural resources, cemeteries, and archaeological sites	1.80
Environmental Justice	• Greatest impact to minority populations when compared to county level data • Substantial impact to low income families by percent • Substantial impact to schools, hospitals, and churches	2.14
Hazardous Sites	• Greatest impact to number of water supply wells	2.71

5.3.4.2 IH-45 Alternative (IH-45 Alt) – *IH-45*

Engineering

The total length of the IH-45 Alt alignment alternative would be approximately 112.0 miles with approximately 23.0 miles located adjacent to the existing utility line. The alignment would contain a total of 24 curves requiring a maximum superelevation of five inches for the optimum design speed of 205 mph. This alignment would have average geometry compared to the base.

The total length of viaduct within IH-45 alignment alternative would be approximately 33.7 miles. This alignment would require approximately 17.6 less miles of viaduct than the Base Alignment.

The IH-45 Alt alignment alternative requires a total amount of 138 crossings. This alignment would have more of both moderate and minor roadway crossings. In regards to other crossings, the IH-45 alternative would have four freight crossings and 13 utility crossing compared to the base. In terms of total crossings, this alignment ranks below the base due to many more roadway crossings.

The IH-45 Alt alignment alternative would require a total of 164 stream crossings, would cross 21.9 miles of floodplain, and could affect 16.8 miles of streams and 910 acres of floodplain within the corridor.

When compared to IH-45 Base, the IH-45 Alt alignment alternative would have the least number of stream crossings, a moderate length of floodplain crossings, the least stream length within the alignment, and a moderate amount of floodplain area.

Environmental

The high-level review along the IH-45 Alt alignment alternative identified two environmental areas of concern: an area of reported bald eagle sightings associated with Richland-Chambers Reservoir and being in proximity to Fort Boggy State Park within the IH-45 ROW (See Appendix D, Figure D-4). As presently designed, the alignment would remain within the ROW adjacent to IH-45 and direct impacts to Fort Boggy State Park would not occur. Two constraints would be located in proximity to the alignment buffer (See Appendix D, Figure D-4). Hopewell Church, located on CR 318, would be within 175 feet of the alignment. The Nettles Cemetery, located just north of CR 327, would be located within 300 feet of the buffer.

The results of the analysis show that the IH-45 Alt alignment alternative would have the greatest impact to forested wetlands, acres of hydric soils, parkland (See Appendix D, Figure D-4), developed land acreage, minority populations by count and percent, and the greatest impacts to low income families by county and when compared to county level data. The alignment also would have the greatest number of USEPA registered facilities and PSTs.

The results of the analysis show that the IH-45 Alt alignment alternative would have the least impact to the count and linear feet of stream crossings, number of parallel streams, number of waterbody crossings, and acres of emergent wetlands. The IH-45 Alt would have the least number of acres of high potential for archaeological/cultural resources, and the least number of cemeteries and archaeological sites. The IH-45 Alt alignment alternative would have the least number of prime farmland acreage, lowest number of threatened and endangered species element occurrences, and the lowest number of public water supply wells. The IH-45 Alt alignment alternative would also have the least impact to minority populations when compared to county level data.

Summary Table – IH-45 Alternative (IH-45 Alt)

The following table summarizes the key impacts and ratings for the IH-45 Alt alignment alternative. For rating details, refer to the tables in Appendix B.

Table 16 – IH-45 Alternative (IH-45 Alt) Summary Table

Evaluation Categories	Key Issues/Impacts	Rating
Engineering		
Alignment Length	• Total length of 112.0 mi • 23.0 mi of alignment adjacent to transmission lines	1.50
Alignment Geometry	• Maximum superelevation of 5” • 24 total curves • No speed restrictions	2.67
Viaduct Length and Major Structures	• 33.7 mi of viaduct • 0 complex structures	3.00
Crossings	• 138 total crossings • 0 major roadway crossings • 4 freight line crossings • 13 utility line crossings	1.80
Hydrology	• Least number of stream crossings • Least stream length within corridor	2.50
Environmental		
Streams, Waterbodies, Wetlands	• Greatest impacts to forested/scrub-shrub wetlands and hydric soils	2.43
Natural Resources and Land Cover	• Greatest impacts to developed acres and parkland	2.00
Cultural Resources	• Least impacts to high probability of archaeology/cultural resources and archeological sites	3.00
Environmental Justice	• Greatest impacts to minority populations by percent and count • Greatest impacts to low income families by count and when compared to county level data • Substantial impact to schools, churches, and hospitals	1.29
Hazardous Sites	• Greatest impacts number of USEPA facilities and petroleum storage tanks • Moderate impact to water supply wells	2.43

5.3.4.3 IH-45 Results Summary

Based on the Phase 1 analysis both IH-45 Base and IH-45 Alt were proposed to advance to the Phase 2 analysis. For more information, see Section 7.2.

5.3.5 Bardwell (BA)

The following section describes the results of the Bardwell alignment alternatives Phase 1 analysis. For a summary of the Phase 1 analysis results refer to Section 7.5. For a detailed table summarizing all data used in the analysis, refer to Appendix B.

5.3.5.1 Bardwell Base (BA Base) – *West Utility Corridor*

Engineering

The BA Base alignment alternative would be approximately 57 miles long and would be adjacent to the electrical utility ROW for 51.2 miles. The alignment contains 12 curves with a maximum superelevation of five inches for the optimum design speed of 205 mph.

This alternative would have the least desirable geometry because it requires frequent curves to maintain adjacency to the Utility Corridor. A curve with five inches superelevation would be located to the east of Bardwell Lake around an area with multiple utility lines. The radius was chosen to minimize property impacts and maximize the length adjacent to the utility.

The BA Base alignment alternative would have approximately 20.5 miles of viaduct, predominantly over floodplain. The alignment ranks in the middle in terms of viaduct length.

The BA Base alignment alternative would not have any major road crossings but would have moderate and minor road crossings. The number of crossings would be comparable to BA-1 and BA-2 as they would be adjacent to each other.

The BA Base alignment alternative would require a total of 82 stream crossings, would cross 9.6 miles of floodplain, and could affect 8.8 miles of streams and 410 acres of floodplain within the corridor.

When compared to the other alternatives, the BA Base alignment alternative would have a moderate number of stream crossings, the least length of floodplain crossings, a moderate stream length within the corridor, and the least amount of floodplain area within the corridor.

The BA Base alignment would cross Richland Creek's floodplain twice and follow Briar Creek's floodplain for two miles.

Environmental

The high-level review of environmental areas of concern along the BA Base alignment alternative identified that the alignment crosses an area where bald eagle sightings have been previously recorded near Richland-Chambers Reservoir. In addition, the alignment would be within 700 feet of Boren-Reagor Springs Cemetery (See Appendix D, Figure D-5).

The results of the analysis show that the BA Base alignment alternative would have the least impact on minority populations when compared to county level data.

Summary Table – Bardwell Base (BA Base)

The following table summarizes the key impacts and ratings for the BA Base alignment alternative. For rating details, refer to the tables in Appendix B.

Table 17 – Bardwell Base (BA Base) Summary Table

Evaluation Categories	Key Issues/Impacts	Rating
Engineering		
Alignment Length	• Total length of 57.0 mi • 51.2 mi of alignment adjacent to transmission lines	2.50
Alignment Geometry	• Maximum superelevation of 5” • 12 total curves • No speed restrictions	2.33
Viaduct Length and Major Structures	• 20.5 mi of viaduct • 0 complex structures	3.00
Crossings	• 54 total crossings • 0 major roadway crossings • 3 freight line crossings • 12 utility line crossings	2.00
Hydrology	• Least length of floodplain crossings • Least floodplain area within corridor • Crosses Richland Creek’s floodplain twice • Follows Briar Creek’s floodplain for 2 miles	2.50
Environmental		
Streams, Waterbodies, Wetlands	• Substantial impacts to stream crossings (linear feet) and hydric soils • Moderate impacts to waterbody crossings (count), forested wetlands/scrub-shrub, and parallel streams	1.86
Natural Resources and Land Cover	• Substantial impacts to number of threatened and endangered species element occurrence and prime farmland	2.00
Cultural Resources	• Substantial impact to archaeological sites	2.60
Environmental Justice	• Substantial impacts to minority populations by percent and when compared to county level data • Moderate impacts to low income families by percent and minority populations by count	2.14
Hazardous Sites	• Substantial impact to water supply wells	2.71

5.3.5.2 Bardwell Alternative 1 (BA-1) – *Far West of Utility Corridor*

Engineering

The BA-1 alignment alternative would be approximately 56.9 miles long and adjacent to the Utility Corridor for 26.6 miles. The alignment contains eight curves with a maximum superelevation of two inches for the optimum design speed of 205 mph. The alignment geometry would be preferable to the BA Base alignment alternative as tangents replace curved sections between Barry and Palmer. The radius of the curve east of Bardwell Lake would also be larger than the BA Base alignment alternative; however, the alignment would separate from the electrical utility ROW in this area. The BA-1 alignment alternative geometry would be comparable to the BA-2 alignment alternative.

The alignment would have 27.1 miles of viaduct. This would be the most viaduct in all of the alternatives.

The number of crossings would be comparable to the BA Base alignment alternative and BA-2 as they are adjacent to each other.

The BA-1 alignment alternative would require a total of 88 stream crossings, would cross 9.8 miles of floodplain, and could affect nine miles of streams and 416 acres of floodplain within the corridor.

When compared to the other alternatives, the BA-1 alignment alternative would have a moderate number of stream crossings, a moderate length of floodplain crossings, a moderate stream length within the corridor, and a moderate amount of floodplain area within the corridor.

The BA-1 alignment alternative would cross Richland Creek's floodplain twice, and would follow Briar Creek's floodplain for two miles.

Environmental

The high-level review of environmental areas of concern along BA-1 identified that the alignment would cross an area where bald eagle sightings have been previously recorded near Richland-Chambers Reservoir (See Appendix D, Figure D-5). The BA-1 alignment alternative would be in proximity to a USEPA facility with a petroleum storage tank (gas station) near Highway 287 and north of Bardwell Lake (See Appendix D, Figure D-5).

The results of the analysis showed the BA-1 alignment alternative would have the greatest impact with regard to the number of streams which the alignment parallels, number of minority populations, USEPA facilities, petroleum storage tanks, and acres of emergent wetlands.

BA-1 would have the least impact with regard to individual waterbody crossings and least impact to low income families when compared to county level data.

Summary Table – Bardwell Alternative 1 (BA-1)

The following table summarizes the key impacts and ratings for the Bardwell Alternative 1 (BA-1) alignment. For rating details, refer to the tables in Appendix B.

Table 18 – Bardwell Alternative 1 (BA-1) Summary Table

Evaluation Categories	Key Issues/Impacts	Rating
Engineering		
Alignment Length	• Total length of 56.9 mi • 26.6 mi of alignment adjacent to transmission lines	1.50
Alignment Geometry	• Maximum superelevation of 2” • 8 total curves • No speed restrictions	2.67
Viaduct Length and Major Structures	• 27.1 mi of viaduct • 0 complex structures	2.00
Crossings	• 55 total crossings • 0 major roadway crossings • 3 freight line crossings • 12 utility line crossings	2.00
Hydrology	• Moderate impacts compared to other alignments • Crosses Richland Creek’s floodplain twice • Follows Briar Creek’s floodplain for 2 miles	2.00
Environmental		
Streams, Waterbodies, Wetlands	• Greatest impacts to parallel streams and emergent wetlands • Substantial impacts hydric soils and stream crossings	1.43
Natural Resources and Land Cover	• Substantial impacts to number of threatened and endangered species element occurrence and prime farmland	2.00
Cultural Resources	• Moderate impact to archaeological sites	2.80
Environmental Justice	• Greatest impact to minority populations by count • Substantial impact to minority populations by percent	2.29
Hazardous Sites	• Greatest impacts to EPA facilities and petroleum storage tanks • Substantial impact to water supply wells	2.14

5.3.5.3 Bardwell Alternative 2 (BA-2) –*West of Bardwell Lake*

Engineering

The BA-2 alignment alternative would be approximately 56.3 miles long and would be adjacent to the utility line ROW for 51.2 miles. The alignment would contain 10 curves with a maximum superelevation of 2.5 inches for the optimum design speed of 205 mph. The alignment would be on the eastern side of the electrical utility ROW enabling it to follow the ROW without having to curve around an area with multiple utility lines near Bardwell. Therefore, when compared to the BA Base alignment alternative, there are fewer curves and the radius of the curve adjacent to Bardwell Lake would be increased. The alignment would, however, be closer to Bardwell Lake. The geometry would be comparable to BA-1.

The alignment would have 25.3 miles of viaduct which is comparable to the BA Base alignment alternative.

The number of road and freight crossings would be comparable to the BA Base alignment alternative and BA-1 as they are adjacent to each other. The alignment would have two additional utility crossings compared to the BA Base and BA-1 alignment alternatives. This is because it does not completely avoid the area with multiple utility lines near Bardwell.

The BA-2 alignment alternative would require a total of 86 stream crossings, would cross 10.2 miles of floodplain, and could affect nine miles of streams and 437 acres of floodplain within the corridor.

When compared to the other alternatives, the BA-2 alignment alternative would have a moderate number of stream crossings, a moderate length of floodplain crossings, the greatest stream length within the corridor, and a moderate amount of floodplain area within the corridor.

The BA-2 alignment alternative would cross Richland Creek’s floodplain twice and follow Briar Creek’s floodplain for two miles.

Environmental

The high-level review along BA-2 identified two environmental areas of concern. The alignment would cross an area where bald eagle sightings have been previously recorded near Richland-Chambers Reservoir and the alignment also crosses closer to Bardwell Lake (See Appendix D, Figure D-5) than other alternatives. The alignment also crosses property owned by the USACE and activity affecting this property would require obtaining an easement from the USACE, which can be problematic. This crossing would be on the eastern tip of Bardwell Lake, north of State Highway 34.

The results of the analysis showed the BA-2 alignment alternative would have the greatest potential impact to parkland in the Bardwell Lake area.

BA-2 would have the lowest impact to forested wetlands and minority populations.

Summary Table – Bardwell Alternative 2 (BA-2)

The following table summarizes the key impacts and ratings for the Bardwell Alternative 2 (BA-2) alignment. For rating details, refer to the tables in Appendix B.

Table 19 – Bardwell Alternative 2 (BA-2) Summary Table

Evaluation Categories	**Key Issues/Impacts**	**Rating**
Engineering		
Alignment Length	• Total length of 56.3 mi • 51.2 mi of alignment adjacent to transmission lines	2.50
Alignment Geometry	• Maximum superelevation of 2.5” • 10 total curves • No speed restrictions	2.67
Viaduct Length and Major Structures	• 25.3 mi of viaduct • 0 complex structures	2.50
Crossings	• 56 total crossings • 0 major roadway crossings • 3 freight line crossings • 14 utility line crossings	1.80
Hydrology	• Greatest stream length within corridor • Crosses Richland Creek’s floodplain twice • Follows Briar Creek’s floodplain for 2 miles	1.75
Environmental		
Streams, Waterbodies, Wetlands	• Substantial impacts to stream crossings and hydric soils • Moderate impacts to waterbody crossings and parallel streams	1.86
Natural Resources and Land Cover	• Substantial impact to number of threatened and endangered species element occurrence • Moderate impact to prime farmland • Greatest impact to parkland	1.75
Cultural Resources	• Substantial impact to archaeological sites	2.60
Environmental Justice	• Substantial impacts to minority populations by percent and low income families when compared to county level data • Moderate impacts to low income families by percent and minorities when compared to county level data	2.14
Hazardous Sites	• Substantial impact to water supply wells	2.71

5.3.5.4 Bardwell Alternative 3 (BA-3) – *East of Ennis*

Engineering

The BA-3 alignment alternative would be approximately 54.6 miles long and would be adjacent to the utility line ROW for 11.8 miles. The alignment would contain five curves with a maximum superelevation of 2.5 inches for the optimum design speed 205 mph. This would be the shortest alignment alternative within the Bardwell area, but it would also be parallel to the utility line ROW for the shortest distance. BA-3 would be a “greenfield” option created to reduce the number of curves through a more direct alignment. The alignment would have the best geometry of all of the alternatives.

The alignment would have 19.4 miles of viaduct with the viaduct locations predominantly driven by floodplain and railroads. This is the shortest length of viaduct compared to the alternatives.

This alignment would have the largest number of crossings. It crosses IH-45 twice: once near Ennis and a second time near Palmer. Compared to other alternatives, this alignment would have more minor road crossings and an additional freight crossing due to the more direct route through more developed areas.

The BA-3 alignment alternative would require a total of 76 stream crossings, would cross 10.4 miles of floodplain, and could affect 8.6 miles of streams and 443 acres of floodplain within the corridor.

When compared to the other alternatives, the BA-3 alignment alternative would have the least number of stream crossings, the greatest length of floodplain crossings, the least stream length within the corridor, and a moderate amount of floodplain area within the corridor.

Two miles of the BA-3 alignment alternative would be within Richland’s Creek floodplain.

Environmental

The high-level review along BA-3 identified several environmental areas of concern (See Appendix D, Figure D-5). The alignment would cross an area where bald eagle sightings have been previously recorded near Richland-Chambers Reservoir. The alignment would pass near a TCEQ registered closed landfill site, Melton Landfill, which was located in Navarro County. According to available data, the landfill was open from 1974 to 1976. The extents of the landfill are unknown at this time. Lucille Cemetery is located east of IH-45 south of FM 813 and is 125 feet outside of the alignment buffer. Additionally, a water tower owned by Corbet Water Service Corporation is located 150 feet outside of the alignment buffer near FM 2452.

The results of the analysis showed the BA-3 alignment alternative would have the greatest potential for impact to developed property, waterbody crossings, forested wetlands, archaeology/cultural resources, low income families by count and percent, and minority populations.

BA-3 would have the lowest impact with regard to number of stream crossings, number of parallel streams, acres of hydric soils, prime farmland, minority populations by percent, public water supply wells, archaeological sites, and high probability of cultural resources.

Summary Table – Bardwell Alternative 3 (BA-3)

The following table summarizes the key impacts and ratings for the Bardwell Alternative 3 (BA-3) alignment. For rating details, refer to the tables in Appendix B.

Table 20 – Bardwell Alternative 3 (BA-3) Summary Table

Evaluation Categories	**Key Issues/Impacts**	**Rating**
Engineering		
Alignment Length	• Total length of 54.6 mi • 11.8 mi of alignment adjacent to transmission lines	1.50
Alignment Geometry	• Maximum superelevation of 3.00 • 5 total curves • No speed restrictions	3.00
Viaduct Length and Major Structures	• 19.4 mi of viaduct • 0 complex structures	3.00
Crossings	• 62 total crossings • 2 major roadway crossings • 4 freight line crossings • 12 utility line crossings	1.40
Hydrology	• Least number of stream crossings • Greatest length of floodplain crossings • Least stream length within corridor • Follows Richland's Creek floodplain for 2 miles	2.25
Environmental		
Streams, Waterbodies, Wetlands	• Greatest impacts to waterbody crossings and forested/scrub-shrub wetlands • Substantial impact to stream crossings (linear feet)	2.14
Natural Resources and Land Cover	• Greatest impact to developed acres • Substantial impact to number of threatened and endangered species element occurrence	2.00
Cultural Resources	• Greatest impact to high probability of archaeology/cultural resources	2.60
Environmental Justice	• Greatest impacts to low income families by count and percent, and minorities when compared to county level data • Substantial impact to low income families when compared to county level data • Moderate impact to minority populations by count	1.71
Hazardous Sites	• No impacts	3.00

5.3.5.5 Bardwell Results Summary

Based on the Phase 1 analysis BA-1 and BA-2 are eliminated from further consideration as unreasonable alternatives. BA Base and BA-3 were proposed to advance to the Phase 2 analysis. While some environmental issues of concern were identified on the BA-3 alignment, it does offer a significantly different alignment route from the other BA alternatives. As such, advancement of BA-3 alternative provides for greater flexibility during more advanced planning should significant issues be identified along the BA-Base alignment. For more information, see Section 7.5.

5.3.6 Corsicana (CR)

The following section describes the results of the Corsicana alignment alternatives Phase 1 analysis. For a summary of the Phase 1 analysis results refer to Section 7.6. For a detailed table summarizing all data used in the analysis, refer to Appendix B.

5.3.6.1 Corsicana Base (CR Base) – *West of Utility Corridor*

Engineering

The proposed CR alignment would be approximately 31.5 miles long and follow the utility line ROW along its entire length within alignment curvature constraints where the utility turns. The alignment would contain seven curves with a maximum superelevation of three inches for the optimum design speed of 205 mph. The CR Base alignment alternative would have the least favorable geometry because it curves to maximize adjacency to the utility corridor.

The alignment would include approximately 12.8 miles of viaduct. The viaduct length would be predominantly due to large floodplain crossings. The CR Base alignment alternative would have the greatest length of viaduct out of the three Corsicana alignment alternatives.

The CR Base alignment alternative would not contain any major highway crossings, but would include moderate and minor road crossings, one freight crossing, and five utility crossings. The alignment would have the fewest crossings amongst the Corsicana alignment alternatives.

The CR Base alignment alternative would require a total of 47 stream crossings, would cross 6.5 miles of floodplain, and could affect five miles of streams and 279 acres of floodplain within the corridor.

When compared to the other alternatives, the CR Base alignment alternative would have a moderate number of stream crossings, a moderate length of floodplain crossings, a moderate stream length within the corridor, and a moderate amount of floodplain area within the corridor.

The CR Base alignment alternative would cross Richland Creek's floodplain twice, and would follow Briar Creek's floodplain for two miles.

Environmental

The high-level review of environmental areas of concern along Corsican Base identified an area where bald eagle sightings have been previously recorded near Richland-Chambers Reservoir (See Appendix D, Figure D-6).

The results of the analysis showed the CR Base alignment alternative would have the greatest impact with regard to the acreage of hydric soils in the corridor, parallel streams, and water supply wells.

The Corsicana Base alignment alternative would have the lowest impact with regard to archaeological sites, number of low income families, and acres of forested and emergent wetlands.

Summary Table – Corsicana Base (CR Base)

The following table summarizes the key impacts and ratings for the CR Base alignment alternative. For rating details, refer to the tables in Appendix B.

Table 21 – Corsicana Base (CR Base) Summary Table

Evaluation Categories	**Key Issues/Impacts**	**Rating**
Engineering		
Alignment Length	• Total length of 31.5 mi • 31.5 mi of alignment adjacent to transmission lines	2.50
Alignment Geometry	• Maximum superelevation of 3” • 7 total curves • No speed restrictions	2.33
Viaduct Length and Major Structures	• 12.8 mi of viaduct • 0 complex structures	2.50
Crossings	• 31 total crossings • 0 major roadway crossings • 1 freight line crossing • 5 utility line crossings	2.60
Hydrology	• Moderate impacts compared to other alignments • Crosses Richland Creek’s floodplain twice • Follows Briar Creek’s floodplain for 2 miles	2.00
Environmental		
Streams, Waterbodies, Wetlands	• Greatest impacts to hydric soils and parallel streams • Moderate impacts to stream crossings and waterbody crossings	2.00
Natural Resources and Land Cover	• Substantial impacts to number of threatened and endangered species element occurrence and developed acres • Moderate impact to prime farm land	1.75
Cultural Resources	• Substantial impact to high probability of archeology/cultural resources	2.60
Environmental Justice	• Substantial impacts to minority populations and low income families by percent and when compared to county level data • Moderate impact to minority populations by count	1.71
Hazardous Sites	• Greatest impact to water supply wells	2.71

5.3.6.2 Corsicana Alternative 1 (CR-1) – *Oak Valley*

Engineering

The CR-1 alignment alternative would be approximately 31.8 miles long with approximately 10.1 miles adjacent to the utility corridor. The alignment would include three curves with a maximum superelevation of three inches. The CR-1 alignment alternative does not follow the utility line ROW, but instead minimizes floodplain impacts.

The alignment would include 9.0 miles of viaduct. The route would cross fewer floodplains than the CR Base alignment alternative, minimizing the total length of viaduct required.

The alignment would not include any major highway crossings. However, there are four additional moderate road crossings and two utility crossings when compared to the Corsicana Base alignment alternative.

The CR-1 alignment alternative would require a total of 40 stream crossings, would cross three miles of floodplain, and could affect 4.6 miles of streams and 132 acres of floodplain within the corridor.

When compared to the other alternatives, the CR-1 alignment alternative would have the least number of stream crossings, the least length of floodplain crossings, the least stream length within the corridor, and the least amount of floodplain area within the corridor.

Environmental

The high-level review along CR-1 identified two environmental areas of concern (See Appendix D, Figure D-6). Bald eagle sightings have been previously recorded near Richland-Chambers Reservoir, and a large mining facility is located west of SW County Road 30 near Richland.

The results of the analysis showed the CR-1 alignment alternative would have the greatest impact with regard to number of minority populations.

The CR-1 alignment alternative would have the lowest impact with regard to number and linear feet of stream crossings, number of waterbody crossings, the acreage of hydric soils in the corridor, prime farmland, and high probability of cultural resources.

Summary Table – Corsicana Alternative 1 (CR-1)

The following table summarizes the key impacts and ratings for the Corsicana Alternative 1 (CR-1) alignment. For rating details, refer to the tables in Appendix B.

Table 22 – Corsicana Alternative 1 (CR-1) Summary Table

Evaluation Categories	**Key Issues/Impacts**	**Rating**
Engineering		
Alignment Length	• Total length of 31.8 mi • 10.1 mi of alignment adjacent to transmission lines	1.50
Alignment Geometry	• Maximum superelevation of 3” • 3 total curves • No speed restrictions	2.67
Viaduct Length and Major Structures	• 9.0 mi of viaduct • 0 complex structures	3.00
Crossings	• 36 total crossings • 0 major roadway crossings • 1 freight line crossing • 7 utility line crossings	2.00
Hydrology	• Least impacts compared to other alignments	3.00
Environmental		
Streams, Waterbodies, Wetlands	• Substantial impact to emergent wetlands • Moderate impact to forested/shrub-scrub wetlands	2.57
Natural Resources and Land Cover	• Substantial impacts to number of threatened and endangered species element occurrence and developed acres	2.00
Cultural Resources	• Substantial impact to archaeological sites	2.60
Environmental Justice	• Substantial impacts to all population demographic categories	1.29
Hazardous Sites	• No impacts	3.00

5.3.6.3 Corsicana Alternative 2 (CR-2) – *Central Utility Corridor*

Engineering

The proposed CR-2 alignment alternative would be approximately 31.2 miles long with 16.6 miles adjacent to the utility line ROW. The alignment would include one curve with a maximum superelevation of 1.5 inches to support the optimum 205 mph operations. This alignment would provide the most favorable geometry with the fewest curves.

The alignment would require 15.6 miles of viaduct due to large floodplain crossings.

There would not be any proposed major road crossings. There would be seven utility crossings as CR-2 crosses the utility ROW to provide favorable geometry.

The CR-2 alignment alternative would require a total of 56 stream crossings, would cross 7.7 miles of floodplain, and could affect 5.8 miles of streams and 327 acres of floodplain within the corridor.

When compared to the other alternatives, the CR-2 alignment alternative would have a moderate number of stream crossings, a moderate length of floodplain crossings, a moderate stream length within the corridor, and a moderate amount of floodplain area within the corridor.

Four miles of the CR-2 alignment alternative would lie within the Richland Creek's floodplain and the alignment would follow Briar Creek's floodplain for two miles.

Environmental

The high-level review along CR-2 identified one environmental constraint. The alignment would pass near a TCEQ registered closed landfill site, Melton Landfill, which was located in Navarro County. According to available data the landfill was open from 1974 to 1976. The extents of the landfill are unknown at this time.

The results of the analysis showed the CR-2 alignment alternative would have the greatest impact with regard to acres of prime farm land, stream crossings (count and linear feet), waterbody crossings, and forested/scrub-shrub wetlands (See Appendix D, Figure D-6).

The CR-2 alignment alternative would have the lowest impact with regard to developed land, number of federal and state threatened and endangered species element occurrences, and number of minority populations. CR-2 is the only alignment in the Corsicana Alternative Group that does not impact the bald eagle sighting area.

Summary Table – Corsicana Alternative 2 (CR-2)

The following table summarizes the key impacts and ratings for the Corsicana Alternative 2 (CR-2) alignment. For rating details, refer to the tables in Appendix B.

Table 23 – Corsicana Alternative 2 (CR-2) Summary Table

Evaluation Categories	Key Issues/Impacts	Rating
Engineering		
Alignment Length	• Total length of 31.2 mi • 16.6 mi of alignment adjacent to transmission lines	2.00
Alignment Geometry	• Maximum superelevation of 1.5” • 1 total curves • No speed restrictions	3.00
Viaduct Length and Major Structures	• 15.6 mi of viaduct • 0 complex structures	2.00
Crossings	• 35 total crossings • 0 major roadway crossings • 1 freight line crossing • 7 utility line crossings	2.40
Hydrology	• Moderate impacts compared to other alignments • 4 mile crossing across Richland Creek’s floodplain • Follows Briar Creek’s floodplain for 2 miles	2.00
Environmental		
Streams, Waterbodies, Wetlands	• Greatest impacts to stream crossings, waterbody crossings, and forested/shrub-scrub wetlands • Substantial impact to emergent wetlands • Moderate impact to hydric soils	1.43
Natural Resources and Land Cover	• Greatest impact to prime farmland	2.50
Cultural Resources	• Substantial impacts to high probability of archeology/cultural resources and archaeological sites	2.20
Environmental Justice	• Substantial impacts to all population demographic categories, except minority populations by count	1.57
Hazardous Sites	• No impacts	3.00

5.3.6.4 Corsicana Results Summary

Based on the Phase 1 analysis CR-2 are eliminated from further consideration as unreasonable alternatives. CR Base and CR-2 were proposed to advance to the Phase 2 analysis. For more information, see Section 7.6.

6 Phase 2 Analysis

A Phase 2 analysis method was developed to evaluate the alignment alternatives advancing through the Phase 1 analysis with respect to project delivery considerations. Meaningful project delivery evaluation categories were selected to evaluate each alignment alternative in order to identify the most financially viable alignments that would meet the Project's Purpose and Need criteria.

Additional conceptual engineering and planning efforts were undertaken for all alignments included in the Phase 2 analysis, including development of figures (See Appendix E). Alternatives were developed to a sufficient and consistent level of detail to enable this comparative assessment of competing alignments. Phase 2 utilized a qualitative approach based on engineering judgment, corridor understanding, and prior experience with passenger rail and heavy infrastructure projects to assess and assign the alignment alternatives based on data from capital construction cost measures, construction duration measures, and construction challenges.

6.1 Evaluation Method

Project delivery evaluation criteria covering capital construction cost, construction duration, and constructability were used in the Phase 2 comparison of alignment alternatives. A comparison chart was made for each alternative using professional judgment, considering the cost and schedule output from the constructability evaluation. The evaluation method accounts for variation in the importance of potential evaluation criteria and focuses on those criteria that are most relevant to the viability of the alternatives.

Like the Phase 1 analysis, the comparison approach was used to be consistent with the alternative corridor screening evaluations documented in the *Step 1 Screening of Alternatives Report* and the alternatives in the *Last Mile Analysis Report* (with the exception of using a direct comparison between the two remaining Alternative Groups instead of numeric stoplight chart ratings). Note that the constructability evaluation used for the Phase 2 analysis requires a more qualitative assessment using professional judgment, such as expected risks during construction.

The evaluation categories of criteria used in the comparative analysis are outlined in the following section.

6.2 Evaluation Criteria

The categories of criteria selected for the Phase 2 comparative assessments are identified below. Key considerations used in the evaluation of each alternative are provided, along with general guidelines for how the alternatives were compared with respect to that category.

Capital Cost: The estimated capital construction costs for the heavy infrastructure elements of the Project. It does not include items that are of the same quantity and cost magnitude relative to all the alignments, such as the vehicle fleet, maintenance facilities, and systems.

Construction Duration: The total time from beginning of construction to beginning of revenue service. The greater the duration, the greater the overall Project costs due to factors such as financing and insurance costs, inflation, and contractor administrative costs.

Constructability: This category captures the expected degree of difficulty in constructing the Project: the greater the expected construction difficulty, the greater the risk of cost or schedule impacts. Typical constructability concerns are described in Section 0 below.

6.3 Project Delivery Screening

6.3.1 Cost Analysis

Cost estimates were developed for all alignment alternatives identified in Section 4 using conceptual design information. Cost estimate data was used for the remaining alternatives as part of the Phase 2 analysis. These estimates are classified as Class 5 Rough Order of Magnitude (ROM) estimates in accordance with the Association for the Advancement of Cost Engineering International (AACE International) best practices.

6.3.1.1 Estimating Approach

The estimates were developed for each of the alternatives to determine the relative cost difference. The estimates include the following key differentiators:

- Heavy civil infrastructure for the HSR alignment (at-grade, cut, and viaduct)
- Complexity factors for sections of the alignment within urban and suburban areas
- Roadway grade separations
- HSR trackwork
- Major structures
- Environmental mitigation

Key assumptions used in the development of estimates included:

- Estimates were developed to evaluate the heavy infrastructure costs only.
- Historical benchmark data was used from Arup's internal database of international HSR projects. Rates and costs were normalized for construction in the Texas market.
- The estimates assume normal ground conditions. No allowances were made for ground decontamination or discovery of archaeological artifacts and their consequential effects on the Project.
- The estimates did not include impact mitigation costs for compensatory works or betterments to existing utilities, roadways, or developments.
- Unit rates used reflect the cost of direct construction and include labor, equipment, and materials.
- The quantities in the estimates are preliminary in nature and would require refinement as more information becomes available and the design progresses.

- A 25% construction contingency allowance was included, but was not intended to address changes in scope.

6.3.1.2 Segments

While cost estimate data was developed for all alternative alignments, the 10 alternative segments included in the Phase 2 cost analysis were as follows:

Hockley

- HC-2
- HC-4

Middle

- MD-1
- MD-4

Corsicana

- CR Base
- CR-1

Bardwell

- BA Base
- BA-3

IH-45

- IH-45 Base (Base Utility Corridor with MD-4 Alignment)
- IH-45 Alt

6.3.1.3 Heavy Civil Infrastructure

To develop an estimate of the infrastructure requirements at this conceptual level of design development, thirteen typical heavy civil infrastructure cross sections were developed as follows:

- Retained Cut -25 ft and deeper
- Retained Cut -20 ft to -25 ft
- Retained Cut -15 ft to -20 ft
- Cut -10 ft to -15 ft
- Cut -5 ft to -10 ft
- Cut 0 ft to -5 ft
- Embankment 0 ft to 5 ft
- Embankment 5 ft to 10 ft
- Embankment 10 ft to 15 ft
- Retained Embankment 15 ft to 20 ft
- Retained Embankment 20 ft to 25 ft
- Viaduct 25 ft to 35 ft
- Viaduct 35+ ft

The plans and profiles were then reviewed to determine the expected typical section type along each segment of the alignment. Section type quantities were developed by assigning the selected section type in increments of 500 feet along each alignment.

The table below shows the percentages of heavy civil infrastructure type for each alignment alternative.

Table 24 – Percentages of Heavy Civil Infrastructure

Section Type	HC-2	HC-4	MD-1	MD-4	CR Base	CR-1	BA Base	BA-3	IH-45 Base	IH-45 Alt
Retained Cut -25+	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%
Retained Cut -25 to -20	0%	0%	1%	1%	0%	0%	0%	0%	1%	0%
Retained Cut -20 to -15	0%	0%	0%	0%	1%	0%	1%	0%	2%	1%
Cut -15 to -10	0%	0%	1%	1%	0%	1%	0%	1%	3%	2%
Cut -10 to -5	2%	2%	3%	4%	5%	2%	3%	2%	4%	4%
Cut -5 to 0	7%	11%	5%	5%	8%	7%	6%	4%	7%	7%
Embankment 0 to 5	38%	48%	9%	10%	14%	22%	15%	9%	11%	13%
Embankment 5 to 10	18%	11%	11%	15%	13%	16%	18%	17%	11%	17%
Embankment 10 to 15	6%	5%	12%	16%	11%	13%	14%	16%	13%	10%
Retained Embankment 15 to 20	4%	7%	11%	13%	8%	8%	9%	10%	9%	8%
Retained Embankment 20 to 25	6%	4%	8%	10%	10%	9%	6%	7%	7%	7%
Viaduct 25 to 35	13%	9%	16%	15%	23%	16%	17%	13%	11%	11%
Viaduct 35+	5%	3%	22%	12%	6%	7%	12%	21%	21%	18%

6.3.1.4 Development Complexity Factor Percentages

The alternatives were broken down into the following development complexity factor percentage categories based on reviews of the alignments:

- Urban (20% cost premium)
- Developed (10% cost premium)
- Undeveloped (0% cost premium)

The alignment plans were reviewed to assign the appropriate complexity factor along each section of the alignment. The table below shows the percentages used to estimate complexity factors for each alignment.

Table 25 – Summary of Complexity Percentages

	HC-2	HC-4	MD-1	MD-4	CR Base	CR-1	BA Base	BA-3	IH-45 Base	IH-45 Alt
Urban	6%	5%	0%	0%	0%	0%	0%	0%	0%	3%
Developed	79%	86%	21%	27%	17%	30%	39%	58%	15%	39%
Undeveloped	15%	9%	79%	73%	83%	70%	61%	42%	85%	58%

6.3.1.5 Environmental Complexity Factor Percentages

The alternatives were broken down into the following environmental complexity factor percentage categories:

- Wetlands greater than 500 ft (25% cost premium)
- Waterbodies greater than 500 ft (25% cost premium)

The alignment plans were reviewed to assign the appropriate environmental complexity factor along each section of the alignment. The table below shows the percentages used to estimate environmental complexity factors for each alignment.

Table 26 – Summary of Complexity Percentages

	HC-2	HC-4	MD-1	MD-4	CR Base	CR-1	BA Base	BA-3	IH-45 Base	IH-45 Alt
Wetlands	10%	10%	1%	1%	0%	0%	0%	2%	1%	2%
Waterbodies	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%

6.3.1.6 Third-Party Coordination Complexity Factor Percentages

The alternatives were broken down into the following third-party coordination complexity factor percentage categories:

- Oil and gas field coordination (25% cost premium)
- Interstate highway coordination (25% cost premium)

The alignment plans were reviewed to assign the appropriate third-party coordination complexity factor along each section of the alignment. The table below shows the percentages used to estimate third-party coordination complexity factors for each alignment.

Table 27 – Summary of Complexity Percentages

	HC-2	HC-4	MD-1	MD-4	CR Base	CR-1	BA Base	BA-3	IH-45 Base	IH-45 Alt
Oil and Gas Field	0%	0%	23%	22%	0%	0%	0%	0%	15%	0%
Interstate Highway	0%	0%	0%	0%	0%	0%	0%	0%	0%	48%

6.3.1.7 Grade Separations Cost Impacts

Cost allowances were made for grade separated roadway crossings required along at-grade portions of the alignment. These allowances account for structures to cross roadways within at-grade sections of the alignment and the additional costs associated with maintaining live traffic during construction operations. For each alternative, the total number of road crossings was counted based on visual inspections using Google Earth.

The table below shows the total number of roadway crossings for each alternative.

Table 28 – Summary of Roadway Crossings

	HC-2	HC-4	MD-1	MD-4	CR Base	CR-1	BA Base	BA-3	IH-45 Base	IH-45 Alt
1-2 Lane Road Crossings	23	21	55	52	26	30	53	55	85	121
3-4 Lane Road Crossings	3	4	1	1	1	1	2	3	0	0

6.3.1.8 Transmission Line Relocation Cost Impacts

Cost allowances were made for electrical transmission line relocations required along portions of the alignment where the alignment crosses the transmission lines. These allowances account for modifications to the existing transmission lines and transmission line towers. For each alternative, the total number of transmission line crossings were counted based on visual inspections using Google Earth.

The table below shows the total number of transmission line crossings for each alternative.

Table 29 – Summary of Transmission Line Crossings

	HC-2	HC-4	MD-1	MD-4	CR Base	CR-1	BA Base	BA-3	IH-45 Base	IH-45 Alt
Transmission Line Crossings	9	16	10	16	5	7	14	14	15	13

6.3.1.9 Complex Structures Cost Impacts

Complex structures that required additional consideration and allowances in capital cost requirements, schedule, and constructability were assessed and are listed below:

- SH 99
- US 290
- IH-45

6.3.1.10 Environmental Cost Impacts

Cost allowances were made for forested wetland, emergent wetland, and stream mitigation costs along the alignment. Mitigation credit costs were estimated using prior reported credit costs from mitigation banks in the project area. The following mitigation ratios were assumed:

- Forested Wetland – 3:1 Mitigation Ratio (acres)
- Emergent Wetland – 2:1 Mitigation Ratio (acres)
- Stream – Linear Feet of Stream Crossings

The table below shows the forested wetland, emergent wetland, and stream mitigation quantities for each alternative.

Table 30 – Summary of Environmental Mitigation Quantities

	HC-2	HC-4	MD-1	MD-4	CR Base	CR-1	BA Base	BA-3	IH-45 Base	IH-45 Alt
Emergent Wetlands Mitigation (Acres)	270	254	22	34	4	6	8	8	32	20
Forested Wetlands Mitigation (Acres)	60	42	138	120	21	30	42	165	159	225
Streams (LF)	18416	13798	81260	76066	26144	24115	46268	45591	108387	88581

6.3.1.11 Exclusions

The following items will be excluded from the estimate:

- ROW costs and/or demolition of existing structures
- all system costs
- signaling
- catenary
- traction power sub-stations
- communications
- rolling stock
- program costs/soft costs
- preliminary design
- final design
- project management for design and construction
- construction administration and management
- legal fees
- permit costs, local planning obligations, agreements, and any fees associated with these

- review fees
- surveys
- testing
- inspections
- insurance
- contractors' bond
- tax
- owner's contingency
- escalation/inflation/deflation beyond Q2 2015
- owner's direct management costs, running and maintenance costs
- costs or impacts of latent environmental issues that result in litigation or development delays
- removal of any of the works at the end of their useful life — including allowance for any residual value
- financing charges
- credits for capital taxation allowances
- compensatory costs to other interested parties
- maintenance costs
- hard rock excavations
- impact of encountering unfavorable soil conditions, hazardous materials, or poor working conditions during the construction process

The estimates were developed assuming that the major civil works within the project would be procured using a design-build contracting method.

6.3.1.12 Summary of Results

Based on the methods described above, the table below shows the normalized cost estimate results obtained for each Phase 2 alternative. Note that results were normalized for comparison of alignment alternatives within the same Alternative Group (with the "Base" alignment alternative rating of 1.0).

Table 31 – Summary of Normalized Capital Cost Results

	HC-2	HC-4	MD-1	MD-4	CR Base	CR-1	BA Base	BA-3	IH-45 Base	IH-45 Alt
Normalized Capital Costs	0.83	0.81	1.13	0.96	1.00	0.95	1.00	1.08	1.00	1.04

For comparative purposes only, alignment alternatives not passing the Phase 2 analysis had the following construction duration factors:

- HC Base: 1.00
- HC-1: 0.83
- HC-3: 0.84

- MD Base: 1.00
- MD-2: 0.99
- MD-3: 1.01
- CR-2: 1.05
- BA-1: 1.15
- BA-2: 0.98

6.3.2 Construction Duration Analysis

A high-level comparative construction duration analysis was performed during Phase 2. Production ratios for each of the typical infrastructure configurations identified in Section 5.3.1.3 were defined to establish a construction duration penalty for slower construction types. The ratio was determined from the rate of production of the alignment configuration normalized to the equivalent length of alignment on 0-5 ft embankment.

The production ratios were aggregated with the quantities developed for the cost analysis to yield relative construction durations for the alignment alternative. The competing alternatives were then ranked in each Alternative Group against each other to provide normalized rankings similar to the cost analysis (with the "Base" alignment alternative rating of 1.0). Total program construction durations and a logic-tied construction schedule were not generated for this analysis.

The table below shows a summary of the schedule analysis results.

Table 32 – Summary of Construction Durations

	HC-2	HC-4	MD-1	MD-4	CR Base	CR-1	BA Base	BA-3	IH-45 Base	IH-45 Alt
Normalized Construction Durations	0.60	0.48	1.22	0.95	1.00	0.85	1.00	1.16	1.00	0.92

For comparative purposes only, alignment alternatives not passing the Phase 2 analysis had the following construction duration factors:

- HC Base: 1.00
- HC-1: 0.70
- HC-3: 0.55
- MD Base: 1.00
- MD-2: 0.98
- MD-3: 0.98
- CR-2: 1.15
- BA-1: 1.33
- BA-2: 1.00

6.3.3 Constructability Analysis

A constructability analysis of each alternative was undertaken to ascertain the degree of difficulty in constructing each alternative segment. The greater the expected construction difficulty, the greater the risk of cost or schedule impacts. Segments requiring specially constructed approaches (including types of equipment and construction skills) would be more costly to deliver and construction schedules would be extended.

Typical constructability concerns are described in the following sections.

6.3.3.1 Accessibility

The ease of access to the construction area is a critical element in the constructability assessment. Access limitations will determine the amount of auxiliary work required such as temporary access roads, with obvious implications to project cost and schedule. Access will also determine the types of equipment that will be required to reach the work zone and perform the work. Insufficient access might preclude large precast elements or large construction equipment from accessing the construction area, and could require additional work to adapt existing adjacent infrastructure.

Additionally, the availability of space for construction operations (free of obtrusive infrastructure or obstacles) is a key constructability factor. Sufficient space for staging, storage, and construction operations is needed along the alignment. Space is required for not only large equipment and major construction operations, but also for construction crew access, parking lots, and work areas.

6.3.3.2 Pre-Construction Activities

The proximity of major roads and freight rail lines to the alignment is an important factor for hauling materials and equipment. Using local roads for construction haul routes will add traffic to local areas and cause potential damage to infrastructure not designed for heavy loads. Thus, reinforcement of local roads and bridges will add cost and time to the construction process. Freight rail lines will also be required to haul larger quantities of materials and equipment. Proximity to the existing freight rail lines should be considered to limit the need for the construction of auxiliary freight tracks to access the construction site.

6.3.3.3 Floodplain Crossings

Alignments passing through major floodplains, wetland, and environmentally sensitive areas will require mitigation measures and added construction difficulties. Long lengths of the alignment in wetland areas will require viaducts with long spans to avoid disruption of the original conditions of soil and vegetation. Additionally, construction in floodplain areas typically contains poor soil conditions that will result in cost increases associated with the removal of inadequate materials and require the excavation and hauling of significant amounts of borrow pit materials.

6.3.3.4 Road Crossings

Grade separations at intersections between the alignment and existing roadway infrastructure will not only require bridge structures for either the HSR line or for the roadway, they will require complex coordination efforts that will increase the schedule, and the schedule risk, of the project. Road crossings frequently require complicated structures and carefully phased construction to maintain existing traffic operations.

6.3.3.5 Railroad Crossings

Railroad crossings generally require extremely complex coordination efforts and approval from railroad operators that will limit construction times and increase the schedule risk of the project. Construction in the vicinity of live freight operations will require additional safety considerations and defined procedures such as the use of flagmen that will result in increased construction duration and costs.

6.3.3.6 Complex and Skewed Structures

When intersecting with current infrastructure (e.g. highways, roadways, railways), skewed elevated crossings add to construction complexity. Perpendicular crossings can typically be designed and constructed as a conventional bridge with smaller spans, whereas skewed structures will require a more complicated site-specific design and construction with longer spans or long straddle bents.

6.3.3.7 Utilities

Utility relocations increase construction cost and schedule risk due to third party coordination and protection requirements. Additionally, working in the proximity of utilities such as electric power lines or gas pipelines creates numerous safety challenges.

6.3.3.8 Right-of-Way (ROW)

Lack of adequate property rights or site access would cause schedule delays and increased construction costs. Accordingly, alignments with more complicated ROW acquisition requirements would require significant advance efforts and third party coordination. As such, alignment alternatives with limited requirements for acquisitions would reduce project cost and schedule risks.

6.3.3.9 Permitting

Permitting requirements from local, state, federal, and other public entities have the potential to cause schedule delays and increase project costs. When possible, avoiding areas (such as wetlands) with complex permitting requirements would minimize schedule and cost risks associated with the project.

6.4 Phase 2 Analysis Results

The following sections describe the results of the Phase 2 alignment alternatives analysis. For a summary of the Phase 1 analysis results refer to Section 7.

6.4.1 Hockley (HC)

The following section describes the results of the Hockley alignment alternatives Phase 2 analysis. For constructability analysis details, refer to the figure and table in Appendix E.

Capital Cost

The HC-2 alignment alternative has a cost savings of less than 2% compared with the HC-4 alignment alternative. While the HC-4 alignment alternative has a shorter distance of viaduct and smaller area of required wetland and stream mitigation, the longer alignment length contributes to a slightly higher overall cost. Given the construction duration difference for both alternatives is less than 2%, both alternatives are considered to be rated equal.

Construction Duration

The HC-4 alignment alternative has a 12% shorter construction duration compared with the HC-2 alignment alternative. While the HC-2 alignment alternative has a shorter overall length, the longer distance of viaduct and retained embankment contributes to a longer schedule duration.

Constructability

The HC-2 structure would cross 10 traffic lanes of US 290 and its frontage roads in a high skew and in close proximity to the railroad, which would require a complex structure with longer spans. Column placement would be constrained, requiring longer spans and potentially straddle bents to be constructed. Locating the columns and footings in the vicinity of the on and off ramps may require temporary closures of the ramps.

The HC-4 alignment alternative crosses US 290 more perpendicular to the existing roadways, does not cross additional US 290 frontage roads which would allow for shorter spans, and has a separate railroad crossing. The HC-4 structure would cross five traffic lanes of US 290. There are no frontage roads and the skew angle is more favorable than for HC-2. Due to the low skew angle of the crossing, the span required to cross US 290 would be shorter than for HC-2, and column placement would be simpler as there are fewer constraints on their location.

While both of these alignments will require permitting coordination with TxDOT for construction of the crossing of US 290 and SH 99 it is expected that the more complex crossing of the HC-2 alternative would involve increased traffic impact mitigation measures and extended construction schedules. Accessibility is not anticipated to be a construction concern given the close proximity of US 290, SH 99 and other local roads.

HC-2 crosses adjacent to a large stormwater detention pond and crosses through TxDOT wetland area (requiring extensive permitting) in vicinity of the complex roadway crossing of US290 and freight railroad.

HC-4 is considered to have fewer constructability challenges compared to HC-2, with the crossing of US 290, SH 99, and the UPRR railroad presenting the greatest concerns.

Results Summary

Based on the Phase 2 analysis the HC-4 alignment alternative is the recommended alignment resulting from the Phase 2 analysis. The HC-2 alignment alternative is not recommended for further consideration. For more information, see Section 7.2.

6.4.2 Middle (MD)

The following section describes the results of the Middle alignment alternatives Phase 2 analysis. For constructability analysis details, refer to the figure and table in Appendix E.

Capital Cost

The MD-4 alignment alternative has a cost savings of 17% compared with the MD-1 alignment alternative. The MD-4 alignment alternative has a longer length of retained cut; however, the MD-1 alignment alternative has a longer length of viaduct which contributes to a higher overall cost.

Construction Duration

The MD-4 alignment alternative has a 27% shorter construction duration compared with the MD-1 alignment alternative. The MD-1 alignment alternative has both a longer overall length and longer distance of viaduct which contributes to a longer schedule duration.

Constructability

The MD-1 and MD-4 alignment alternatives both have similar constructability issues. Both alignments pass through the existing oil and gas fields; however, the MD-4 alignment alternative has a shorter segment through the fields. Nonetheless, rigorous third party coordination and mitigation of impacts to those operations would be required. In addition to the oil and gas fields, both alignment alternatives cross numerous utility transmission lines, which would also require additional coordination with power companies.

Both alignments are a great distance from major roadways, which results in accessibility issues. Construction roads would be required to access and transport material to the construction site. The one constructability impact that separated the two alignments was that the MD-1 alignment alternative would have over 15% of its alignment length in floodplain.

Although both alignments are similar in constructability issues with utilities and accessibility, the MD-4 alignment alternative has slightly less constructability concerns due to the shorter length of floodplain crossings.

Results Summary

Based on the Phase 2 analysis the MD-4 alignment alternative is the recommended alignment resulting from the Phase 2 analysis. The MD-1 alignment alternative is not recommended for further consideration. For more information, see Section 7.3.

6.4.3 Bardwell (BA)

The following section describes the results of the Bardwell alignment alternatives Phase 2 analysis. For constructability analysis details, refer to the figure and table in Appendix E.

Capital Cost

The BA Base alignment alternative has a cost savings of 8% compared with the BA BA-3 alignment alternative. The BA-3 alignment alternative has additional complexity due to developed areas and greater wetland mitigation requirements.

Construction Duration

The BA-3 alignment alternative has a 16% longer construction duration compared with the BA Base alignment alternative. The BA-3 alignment alternative has a longer distance of viaduct which contributes to a longer schedule duration.

Constructability

The BA Base and BA-3 alignment alternatives have several constructability concerns. Both the alignments have a relatively high number of utility crossings that would require coordination with power companies. Additionally, BA-3 crosses IH-45 twice, which would require TxDOT coordination and permits. The BA-3 alignment alternative also has a high number of roadway crossings and a greater length of floodplain crossings.

The BA Base alignment alternative is a greater distance away from major roadways and would require additional access roads to be constructed.

Overall, the BA Base alignment alternative has fewer constructability issues.

Results Summary

While the BA-3 alignment alternative does not fare well in terms of cost and schedule relative to the BA Base alignment alternative, it does offer a significantly different alignment route. As such, both the BA Base and BA-3 alignment alternatives are recommended for advancement to provide for greater flexibility during more advanced planning should significant issues be identified along the BA-Base alignment. For more information, see Section 7.5.

6.4.4 Corsicana (CR)

The following section describes the results of the Corsicana alignment alternatives Phase 2 analysis. For constructability analysis details, refer to the figure and table in Appendix E.

Capital Cost

The CR-1 alignment alternative has a cost savings of 5% compared with the CR Base alignment alternative. The CR-1 alignment alternative has additional complexity due to developed areas and greater wetland mitigation requirements; however, the CR Base alignment alternative has a longer length of viaduct, which contributes to a higher overall cost.

Construction Duration

The CR-1 alignment alternative has a 15% shorter construction duration compared with the CR Base alignment alternative. The CR Base alignment alternative has substantially longer distance of viaduct which contributes to the longer schedule duration.

Constructability

The CR Base and the CR-1 alignment alternative both have similar constructability issues. Both alignments would have utility crossing impacts that would require additional coordination with power companies. There would be significant ROW concerns associated with the CR-1 alignment alternative given impacts to residential areas and existing mining operations. The CR Base alignment alternative would cross through more floodplain areas than the CR-1 alignment alternative, which would present some challenges.

Results Summary

Based on the Phase 2 analysis the CR-1 alignment alternative is the recommended alignment resulting from the Phase 2 analysis. The CR Base alignment alternative is not recommended for further consideration. For more information, see Section 7.6.

6.4.5 IH-45 Analysis

The IH-45 alternative (IH-45 Alt) was originally analyzed in comparison to the Base Utility Corridor Alignment developed during the *Step 1 Screening of Alternatives* analysis. However, as stated in Section 6.4.2, MD-4 was found to be the preferred alignment in the Middle Alternative Group. As such, the Phase 2 analysis analyzed the IH-45 Alt in comparison to an alignment that incorporated MD-4 and was identified as the IH-45 Base alignment alternative.

The following section describes the results of the IH-45 alignment alternatives Phase 2 analysis. For constructability analysis details, refer to the figure and table in Appendix E.

Capital Cost

The IH-45 Base has a cost savings of 4% compared with the IH-45 Alt. The IH-45 Alt alignment alternative has a longer length, additional complexity due to developed areas, and additional complexity due to third party coordination along IH-45. The IH-45 Base alignment alternative has a longer length of viaduct and additional complexity due to third party coordination within the oil and gas fields.

Construction Duration

The IH-45 Alt alignment alternative would have an 8% shorter construction duration compared with the Base Utility Corridor (with MD-4). The Base Utility Corridor (with MD-4) alignment has substantially longer distance of viaduct, which contributes to the longer schedule duration.

Constructability

The IH-45 Base and IH-45 Alt alignment alternatives will have multiple constructability issues. The IH-45 Base alignment alternative crosses through the oil and gas fields which would require some level of third party coordination. One of the biggest constructability challenges with IH-45 Base would be coordinating with oil and gas companies to modify or relocate existing wells and all associated modifications to existing piping and access networks. Obtaining ROW through this area would also require significant effort. The IH-45 Base alignment alternative also has a greater number of utility crossings, which would require additional coordination with power companies relative to the IH-45 Alt alignment alternative.

The IH-45 Alt alignment alternative extends into the existing IH-45 TxDOT ROW. Within the TxDOT ROW, the proposed HSR track would be mostly on embankment between the main highway lanes and the frontage roads; therefore, most road crossings of the highway would need to be extended over the new HSR line and an extended portion of frontage road would require realignment where sufficient space between the frontage roads and highway does not exist. This would result in numerous roadway and bridge reconstruction projects. These additional projects would involve significant secondary improvements and betterments to the existing infrastructure. Construction of the IH-45 Alt alignment alternative would negatively impact access to businesses and homes during construction. The frontage roads and driveways would need to be rebuilt to accommodate the HSR track alignment at multiple locations. Coordinating with TxDOT to permit the numerous roadway improvements would be a major challenge for construction of the IH-45 Alt alignment alternative due to its greater distance within the existing ROW.

In addition to the existing IH-45 and utility impacts, both alternatives would have 20% of the alignment length in floodplain. Overall, the rating shows the IH-45 Base alignment alternative has fewer constructability issues than the IH-45 Alt alignment alternative.

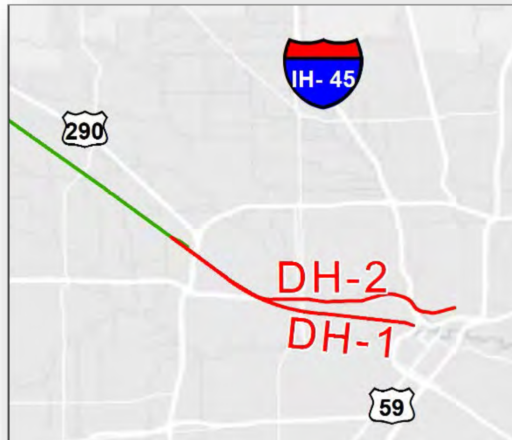
Results Summary

Based on the Phase 2 analysis the IH-45 Base and IH-45 Alt alignment alternatives are both recommended alignments. For more information, see Section 7.4.

7 Step 2 Screening Analysis Results Summary

The results of the Phase 1 and Phase 2 Step 2 Screening Analysis are presented for each Alternative Group in this section.

7.1 Downtown Houston (DH)



The alternatives analysis within the Downtown Houston Alternative Group was undertaken to study alignment alternatives reaching Downtown Houston from the proposed Utility Corridor. The farther an alignment extends into Downtown Houston, the more challenging construction would become and the more property impacts would be expected.

Phase 1 Results

The area surrounding the Downtown Houston alternative alignments is generally characterized by high density urban development with little rural land or open space. From an environmental perspective, the Downtown Houston alternatives were generally developed to find an acceptable route into downtown Houston, while minimizing impacts to historical and other problem areas, as well as local homes and businesses. Common areas of concern observed along the Downtown Houston alternatives are the Houston and Texas Central Railroad archaeology site, U.S. Healthways Hospital, the Heights Esplanade Historic District, the Smith Industries USEPA brownfield site, and Cottage Grove Park. (Figure D-1). Other major alignment specific constraints in the Downtown Houston alternative grouping include:

- Potential impacts to the Former Jefferson Davis Memorial Hospital and EPA brownfield site along DH-1
- Impacts to White Oak, Hogg, and Stude Park along DH-2
- Geometry that requires 3 curves for DH-1 and 11 total curves for DH-2
- Two major roadway crossings and four freight line crossings for DH-1
- Six major roadway crossings and three freight line crossings for DH-2

Based upon the Phase 1 analysis, the DH-2 alignment alternative was found less desirable than the DH-1 alignment alternative with respect to environmental impacts, and engineering concerns. Given that the DH-1 alternative was found infeasible within the Last Mile Analysis, DH-1 and DH-2 are therefore eliminated from further consideration as infeasible alternatives. A Phase 2 analysis within the Step 2 Screening was not considered warranted for access to Downtown Houston and DH-2 total scores. The significant additional impacts that would be realized would be difficult to mitigate, and expected schedules and costs would make the project financially infeasible. The Step 2 Screening analysis therefore supports the prior decision to terminate service at Loop 610.

Table 33 – Summary of Downtown Houston Ratings

Evaluation Categories	Downtown Houston Ratings DH-1 Downtown Amtrak	DH-2 Downtown IH-10
Engineering		
Alignment Length	2.50	1.50
Alignment Geometry	2.50	1.50
Viaduct Length and Major Structures	2.00	1.00
Crossings	1.20	1.60
Hydrology	3.00	1.00
ENGINEERING TOTAL	**11.20**	**6.60**
Environmental		
Streams, Wetlands, and Waterbodies	2.71	1.86
Natural Resources and Land Cover	2.50	2.00
Cultural Resources	2.20	1.80
Environmental Justice	1.86	1.86
Hazardous Sites	2.43	2.71
ENVIRONMENTAL TOTAL	**11.70**	**10.23**

Facts Supporting Elimination:

DH-1

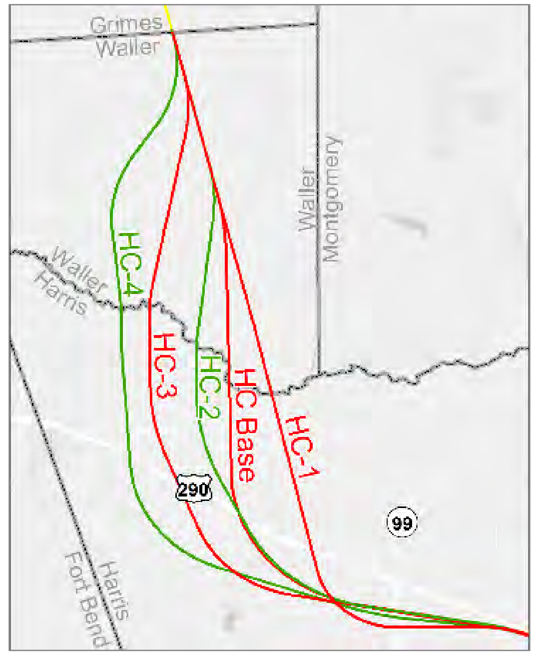
- Greatest impact to minorities
- Potential impacts to Jefferson Davis Memorial Hospital and Brownfield Site
- Greatest impact to USEPA facilities

DH-2

- Greatest impact to stream crossings, parallel streams, and waterbody crossings
- Greatest impact to low income families
- Direct impact to Hogg, Stude, White Oak Parks

Figure 17 – Chart of Downtown Houston Ratings

7.2 Hockley (HC)



The area surrounding the Hockley alternative alignments is generally characterized by new and expanding residential development. The Hockley Curve alternatives were developed to address the potential impacts to floodplain crossings, existing and planned residential communities, and tight curvature.

Phase 1 Results

A common area of concern observed along the Hockley alternatives is Saint Aidan's Church south of 290 (Figure D-2). Other alignment-specific constraints in the Hockley alternative grouping include:

- Zube Park and Hegar Cemetery along HC-1
- Kickapoo Preserve (planned residential development) along HC-3
- Greatest impacts to stream crossings, parallel streams, and waterbody crossings along HC Base

Based on the Phase 1 analysis, HC Base, HC-1, and HC-3 alignment alternatives can be eliminated from further consideration as unreasonable alternatives.

HC-4 and HC-2 had the highest scores and were proposed to move further into Phase 2 analysis. Both alignments avoid park land, have moderate impacts to waters of the U.S. and have no impact to hazardous sites. HC-4, which is the farthest to the west, avoids the existing and planned residential developments.

Table 34 – Summary of Hockley Ratings

Evaluation Categories	Hockley Ratings				
	HC Base Hegar Road	**HC-1** East of Hegar Road	**HC-2** West of Hegar Road	**HC-3** Kickapoo Road	**HC-4** West of Kickapoo Road
Engineering					
Alignment Length	2.00	2.50	1.50	1.50	1.00
Alignment Geometry	2.67	2.00	2.33	2.00	2.00
Viaduct Length and Major Structures	1.00	1.00	2.00	2.50	2.50
Crossings	1.80	2.00	1.80	1.60	1.80
Hydrology	1.75	1.50	2.00	2.50	2.50
ENGINEERING TOTAL	**9.22**	**9.00**	**9.63**	**10.10**	**9.80**
Environmental					
Streams, Wetlands, and Waterbodies	1.71	2.00	1.71	2.29	2.43
Natural Resources and Land Cover	2.25	2.25	2.50	2.00	2.50
Cultural Resources	2.60	2.20	2.80	3.00	2.60
Environmental Justice	2.29	1.71	2.29	1.57	2.00
Hazardous Sites	3.00	2.43	3.00	2.71	3.00
ENVIRONMENTAL TOTAL	**11.85**	**10.59**	**12.30**	**11.57**	**12.53**

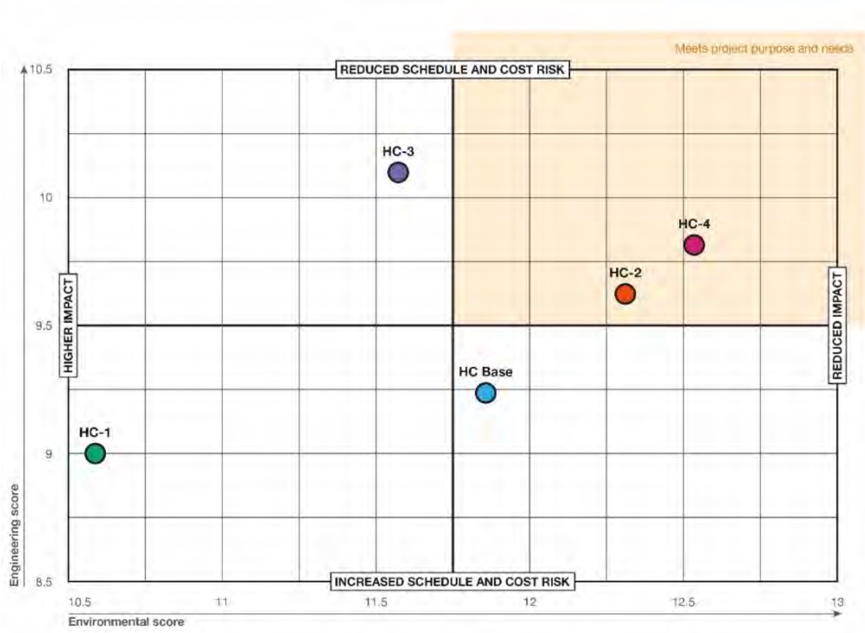


Figure 18 – Chart of Hockley Ratings

<u>Facts Supporting Elimination:</u>

HC Base

- Greatest impact to water resources

HC-1

- Direct impacts to Zube Park
- Worst environmental score
- Direct impact to Hegar Cemetery
- Alignment geometry

HC-3

- Kickapoo Preserve Housing Development
- Number of FEMA floodplain crossings
- Impact to Hockley Park

Phase 2 Results

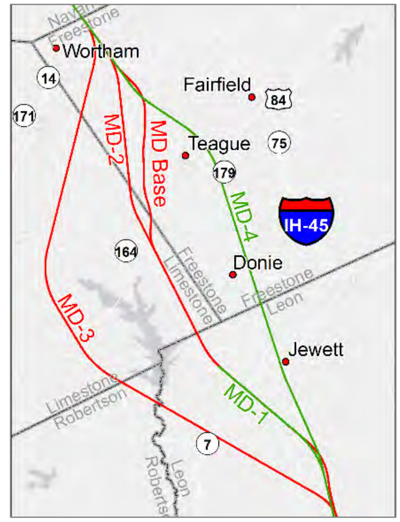
The following table summarizes the key Phase 2 analysis results for the Hockley alignment alternatives.

Table 35 – Summary of Phase 2 Hockley Alignment Alternative Summary

	Hockley Comparison	
	HC-2	**HC-4**
Evaluation Categories	***West of Hegar Road***	***West of Kickapoo Road***
Capital Cost	• 0.83 Cost Factor	• 0.81 Cost Factor
Construction Duration	• 0.60 Construction Duration Factor	• 0.48 Construction Duration Factor
Constructability	• Complex Crossing of US 290 • More Roadway Crossings Compared with HC-4 • Impacts to Large Detention Basin • Impacts to TxDOT Wetland area • ROW impacts to large (3970 acre) Rice University property	• Minor Impacts at Crossing of US 290

In the Phase 2 analysis, both HC-2 and HC-4 alignment alternatives have similar capital cost and construction durations. However, the Phase 2 analysis did identify several major project delivery concerns associated with the HC-2 alignment alternative (including complex US 290 10 lane crossing, impacts to TxDOT wetland area and large detention basin, and impacts to Rice University owned property). As such, HC-2 is not recommended for further consideration and the HC-4 alignment alternative is proposed to move forward to further analysis through the NEPA process.

7.3 Middle (MD)



The Middle alternative alignment grouping surrounds Lake Limestone, an impoundment of the Navasota River, which straddles the shared border of Robertson, Limestone, and Leon Counties. The landscape setting is heavily influenced by oil and gas development and mining east of the lake. Wetlands and floodplains are common along the larger tributaries that feed Lake Limestone. The Middle alternatives were generally developed to avoid impacts to oil and gas infrastructure, the City of Jewett, and Lake Limestone.

Phase 1 Results

Common areas of concern for all alternative alignments are Oxford Cemetery, Ten Mile Cemetery, and Union Church. Additionally, all alignments run through oil and gas fields (Figure D-3). Other alignment-specific constraints in the Middle alternative grouping include:

- Navasota River crossing and wetlands along MD-3
- Protected species occurrence areas along MD Base, MD-1, and MD-3
- Multiple cemetery impacts along MD-3
- Longest viaduct length for MD Base
- Longest alignment length for MD-3
- Greatest number and length of stream crossings for MD-2

MD-1 and MD-4 had the highest scores and were proposed to move further into Phase 2 analysis. MD Base, MD-2, and MD-3 alignment alternatives can be eliminated from further consideration as unreasonable alternatives based on the Phase 1 analysis.

Table 36 – Summary of Middle Ratings

	Middle Ratings				
	MD Base	**MD-1**	**MD-2**	**MD-3**	**MD-4**
Evaluation Categories	East of Utility Corridor	West of Utility Corridor	West of Browns Lake	West of Lake Limestone	East of Teague
Engineering					
Alignment Length	2.50	2.50	2.00	1.00	2.00
Alignment Geometry	2.33	2.67	2.67	2.67	3.00
Viaduct Length	2.00	2.50	2.00	2.00	3.00
Major Structures	2.20	2.20	2.20	2.20	2.00
Hydrology	2.00	2.00	1.50	2.00	3.00
ENGINEERING TOTAL	**11.03**	**11.87**	**10.37**	**9.87**	**13.00**
Environmental					
Streams, Wetlands, and Waterbodies	2.29	1.86	1.86	2.14	2.29
Natural Resources and Land Cover	2.00	2.00	2.25	2.50	2.00
Cultural Resources	2.20	2.40	2.40	2.00	2.80
Environmental Justice	2.00	2.29	2.29	1.57	2.29
Hazardous Sites	2.86	2.86	2.86	3.00	2.71
ENVIRONMENTAL TOTAL	**11.35**	**11.41**	**11.66**	**11.21**	**12.09**

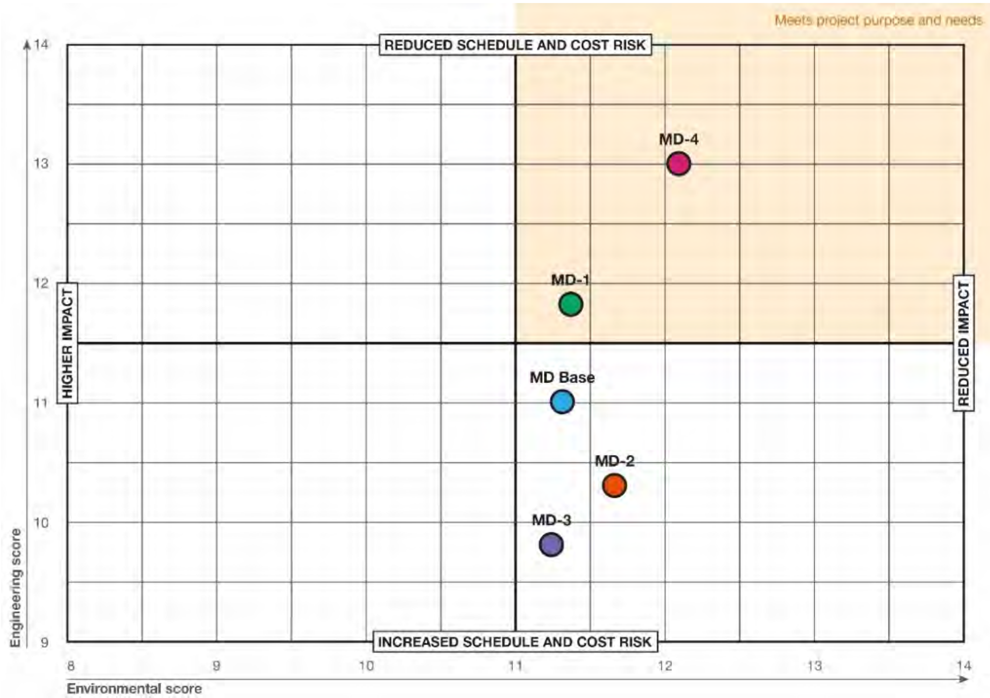


Figure 19 – Chart of Middle Ratings

Facts Supporting Elimination:

MD Base

- Impacts to Union Church & Ten Mile Cemetery
- Longest length of viaducts

MD-2

- Impacts to Union Church & Ten Mile Cemetery

MD-3

- Impacts to Lenamon, Shiloh, and Ten Mile Cemeteries
- Impacts to Union Church
- Oil and gas well impacts
- Multiples FEMA floodplain crossings
- Longest alignment

Phase 2 Results

The following table summarizes the key Phase 2 analysis results for the Middle alignment alternatives.

Table 37 – Summary of Phase 2 Middle Alignment Alternative Summary

Evaluation Categories	Middle Comparison	
	MD-1	**MD-4**
	West of Utility Corridor	***East of Teague***
Capital Cost	• 1.13 Cost Factor	• 0.96 Cost Factor
Construction Duration	• 1.22 Construction Duration Factor	• 0.95 Construction Duration Factor
Constructability	• Over 15% of Length within Floodplain • Accessibility, Pre-Construction Activities, Railroad Crossings, Utility Crossings, ROW, and Permitting Similar between both Alternatives	• Accessibility, Pre-Construction Activities, Railroad Crossings, Utility Crossings, ROW, and Permitting Similar between both Alternatives

In the Phase 2 analysis, the MD-4 alignment alterative has a lower capital cost factor and construction duration factor. Furthermore, The MD-4 alignment alternative would require significantly less construction within floodplains, which would eliminate significant constructability concerns and associated risks and permitting requirements. Based on the results of the Phase 2 analysis the MD-1 alignment alternative is not recommended for further consideration and the MD-4 alignment alternative is proposed to move forward to further analysis through the NEPA process.

7.4 IH-45 (IH-45)

The IH-45 alternative alignment grouping was developed to take in to account public opinion and contrast potential impacts to developed and undeveloped areas. By remaining in proximity to the utility corridor, the IH-45 Base alignment would pass through rural and undeveloped lands. In contrast, The IH-45 Alt alignment would take advantage of the IH-45 rights-of-way, passing through established urban areas.

Phase 1 Results

A common area of concern observed along the IH-45 alternatives is the potential to impact protected species habitat, specifically potential Bald Eagle nesting habitat, in the area surrounding the Richland Chambers Reservoir (Figure D-4). Other alignment specific constraints in the IH-45 alternative grouping include:

- Additional protected species occurrence areas along IH-45 Base
- Impact to Fort Boggy State Park along IH-45 Alt

Engineering and environmental analysis was not sufficient to eliminate one of the alternatives. Both the IH-45 Base and IH-45 Alt alternatives are proposed for advancement to Phase 2 for further analysis.

Table 38 – Summary of IH-45 Ratings

	IH-45 Ratings	
	IH-45 Base	**IH-45 Alt**
Evaluation Categories	Utility Corridor	IH-45
Engineering		
Alignment Length	2.50	1.50
Alignment Geometry	2.67	2.67
Viaduct Length and Major Structures	2.00	3.00
Crossings	2.60	1.80
Hydrology	2.25	2.50
ENGINEERING TOTAL	**12.02**	**11.47**
Environmental		
Streams, Wetlands, and Waterbodies	1.57	2.43
Natural Resources and Land Cover	2.00	2.00
Cultural Resources	1.80	3.00
Environmental Justice	2.14	1.29
Hazardous Sites	2.71	2.43
ENVIRONMENTAL TOTAL	**10.22**	**11.15**

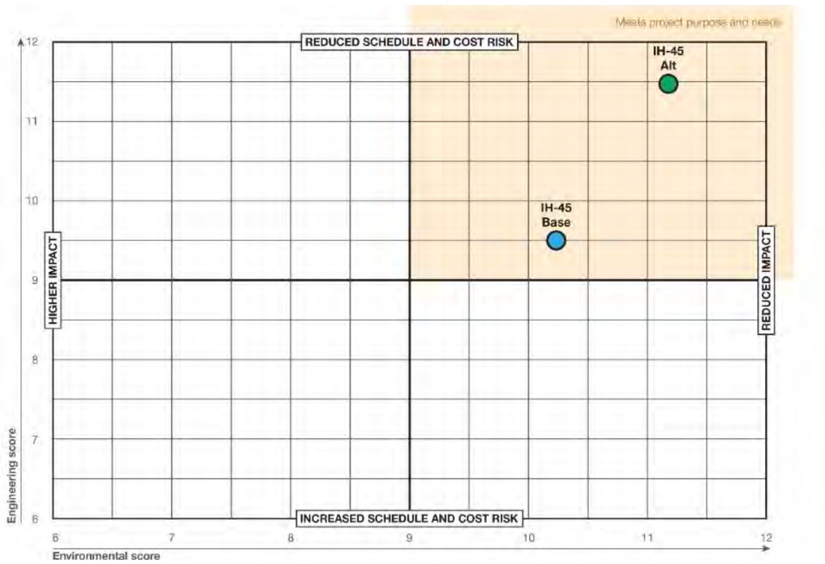


Figure 20 – Chart of IH-45 Ratings

Phase 2 Results

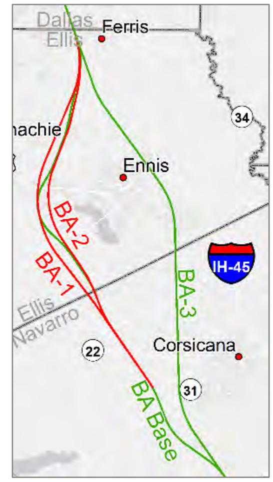
The following table summarizes the key Phase 2 analysis results for the IH-45 alignment alternatives.

Table 39 – Summary of Phase 2 IH-45 Alignment Alternative Summary

	IH-45 Ratings	
	IH-45 Base	**IH-45 Alt**
Evaluation Categories	***Utility Corridor (w/ MD-4)***	***IH-45***
Capital Cost	• 1.00 Cost Factor	• 1.04 Cost Factor
Construction Duration	• 1.00 Construction Duration Factor	• 0.92 Construction Duration Factor
Constructability	• Larger Number of Utility Crossings • Acquisition of ROW within Oil Well Area • Permitting Required for Oil Well Area	• Large Length of IH-45 Service Road Reconstruction • Large Number of Roadway Crossings • Major Structures at IH-45 Interchanges • Acquisition of ROW within IH-45 • Permit Required for IH-45 Area

The Phase 2 analysis of the IH-45 Alt alignment alternative did reveal significant concerns related to associated roadway improvements to frontage roads along IH-45 and coordination requirements with TxDOT. However, given significant comments raised during Project Scoping, and given uncertainties associated with construction through dense oil and gas fields, additional analysis of the IH-45 Alt alignment alternative is warranted. Potential benefits of improvements to IH-45 associated with delivery of the HSR project, potential acceleration of work within the IH-45 ROW through advance coordination with TxDOT, and potential elimination of the need for substantial private ROW acquisition along the Utility Corridor Base Alignment and MD-4 alignment alternative may allow for IH-45 Alt alignment alternative to be the preferable alternative. As such, both alternatives are proposed to move forward to further analysis through the NEPA process.

7.5 Bardwell (BA)



The Bardwell area includes undeveloped and rural agricultural lands with small pockets of residential development near the Cities of Bardwell, Palmer, Corbet, and Alma. Three Bardwell alternatives were generally developed to improve geometric design, avoid floodplains and wetlands, and minimize lake/stream crossings with associated easements near Bardwell Lake.

Phase 1 Results

The primary environmental constraint identified in the Bardwell area is the extensive floodplain and wetland complex along Richland Creek and Bardwell Lake. A common area of concern observed long the Bardwell alternatives is the potential to impact protected species habitat, specifically potential bald eagle nesting habitat, in the area surrounding the Richland Chambers Reservoir (Figure D-5). Other alignment-specific environmental constraints in the Bardwell alternative grouping include:

- USEPA Registered Facilities with petroleum storage along BA-1
- Proximity to Boren-Regar Cemetery along BA-Base and BA-1
- Lake Bardwell crossing and potential USACE easement requirement for BA-2
- Lucille Cemetery, Melton Landfill, and a water tower along BA-3

Based on the Phase 1 analysis, BA-2 is not recommend for further analysis due to direct impacts to Lake Bardwell. Results of the GIS based analysis indicate that BA-1 has the greatest number of parallel stream crossings and impacts to emergent wetlands and USEPA Facilities. Consequently, BA-1 is not recommended for further analysis. The BA-Base (the alignment alternative with the highest engineering score) and BA-3 (the alignment alternative with the highest environmental score) are proposed for advancement to Phase 2 for further analysis.

Table 40 – Summary of Bardwell Ratings

Evaluation Categories	Bardwell Ratings			
	BA Base West UC	**BA-1** Far West UC	**BA-2** West of Bardwell Lake	**BA-3** East of Ennis
Engineering				
Alignment Length	2.50	1.50	2.50	1.50
Alignment Geometry	2.33	2.67	2.67	3.00
Viaduct Length and Major Structures	3.00	2.00	2.50	3.00
Crossings	2.00	2.00	1.80	1.40
Hydrology	2.50	2.00	1.75	2.25
ENGINEERING TOTAL	**12.33**	**10.17**	**11.22**	**11.15**
Environmental				
Streams, Wetlands, and Waterbodies	1.86	1.43	1.86	2.14
Natural Resources and Land Cover	2.00	2.00	1.75	2.00
Cultural Resources	2.60	2.80	2.60	2.60
Environmental Justice	2.14	2.29	2.14	1.71
Hazardous Sites	2.71	2.14	2.71	3.00
ENVIRONMENTAL TOTAL	**11.31**	**10.66**	**11.06**	**11.45**

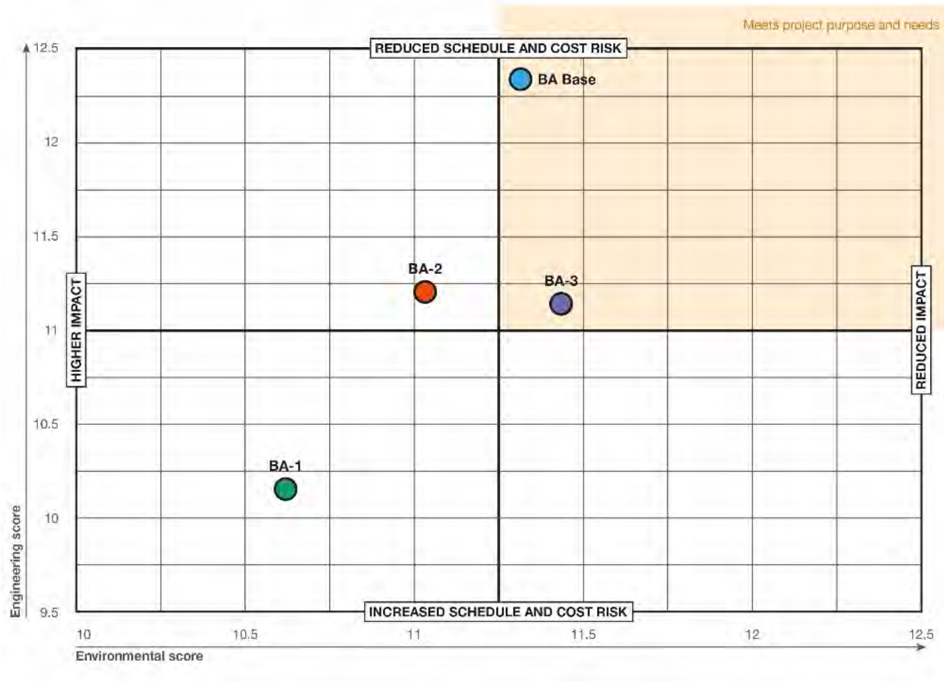


Figure 21 – Chart of Bardwell Ratings

Facts Supporting Elimination:

BA-1

- Direct impact to registered USEPA facility with petroleum storage tank
- Worst overall environmental score

BA-2

- Crossing on Lake Bardwell would require lengthy permitting process with high risk

Phase 2 Results

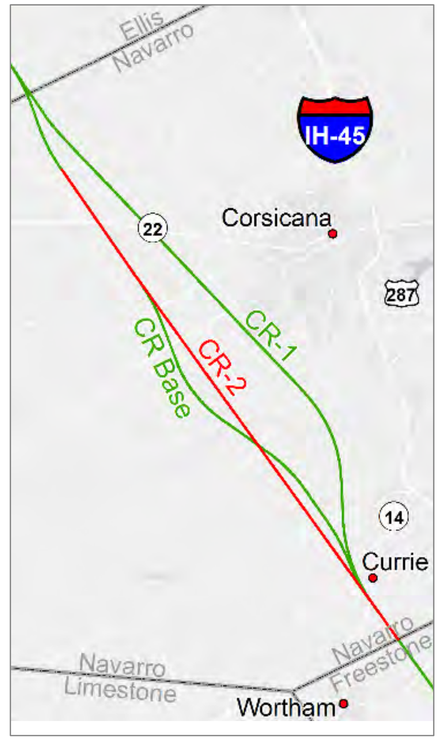
The following table summarizes the key Phase 2 analysis results for the Bardwell alignment alternatives.

Table 41 – Summary of Phase 2 Bardwell Alignment Alternative Summary

	Bardwell Comparison	
	BA Base	**BA-3**
Evaluation Categories	***West Utility Corridor***	***East of Ennis***
Capital Cost	• 1.00 Cost Factor	• 1.08 Cost Factor
Construction Duration	• 1.00 Construction Duration Factor	• 1.16 Construction Duration Factor
Constructability	• Greater Distance from Major Roadways	• Greater Length of Floodplain Impacts • Two Major Crossings of IH-45 • Permit Required for Crossing IH-45

In the Phase 2 analysis, the BA Base has more favorable capital cost and construction durations than the BA-3 alignment alternative. However, the Phase 2 analysis did not identify any major project delivery concerns associated with either alternative, and the two alternatives offer significantly different routes offering flexibility during more detailed planning analyses. As such, both alternatives are proposed to move forward to further analysis through the NEPA process.

7.6 Corsicana (CR)



Similar to Bardwell, the area surrounding the Corsicana alternative alignments is generally characterized by undeveloped land and rural agricultural land, floodplains (Richland Creek), and wetlands. Nearby Cities include Oak Valley and Corsicana. The Corsicana alternatives were generally developed to minimize wetland and floodplain crossings along the larger tributaries (Richland Creek and Pin Oak Creek) feeding Richland Chambers Reservoir.

Phase 1 Results

A common area of concern observed along the Corsicana alternatives is the potential to impact protected species habitat, specifically potential Bald Eagle nesting habitat, in the area surrounding the Richland Chambers Reservoir (Figure D-6). Other alignment-specific environmental constraints in the Corsicana alternative grouping include:

- Mine facility along CR-1
- Melton Landfill along CR-2

Based on the Phase 1 analysis, CR-2 is not recommended for further analysis because it has the greatest potential to impact streams, waterbodies, and wetlands. CR-1 is distinguished by having the lowest impacts to streams, waterbodies, and wetlands; however, the mining facility may pose logistical constraints, which are otherwise avoided by CR-Base. As such, additional analysis is needed to further distinguish CR-1 and CR-Base.

CR Base and CR-1 are proposed for advancement to Phase 2 for further analysis.

Table 42 – Summary of Corsicana Ratings

	Corsicana Ratings		
	CR Base	**CR-1**	**CR-2**
Evaluation Categories	West of Utility Corridor	Oak Valley	Central Utility Corridor
Engineering			
Alignment Length	2.50	1.50	2.00
Alignment Geometry	2.33	2.67	3.00
Viaduct Length and Major Structures	2.50	3.00	2.00
Crossings	2.60	2.00	2.40
Hydrology	2.00	3.00	2.00
ENGINEERING TOTAL	**11.93**	**12.17**	**11.40**
Environmental			
Streams, Wetlands, and Waterbodies	2.00	2.57	1.43
Natural Resources and Land Cover	1.75	2.00	2.50
Cultural Resources	2.60	2.60	2.20
Environmental Justice	1.71	1.29	1.57
Hazardous Sites	2.71	3.00	3.00
ENVIRONMENAL TOTAL	**10.77**	**11.46**	**10.70**

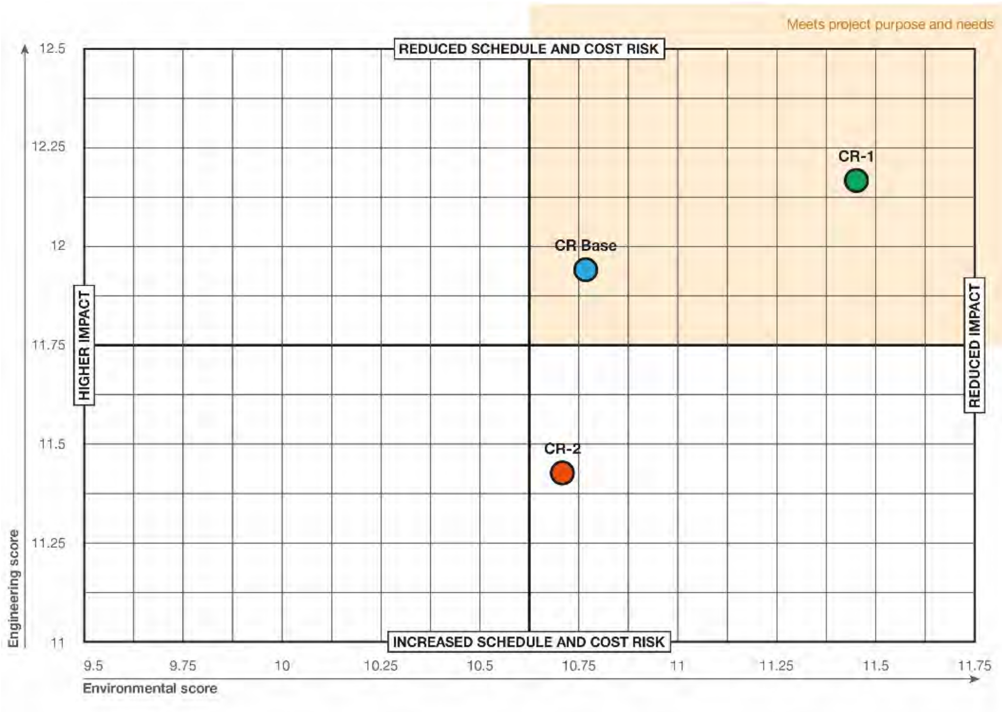


Figure 22 – Chart of Corsicana Ratings

Facts Supporting Elimination:

CR-2

- Number of FEMA floodplain crossings
- Worst overall environmental score

Phase 2 Results

The following table summarizes the key Phase 2 analysis results for the Corsicana alignment alternatives.

Table 43 – Summary of Phase 2 Corsicana Alignment Alternative Summary

	Corsicana Ratings	
	CR Base	**CR-1**
Evaluation Categories	***West of Utility Corridor***	***Oak Valley***
Capital Cost	• 1.00 Cost Factor	• 0.95 Cost Factor
Construction Duration	• 1.00 Construction Duration Factor	• 0.85 Construction Duration Factor
Constructability	• Greater Number and Length of Floodplain Crossings	• Oak Valley Residential Area and Mine Impacted (ROW)

In the Phase 2 analysis, the CR-1 alignment alterative has a lower capital cost factor and construction duration factor. Furthermore, The CR-1 alignment alternative would require significantly less construction within floodplains, which would eliminate significant constructability concerns and associated risks and permitting requirements. Based on the results of the Phase 2 analysis the CR-Base alignment alternative is not recommended for further consideration and the CR-1 alignment alternative is proposed to move forward to further analysis through the NEPA process.

8 End to End Alignment Alternatives Recommended for NEPA Analysis

A summary of alignment alternatives recommended for NEPA analysis based upon the results of the Step 2 Screening are listed in Table 44 below.

Table 44 – Summary of Alternatives Studied and Recommended for NEPA Analysis

Alternative Groups	Alternatives Considered in Phase 1	Alternatives Studied in Phase 2	Recommended Alignment Alternatives for NEPA Analysis
Downtown Houston	2	None*	---
Hockley	5	HC-2 and HC-4	HC-4
Middle	5	MD-1 and MD-4	MD-4
Bardwell	4	BA Base and BA-3	BA Base and BA-3
IH-45	2	IH-45 Base** and IH-45 Alt	IH-45 Alt***
Corsicana	3	CR Base and CR-1	CR-1

*A Phase 2 analysis within the Step 2 Screening was not considered warranted for access to Downtown Houston due to the low DH-2 score and *Last Mile Analysis Report* results of DH-1.

**IH-45 Base includes MD-4 which was found to be preferred over the Base UC Alignment in Phase 1

***The IH-45 Base was also found to be a recommended alternative within the IH-45 Alternative Group, but this base alignment reflects MD-4 in combination with portions of the original Utility Corridor Base Alignment. As such, the IH-45 Base is not a unique alternative.

The alignment alternatives within each Alternative Group recommended to advance for further study through the NEPA process can be combined with segments of the Utility Corridor Base Alignment where no alternatives were studied in the Step 2 Screening effort. To support the NEPA analysis effort, connections between overlapping alignment alternatives recommended to advance within each Alternative Group based upon the Step 2 Screening were developed. These connections allow for the study of four end-to-end alignment alternatives from Houston to Dallas within the Utility Corridor. A preliminary assessment of these connections between overlapping alignment alternatives in the Corsicana, Bardwell, and IH-45 Alternative Groups was performed and no fatal flaws were identified.

Development of these connections between alternative alignment segments essentially changes the limits of common segments and alignment alternatives as studied within the Step 2 Screening. In order to support further analysis through the NEPA process, the alternative alignments studied within the Step 2 Screening effort and recommended for advancement were redefined with new common points to allow for the study of end-to-end combinations of these alternative alignments. These new "Alignment Segments" are identified in Table 45 below and are shown on Figure 23.

Table 45 – NEPA Segments developed from Recommended Alignment Alternatives

NEPA Segment	Description	Contains Phase 2 Alternative
1	Common Segment	*Part of Utility Corridor Base Alignment and HC-4*
2A	East Teague	MD-4, CR-1
2B	IH-45	IH-45 Alt, CR-1
3A	East Bardwell	BA Base, CR-1
3B	West Bardwell	BA-3, CR-1
4	Common Segment	*Part of Utility Corridor Base Alignment. No alternative.*

All possible combinations of "NEPA Segments" were then developed to create four end-to-end alignment alternatives between Houston and Dallas as shown in Appendix G. It is expected that these end-to-end alignment alternatives would be further refined through the NEPA analyses to mitigate any identified impacts.

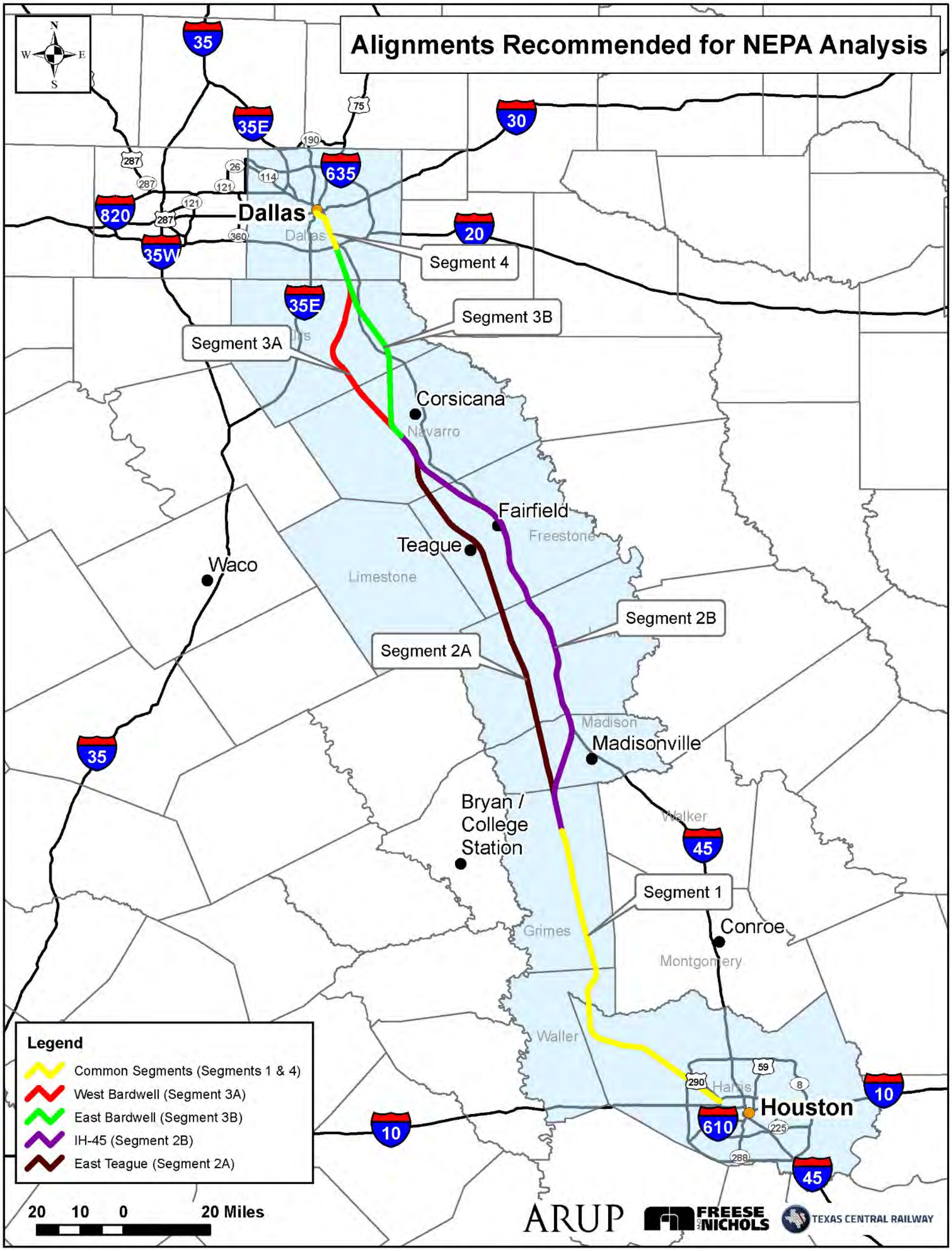


Figure 23 – Summary of Alignments Recommended for NEPA Analysis

9 Conclusion

Through the Step 2 Screening process documented herein, 21 separate alignment alternatives were studied with respect to a broad range of engineering, environmental, and project delivery considerations. Two separate study phases were undertaken to evaluate alignment alternatives and six of those alignment alternatives are recommended for further study within the NEPA process.

The Step 1 Screening process identified a reasonable HSR corridor for development of a HSR system linking Houston and Dallas using the Japanese HSR technology. The corridor was identified as the Utility Corridor in the *Step 1 Screening of Alternatives Report*.

To support the Step 1 Screening analysis of competing corridors, a baseline alignment was developed for each corridor. The alignment used to identify the preferred Utility Corridor in that analysis was carried forward into the Step 2 Screening effort and has been referred to herein as the Utility Corridor Base Alignment.

Potential impacts and constructability concerns were identified along segments of this Base Alignment during the Step 1 Screening process. The Step 2 Screening then developed alignment alternatives within the Utility Corridor that satisfied HSR design criteria. These alignment alternatives were also developed to mitigate the identified impacts and concerns along the Base Alignment while being sensitive to identified environmental constraints within the corridor.

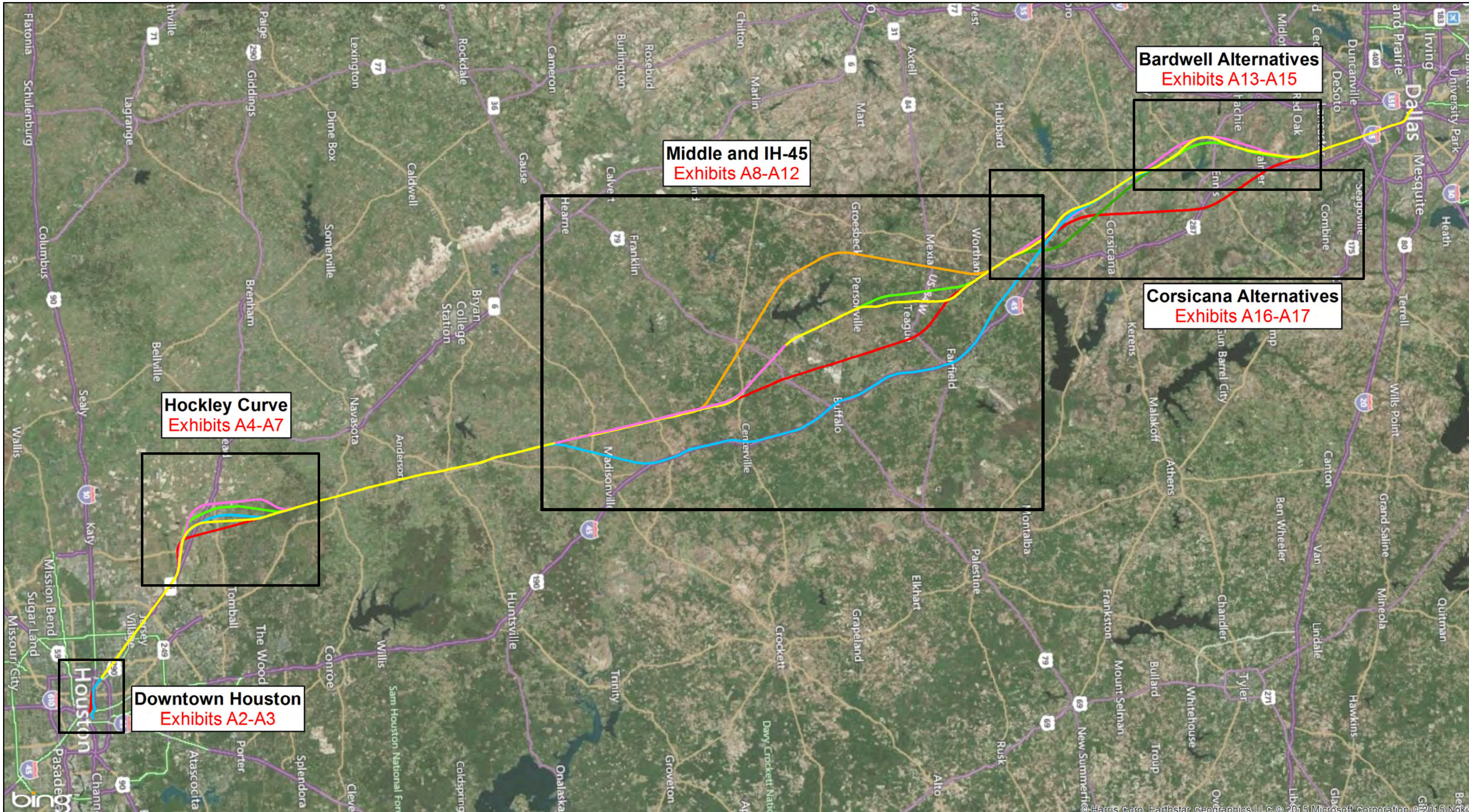
Alignment alternatives were not studied over the full length of the Utility Corridor given that no feasible alignment alternatives existed for the approach into either Houston or Dallas (each approximately 20 miles long) that would not yield significant impacts and constructability concerns. Likewise, no alignment alternatives were developed along approximately 70 miles of the Base Alignment between Hockley and Jewett where the Utility Corridor Base Alignment ran directly adjacent to the electrical transmission line with no major concerns identified. The Step 2 Screening effort was focused on the study of more significant alignment variations within the Utility Corridor where expected impacts or constructability concerns warranted further study of alternatives to mitigate these issues. In all, 21 separate alignment alternatives were developed.

Six separate Alternative Groups were identified to organize the 21 alignment alternatives developed and to allow for the comparative analysis of competing alternatives. The Step 2 Screening process first evaluated the alignments alternatives within the six separate Alternative Groups through a Phase 1 analysis, which looked at a variety of evaluation metrics covering environmental and engineering concerns. The highest rated alignment alternatives within each group were then evaluated with respect to project delivery considerations through the Phase 2 analysis. Through this two phase comparative analysis of competing alternatives those best aligned with the Project Purpose and Need were identified. Alignment alternatives not recommended for further analysis would be expected to have greater environmental impact and more significant constructability concerns that would negatively impact Project financial viability. In addition to the quantitative and qualitative evaluation undertaken through this two phase analysis, specific impacts that supported elimination of alternatives were also identified.

Through the two phase Step 2 Screening process 21 alignment alternatives, including the original Utility Corridor Base Alignment, were studied across a broad range of evaluation metrics covering environmental, engineering, and constructability concerns. Based upon the results of the analysis, six alignment segments are recommended for further study. These six alignment segments were combined into four end-to-end alternatives from Houston to Dallas that are proposed for advancement through the NEPA analysis.

Appendix A

Alternative Alignment Figures



Legend

Base Alignment

0 37,500 75,000 150,000 Feet

N

NAD 1983 StatePlane Texas Central FIPS 4203 Feet US

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1601 Elm Street, Suite 4343, Dallas, Texas 75201

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Texas Registered Engineering Firm: F-1990

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Title
Alternatives Overview

Status	Date	Drawn by
Issue	06-25-2015	BH

Job No	Exhibit No	Rev
234180-00	A1	P1

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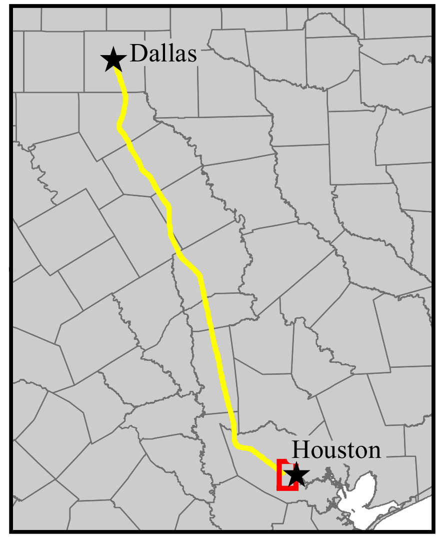
Arup Texas Inc.

Downtown Houston - Alternative DH-1

A-2



Common Analysis End Point

DH-1 Alignment

FEMA Floodplain

NWI Wetland

Electrical Transmission Line

0 1.5 3

Miles

Base UC Alignment Issues	Alternative Approach
Alignment ends at Loop 610 Station	Alignment ends at Downtown Amtrak Station

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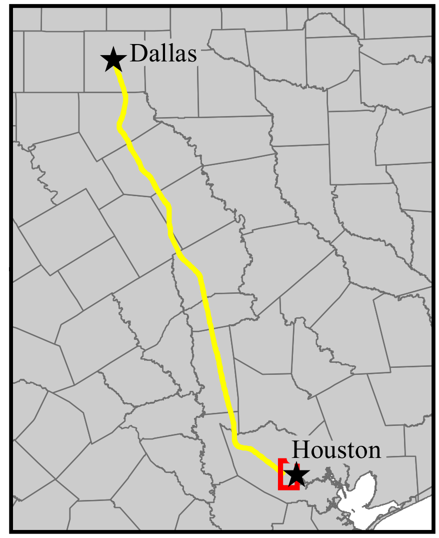
Downtown Houston - Alternative DH-2

A-3



Common Analysis End Point

DH-2 Alignment

FEMA Floodplain

NWI Wetland

Electrical Transmission Line

0 1.5 3

Miles

Base UC Alignment Issues	Alternative Approach
Alignment ends at Loop 610 Station	Alignment ends at Hardy Yards Station

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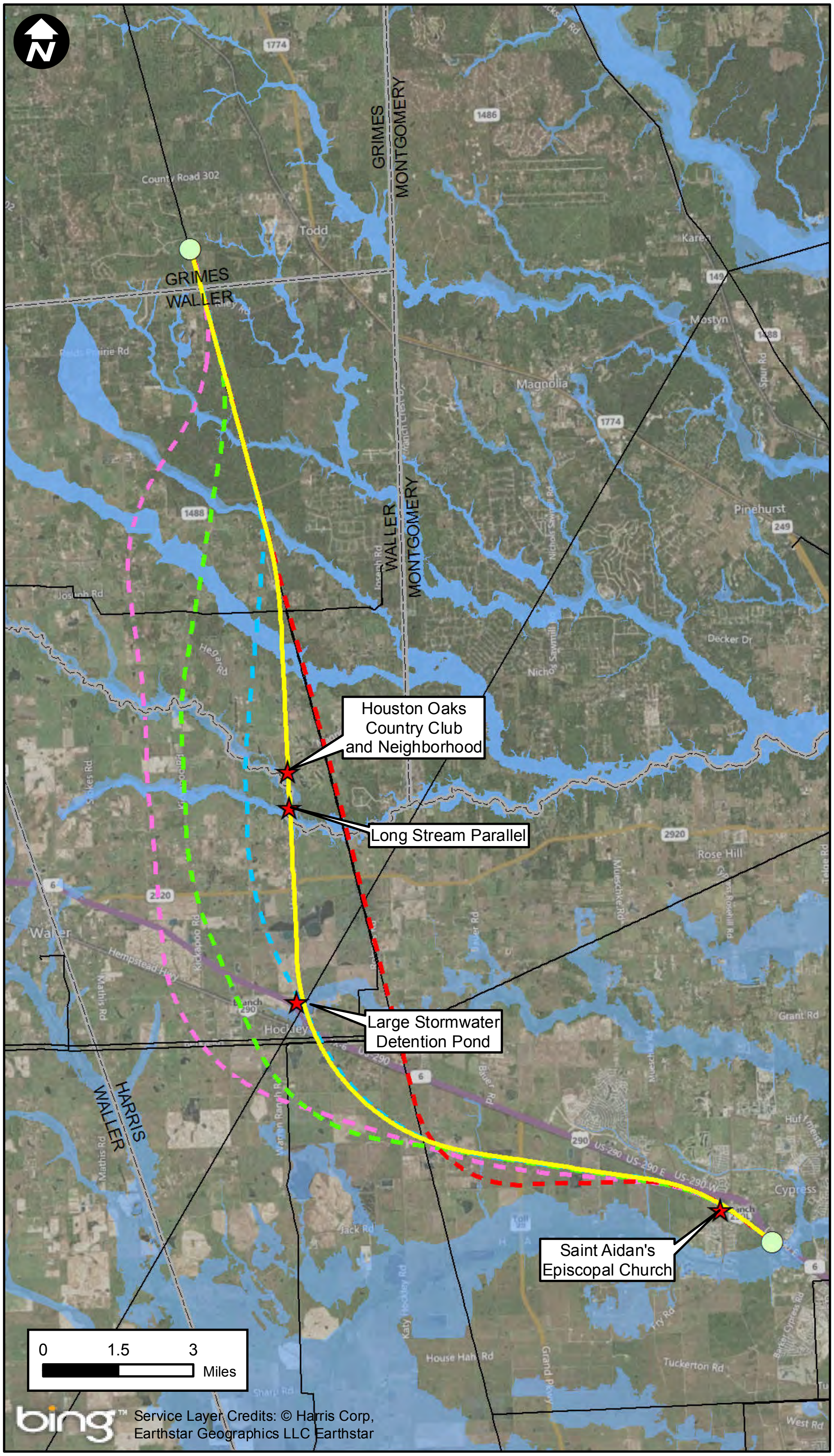
Alternative Group - Hockley



Legend

Environmental Area of Concern

Common Analysis End Point

Electrical Transmission Line

FEMA 100-Yr Floodplain

Alignments

HC Base Alignment

HC-1 Alignment

HC-2 Alignment

HC-3 Alignment

HC-4 Alignment

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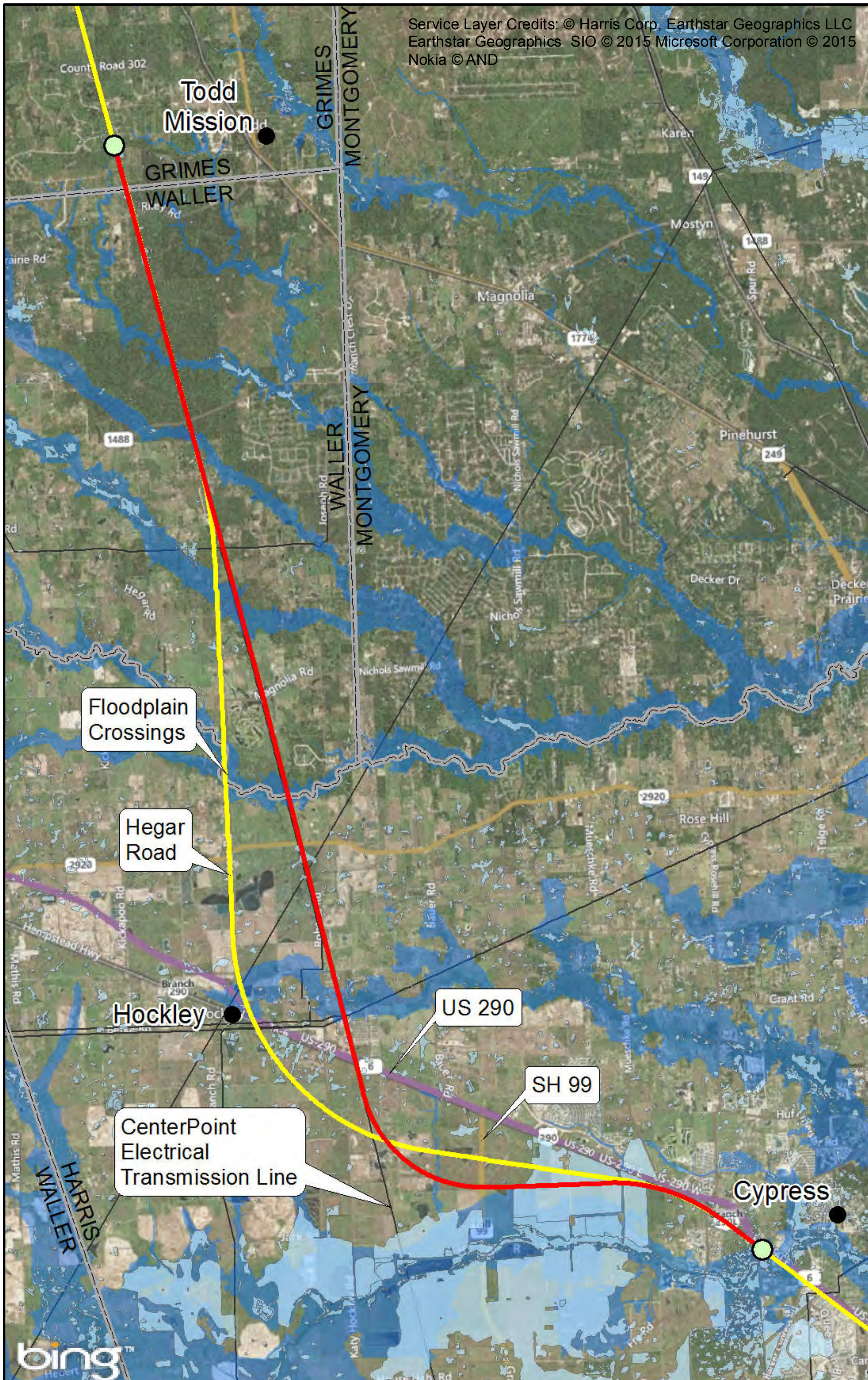
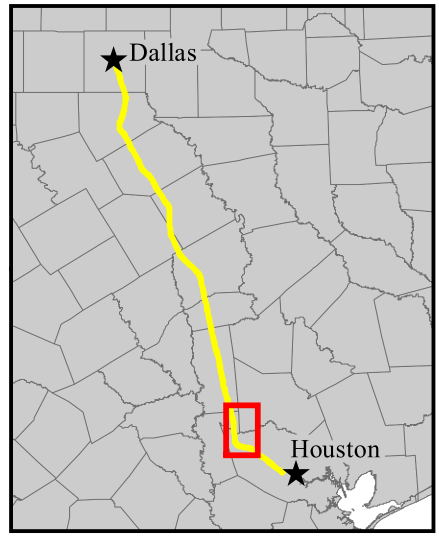
Hockley - Alternative HC-1

A-4





Common Analysis End Point

Base UC Alignment

HC-1 Alternative

FEMA Floodplain

NWI Wetland

Electrical Transmission Line

0 1.5 3 4.5
Miles

Base UC Alignment Issues	Alternative Approach
Away from Utility ROW Possible property impacts Possible floodplain impacts	Follows Utility ROW to the east

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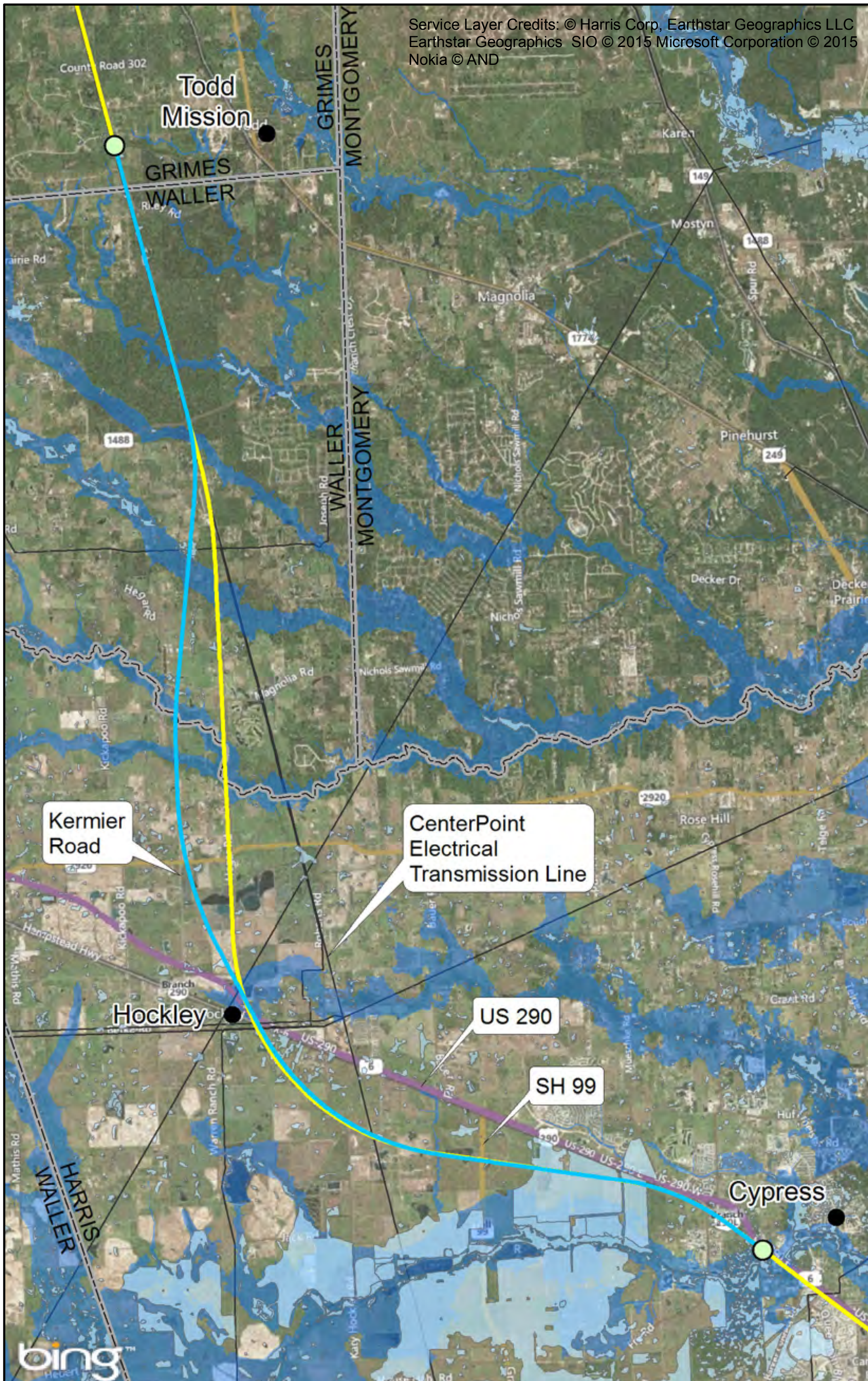
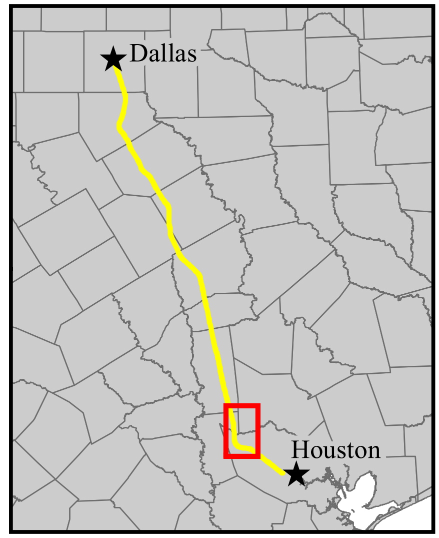
Hockley - Alternative HC-2

A-5





- Common Analysis End Point
- Base UC Alignment
- HC-2 Alignment
- FEMA Floodplain
- NWI Wetland
- Electrical Transmission Line

0 2 4 6
Miles

Base UC Alignment Issues	Alternative Approach
Away from Utility ROW Possible property impacts Possible floodplain impacts	Minimizes property impacts

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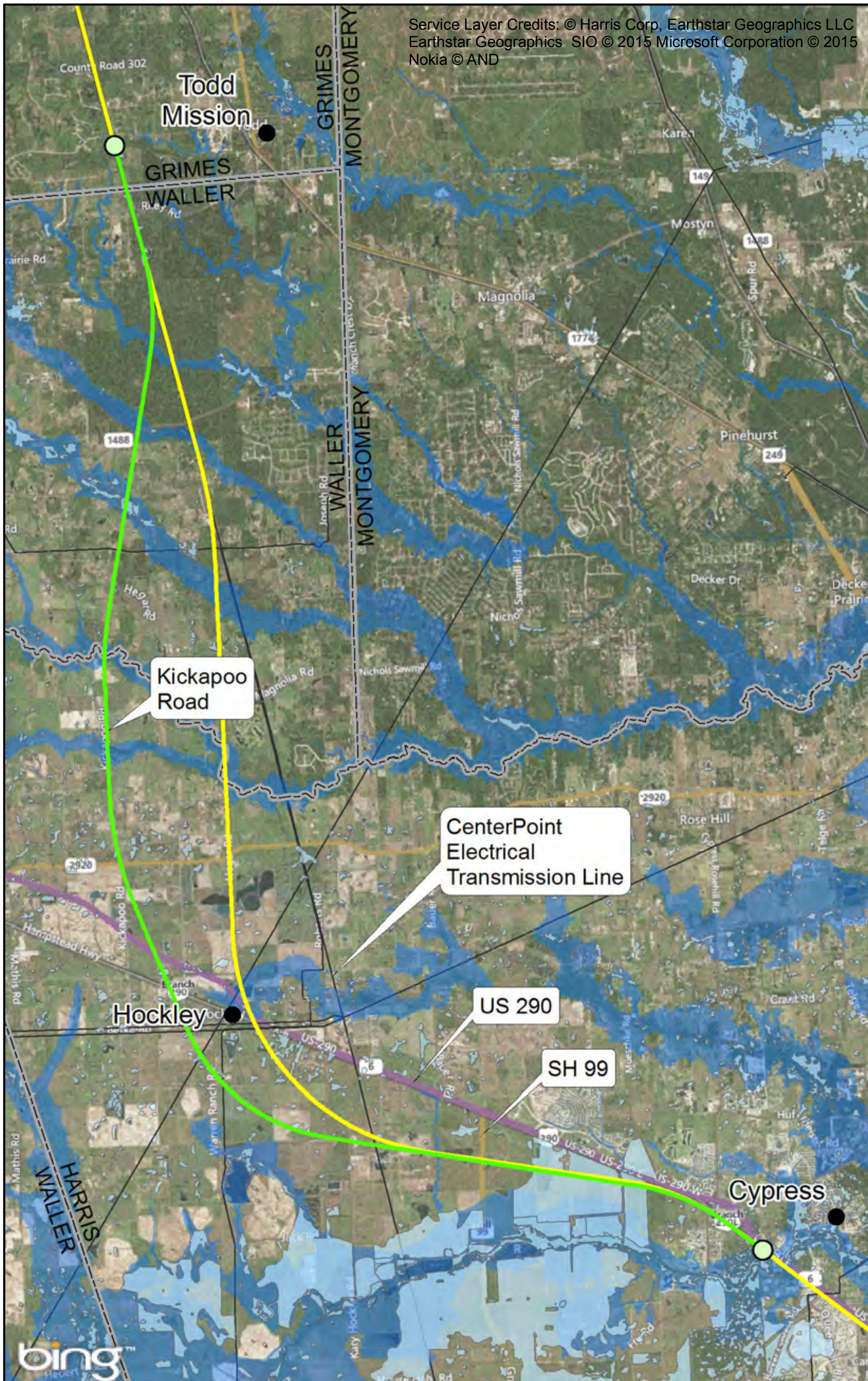
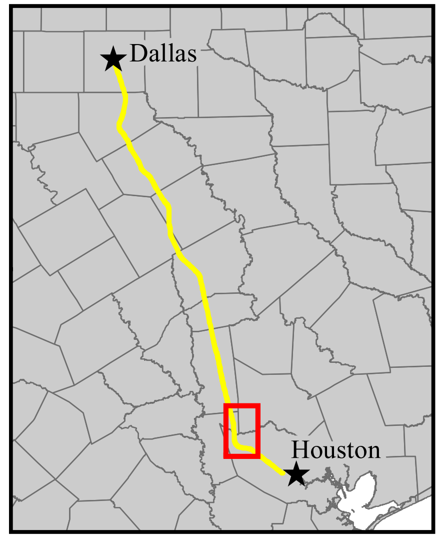
Hockley - Alternative HC-3

A-6





Common Analysis End Point

Base UC Alignment

HC-3 Alignment

FEMA Floodplain

NWI Wetland

Electrical Transmission Line

0 2 4 6

Miles

Base UC Alignment Issues	Alternative Approach
Away from Utility ROW Possible property impacts Possible floodplain impacts	Minimizes floodplain impacts Minimizes property impacts

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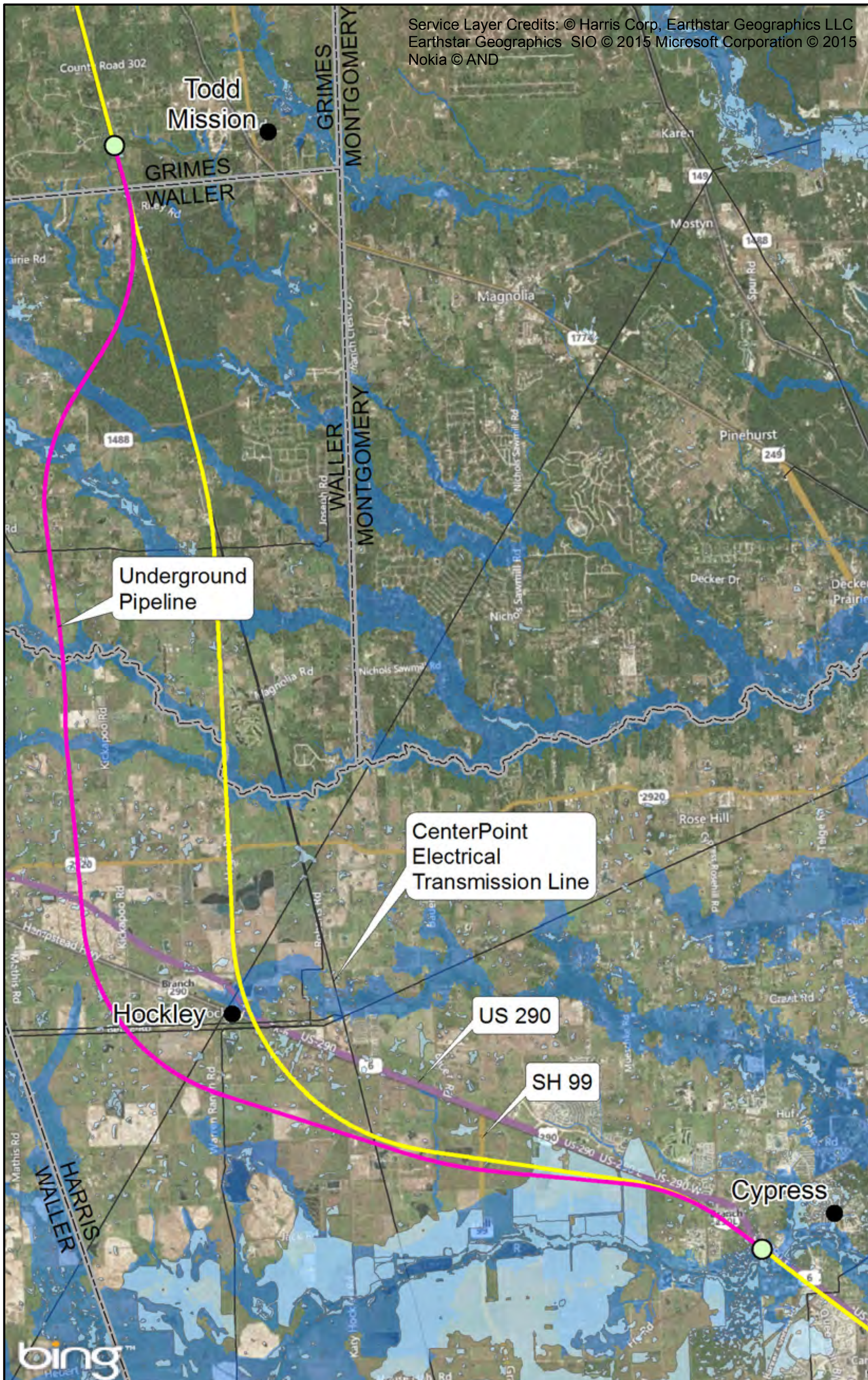
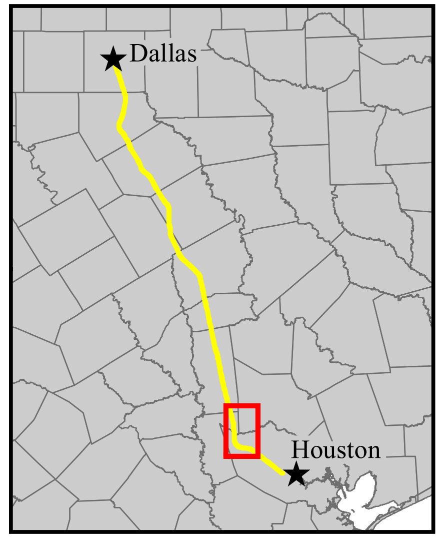
Hockley - Alternative HC-4

A-7





Common Analysis End Point

Base UC Alignment

HC-4 Alignment

FEMA Floodplain

NWI Wetland

Electrical Transmission Line

0 2 4 6

Miles

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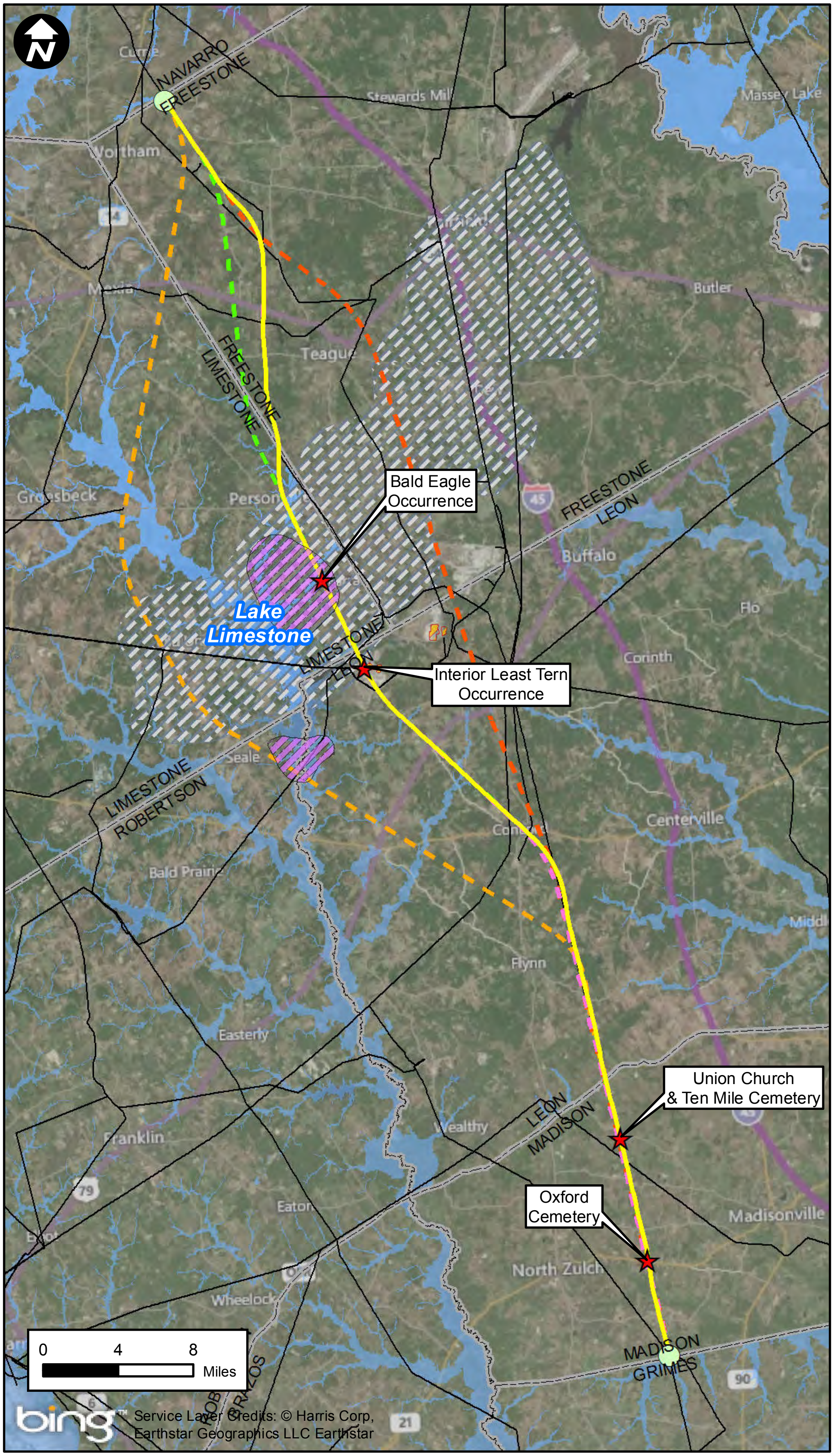
Base UC Alignment Issues	Alternative Approach
Away from Utility ROW Possible property impacts Possible floodplain impacts	Minimizes floodplain impacts Minimizes property impacts Follows pipeline ROW

Alternative Group - Middle



Legend

- Environmental Area of Concern
- Common Analysis End Point
- Electrical Transmission Line
- Bald Eagle Occurrence
- Interior Least Tern Occurrence
- FEMA 100-Yr Floodplain
- Oil & Gas Fields

Alignments

- MD Base Alignment
- MD-1 Alignment
- MD-2 Alignment
- MD-3 Alignment
- MD-4 Alignment

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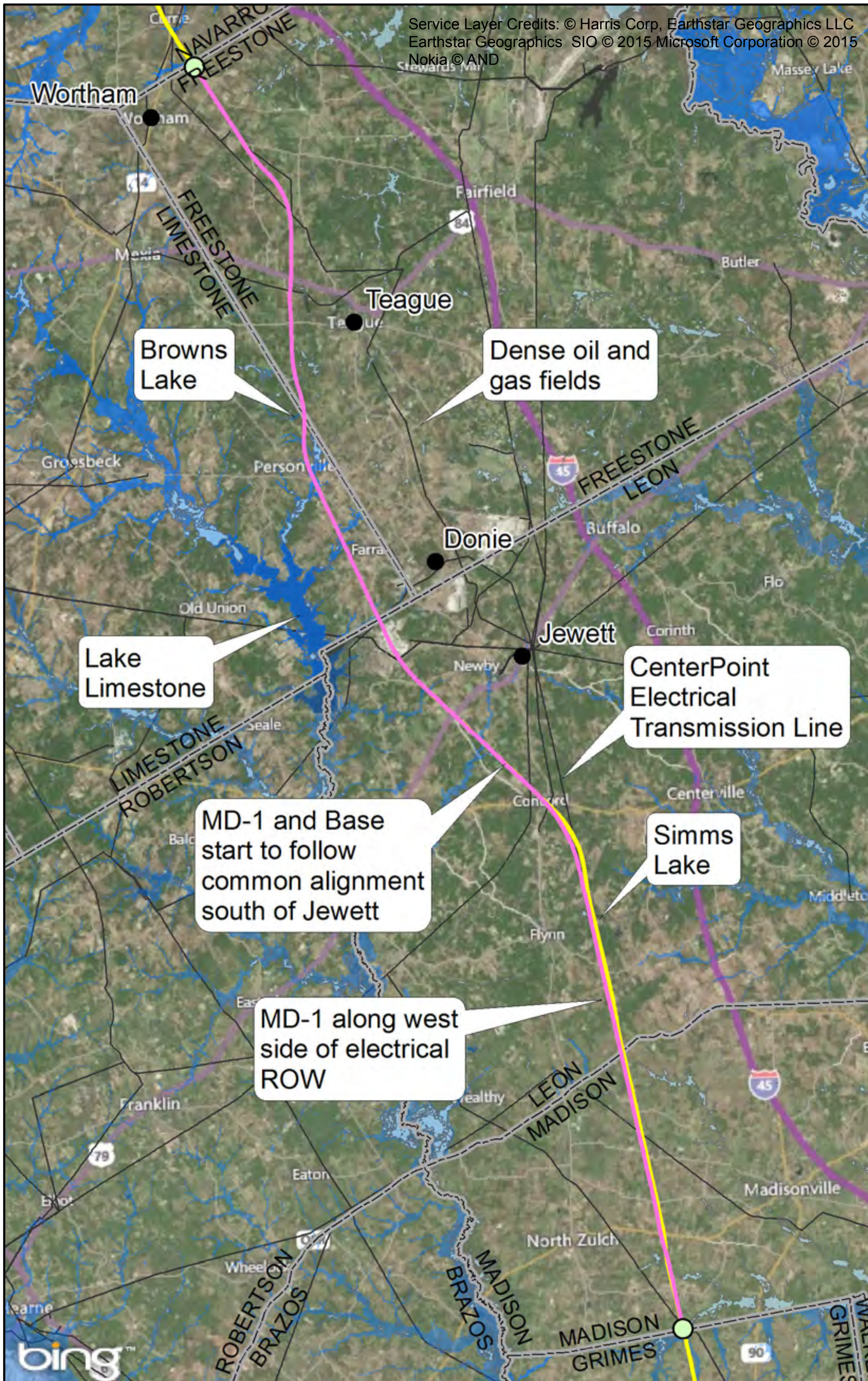
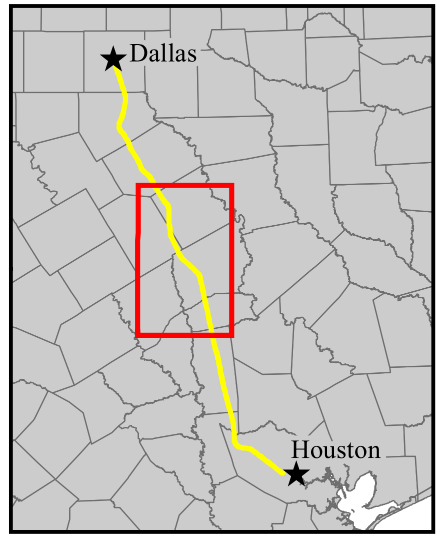
Middle - Alternative MD-1

A-8





Common Analysis End Point

Base UC Alignment

MD-1 Alignment

FEMA Floodplain

NWI Wetland

Electrical Transmission Line

0 5.5 11 16.5

Miles

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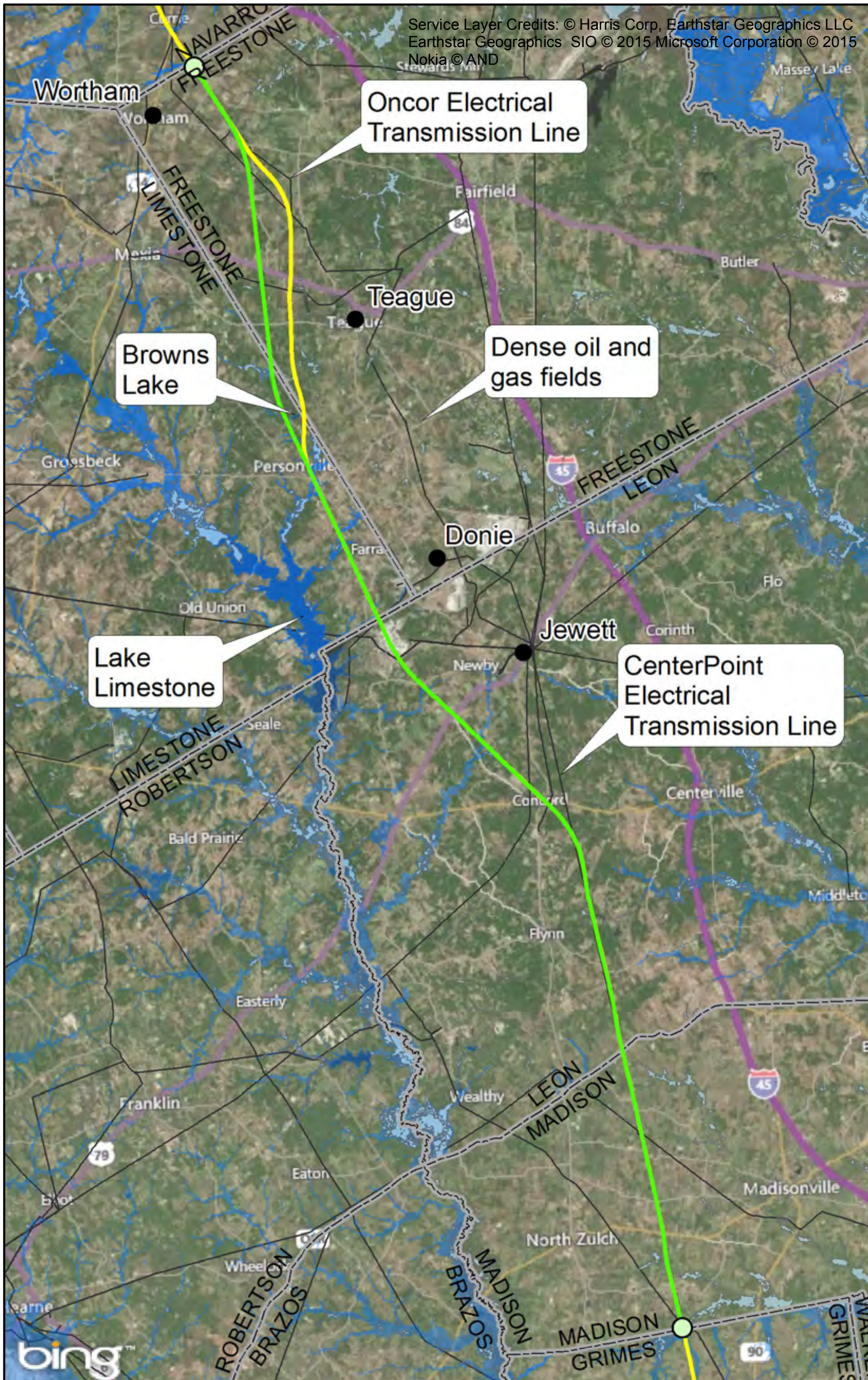
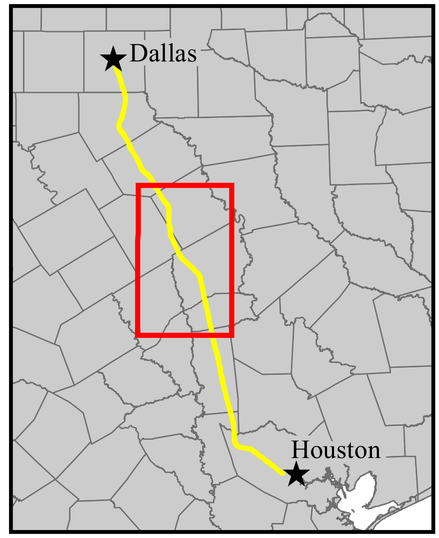
Base UC Alignment Issues	Alternative Approach
Numerous oil field impacts Safety/Constructability concerns	Follows utlilty ROW to the west Avoids impacts to Simms Lake

Middle - Alternative MD-2

A-9





Common Analysis End Point

Base UC Alignment

MD-2 Alignment

FEMA Floodplain

NWI Wetland

Electrical Transmission Line

0 5.5 11 16.5

Miles

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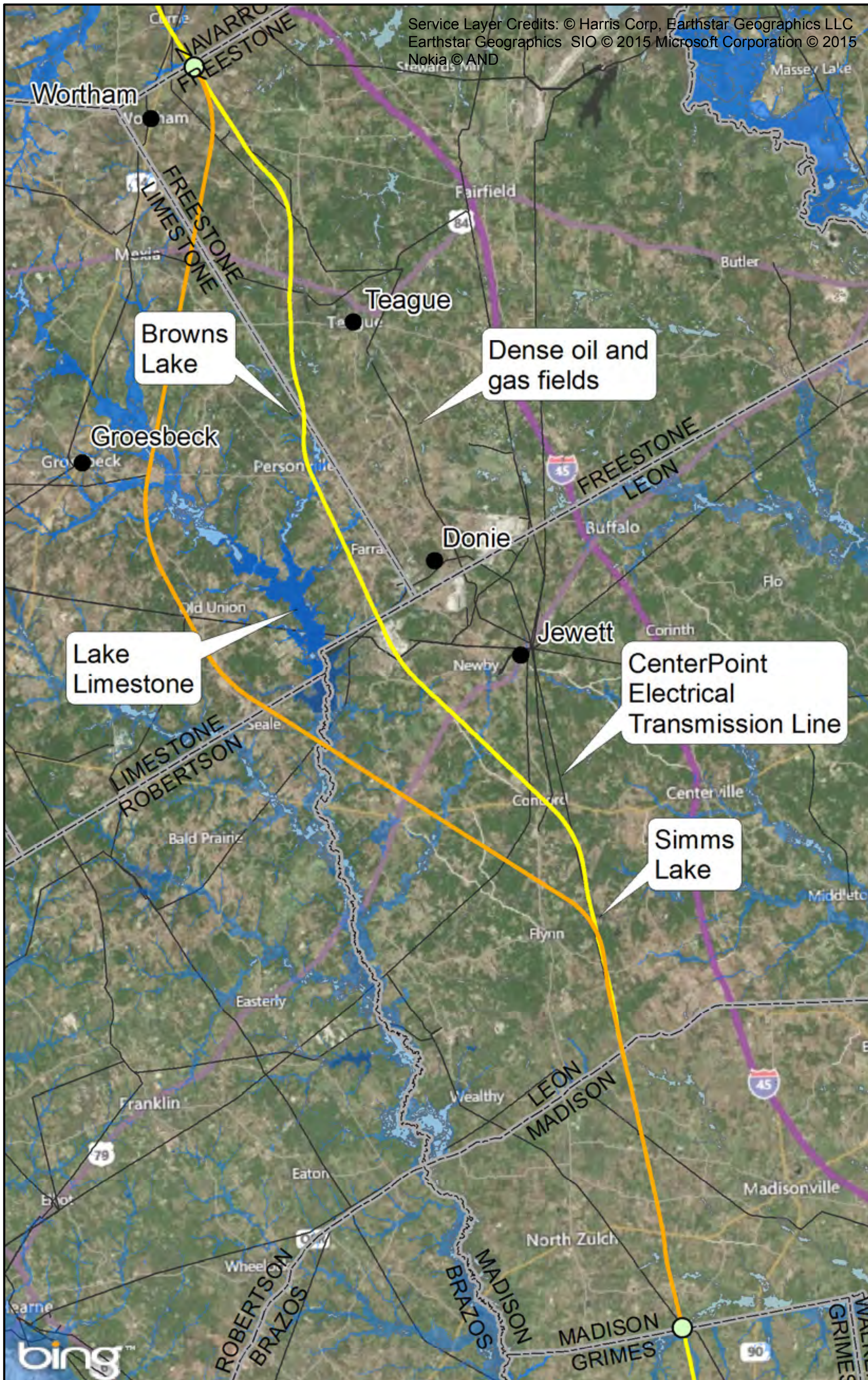
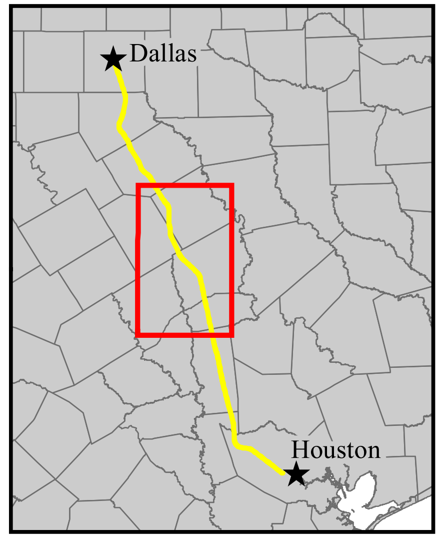
Base UC Alignment Issues	Alternative Approach
Numerous oil field impacts Safety/Constructability concerns	Improves track geometry Avoids impact to Browns Lake

Middle - Alternative MD-3





Common Analysis End Point

Base UC Alignment

MD-3 Alignment

FEMA Floodplain

NWI Wetland

Electrical Transmission Line

0 5.5 11 16.5

Miles

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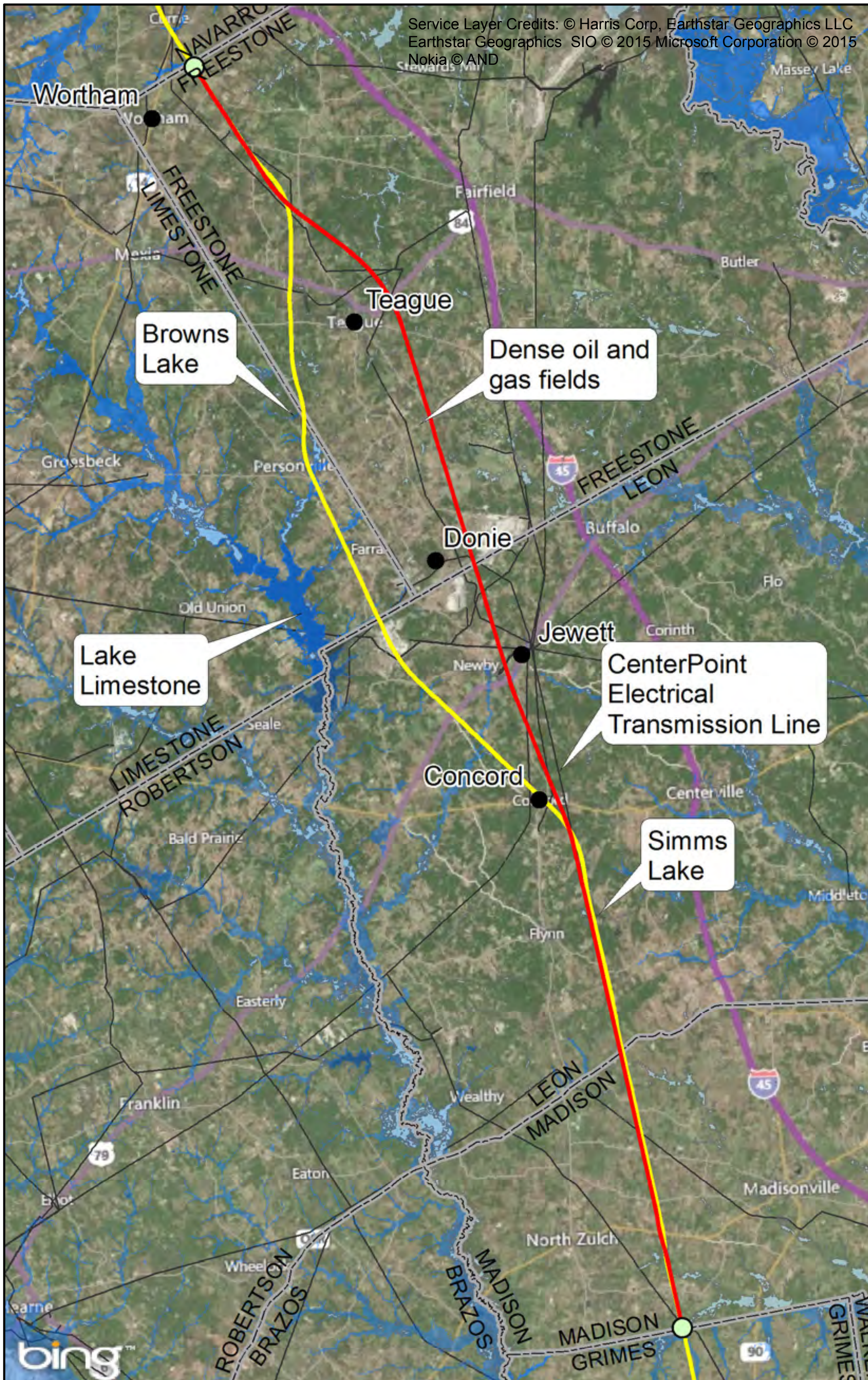
FREESE AND NICHOLS

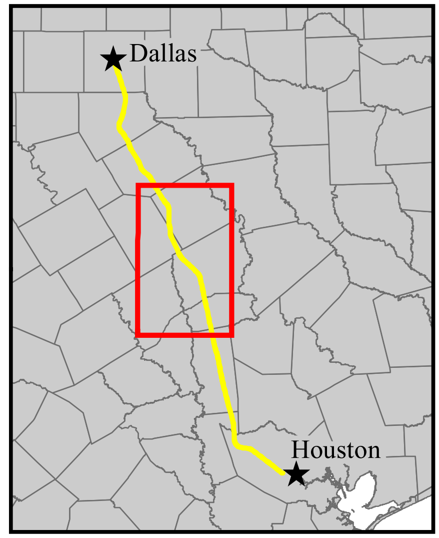
TEXAS CENTRAL RAILWAY

Base UC Alignment Issues	Alternative Approach
Numerous oil field impacts Safety/Constructability concerns	Follows pipeline ROW Minimizes oil and gas well impacts

Middle - Alternative MD-4

A-11





- Common Analysis End Point
- Base UC Alignment
- MD-4 Alignment
- FEMA Floodplain
- NWI Wetland
- Electrical Transmission Line

0 5.5 11 16.5
Miles

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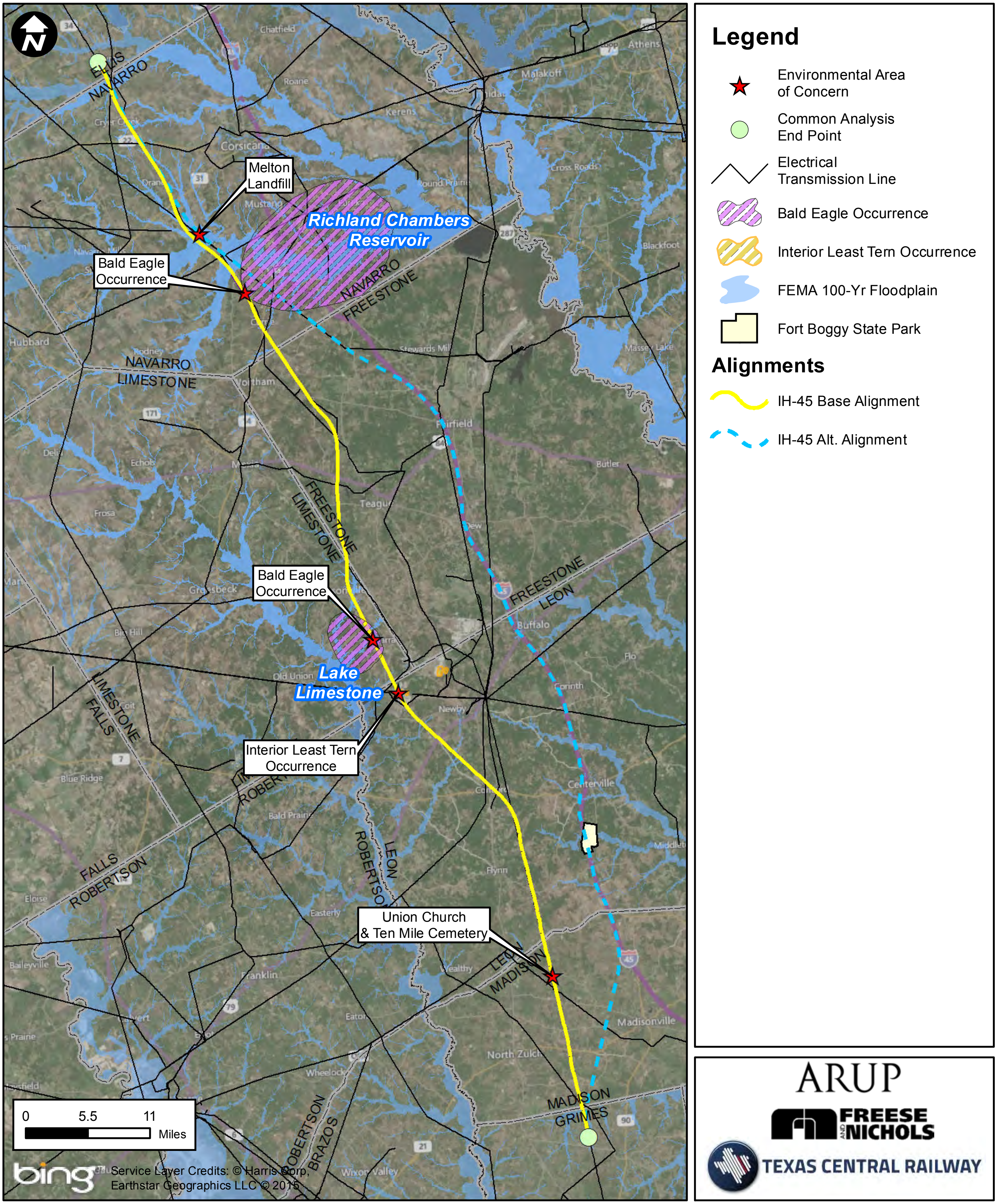
TEXAS CENTRAL RAILWAY

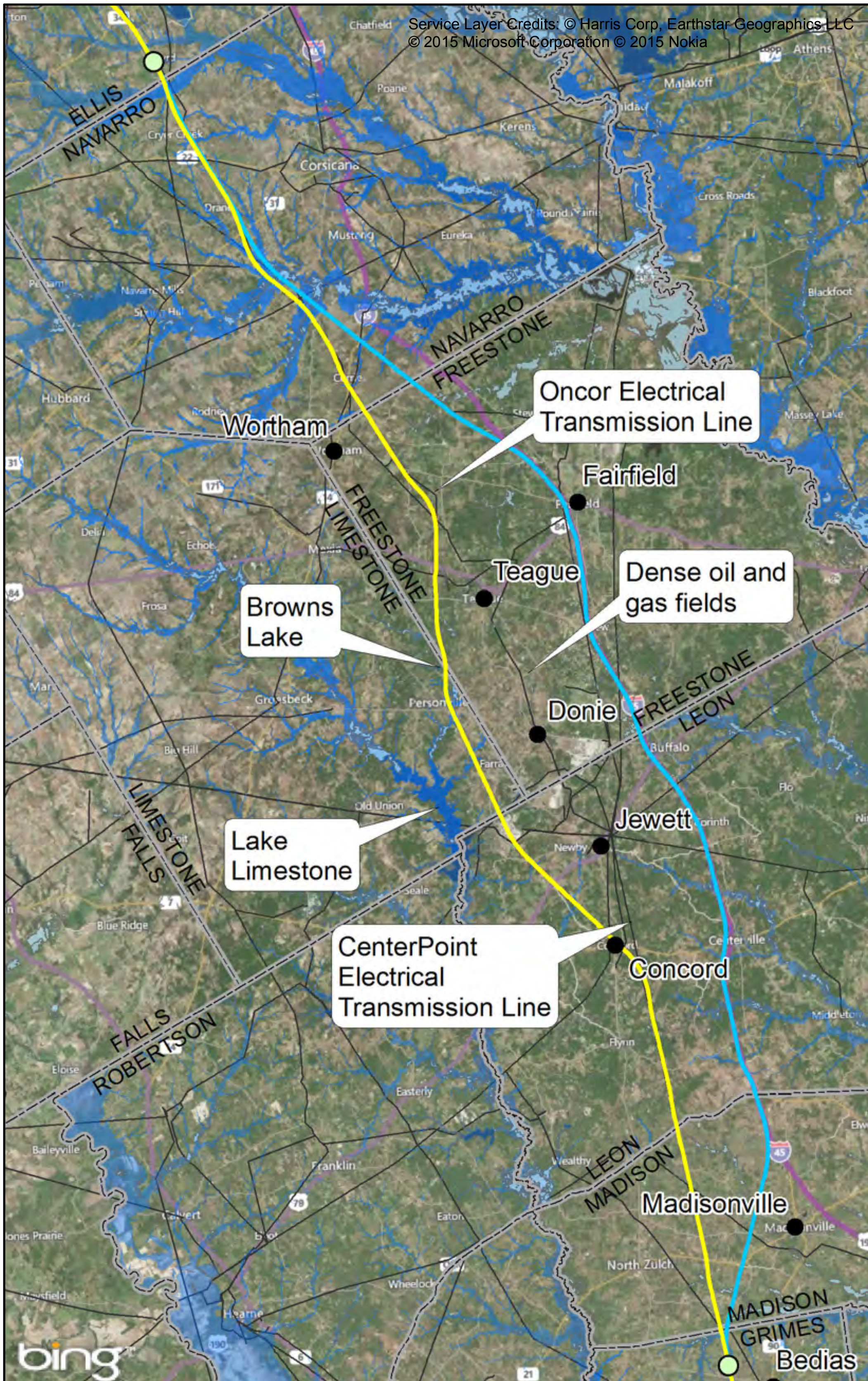
Base UC Alignment Issues	Alternative Approach
Numerous oil field impacts Safety/Constructability concerns	Minimizes oil and gas well impacts

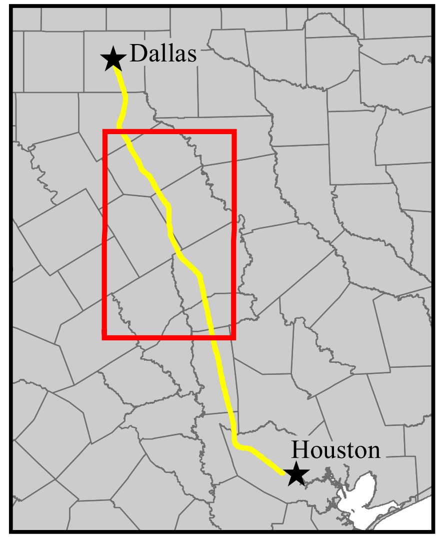
Alternative Group - IH-45



Interstate IH-45 - Alternative

A-12





Common Analysis End Point

Base UC Alignment

IH-45 Alt. Alignment

FEMA Floodplain

NWI Wetland

Electrical Transmission Line

0 7.5 15 22.5

Miles

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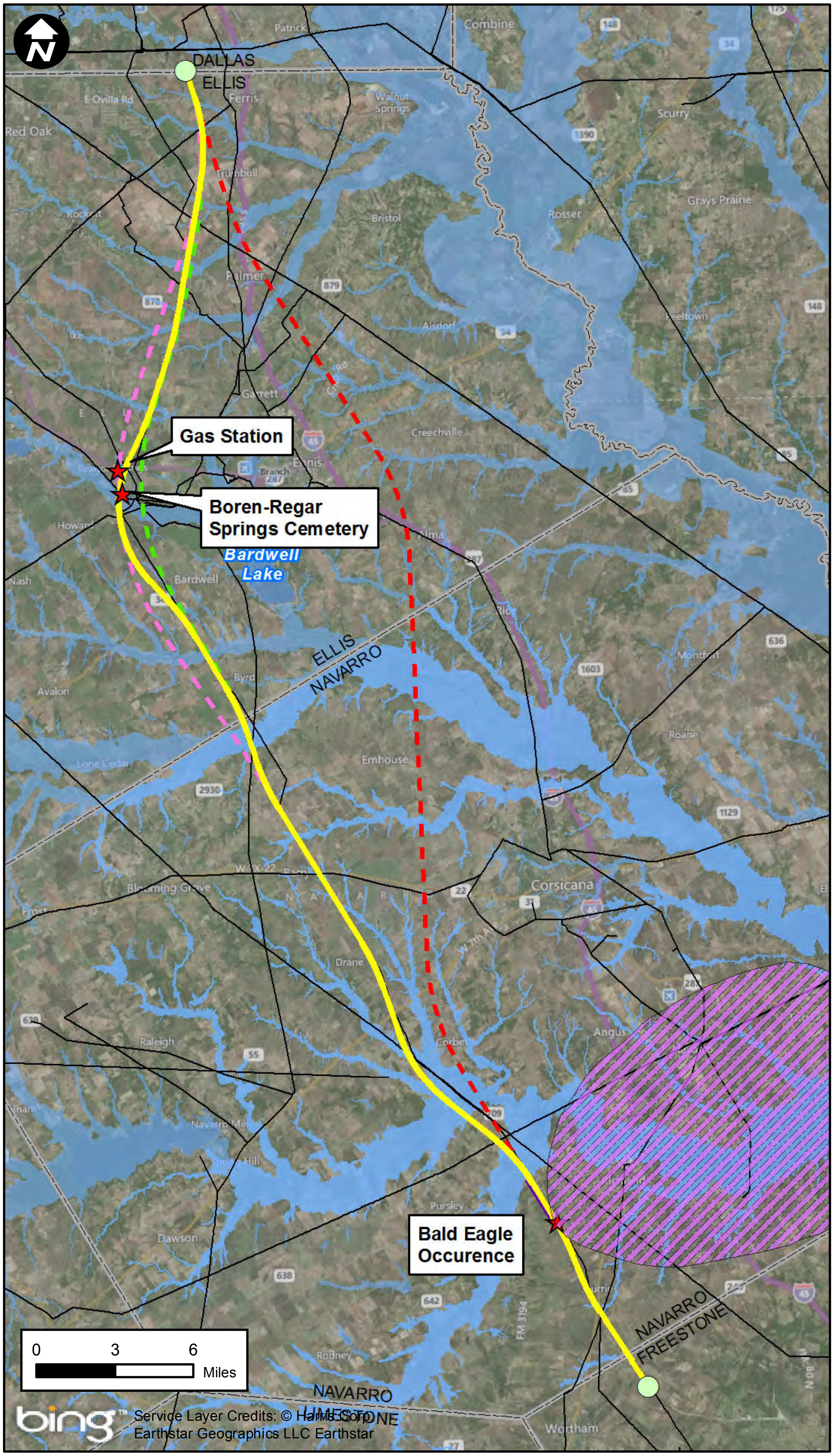
TEXAS CENTRAL RAILWAY

Base UC Alignment Issues	Alternative Approach
Numerous oil field impacts Safety/Constructability concerns	Follows IH-45 ROW Minimizes oil and gas well impacts

Alternative Group - Bardwell



Legend

- Environmental Area of Concern
- Common Analysis End Point
- Electrical Transmission Line
- FEMA 100-Yr Floodplain

Alignments

- BA Base Alignment
- BA-1 Alignment
- BA-2 Alignment
- BA-3 Alignment

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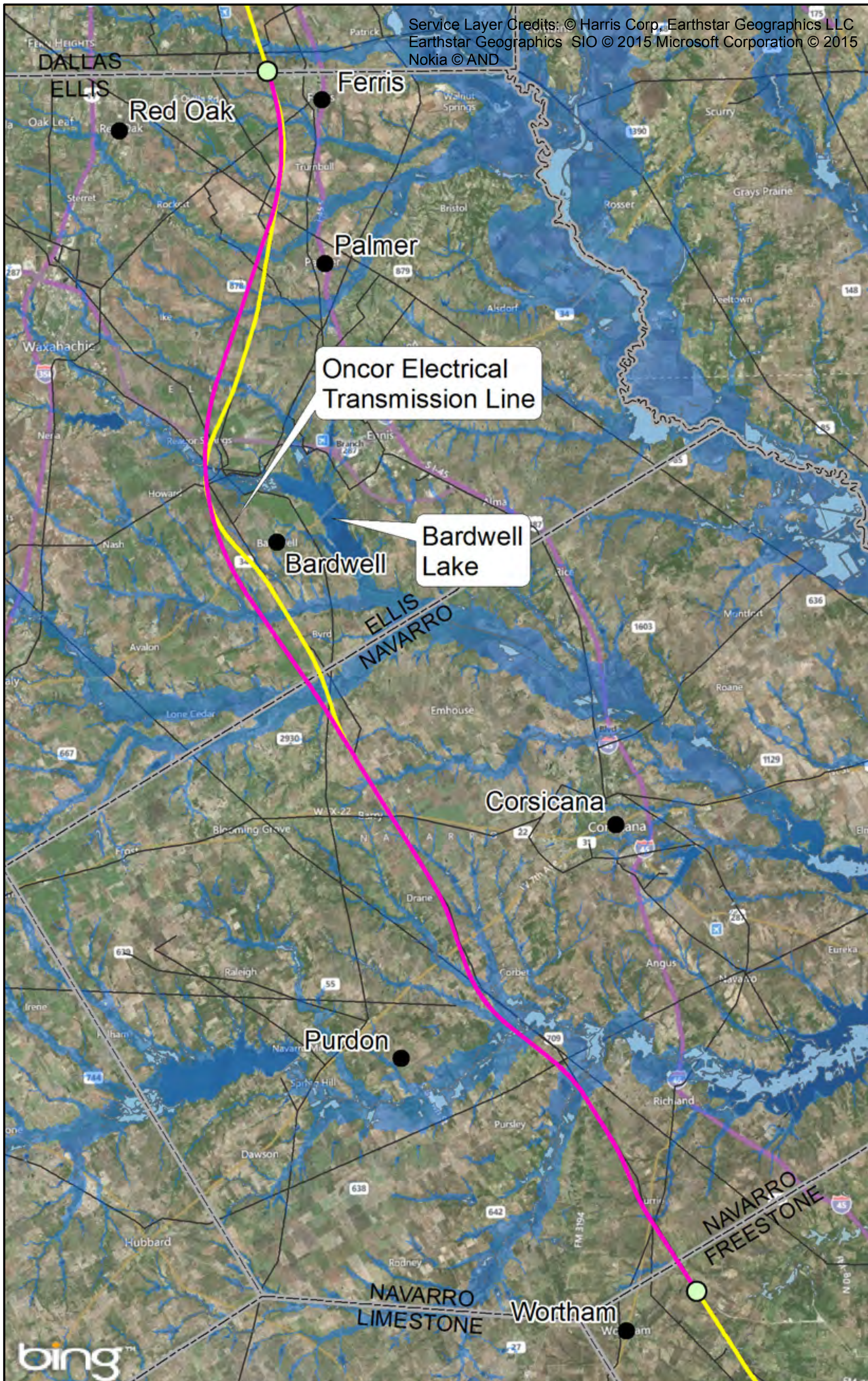
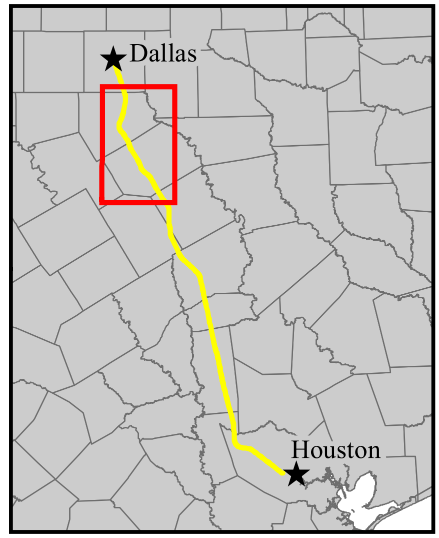
TEXAS CENTRAL RAILWAY

Bardwell - Alternative BA-1

A-13





Common Analysis End Point

Base UC Alignment

BA-1 Alignment

FEMA Floodplain

NWI Wetland

Electrical Transmission Line

0 4 8 12

Miles

Base UC Alignment Issues	Alternative Approach
Follows UC Multiple curves	Improves geometry

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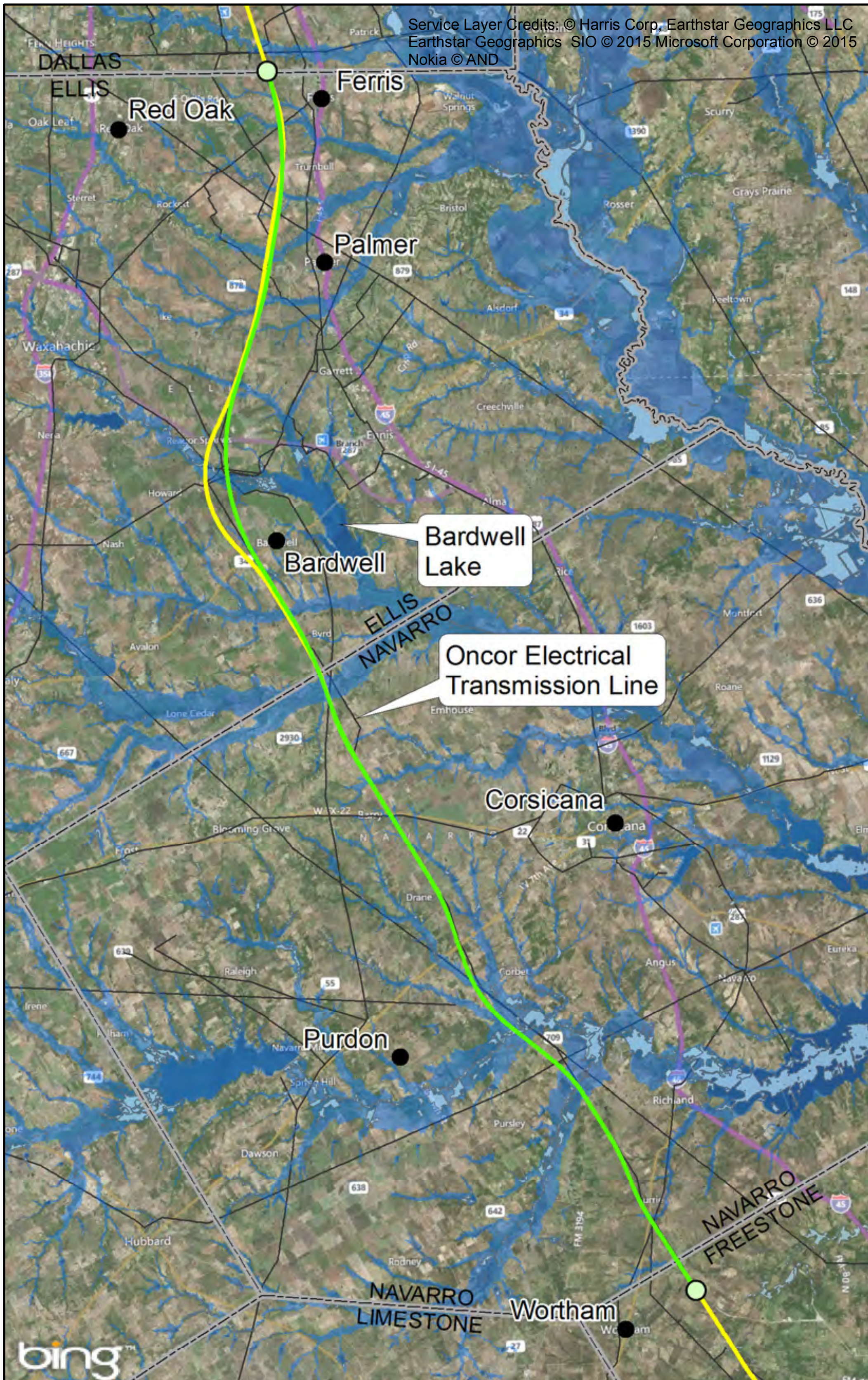
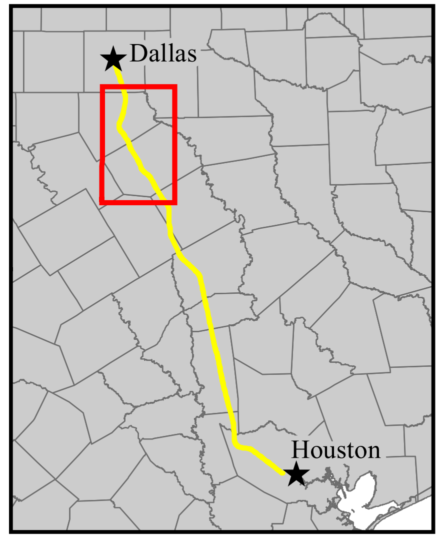
TEXAS CENTRAL RAILWAY

Bardwell - Alternative BA-2

A-14





Common Analysis End Point

Base UC Alignment

BA-2 Alignment

FEMA Floodplain

NWI Wetland

Electrical Transmission Line

0 4 8 12

Miles

Base UC Alignment Issues	Alternative Approach
Follows UC Multiple curves	Improves geometry

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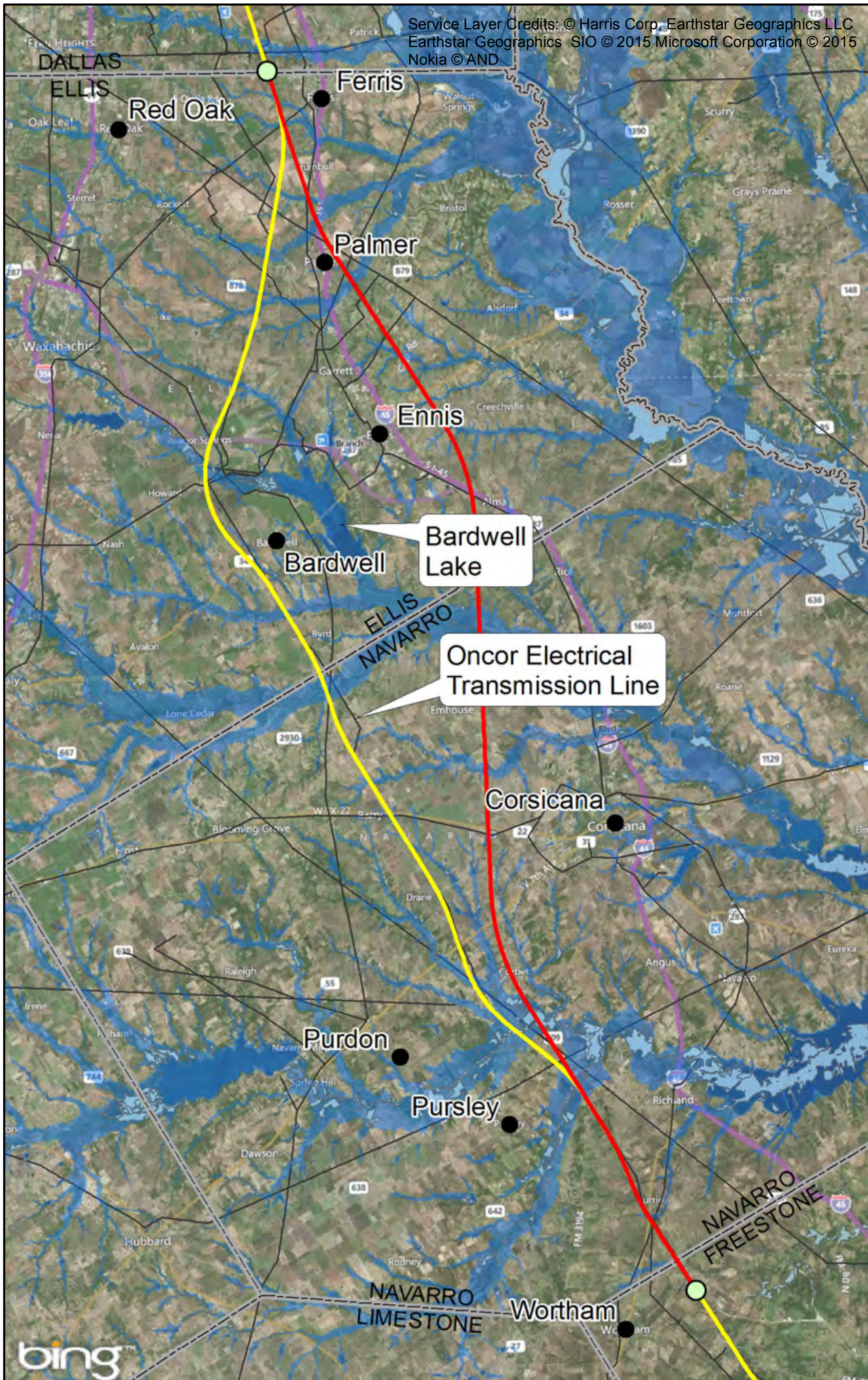
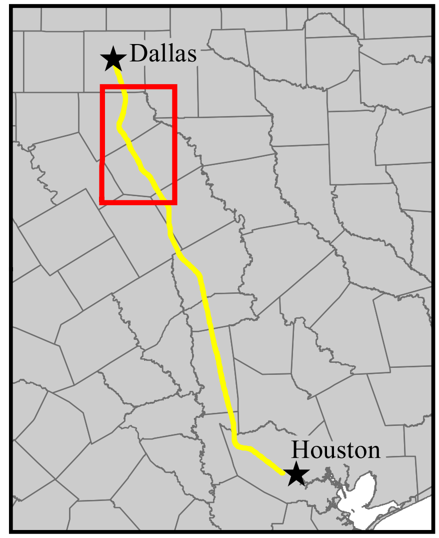
TEXAS CENTRAL RAILWAY

Bardwell - Alternative BA-3

A-15





- Common Analysis End Point
- Base UC Alignment
- BA-3 Alignment
- FEMA Floodplain
- NWI Wetland
- Electrical Transmission Line

0 4 8 12
Miles

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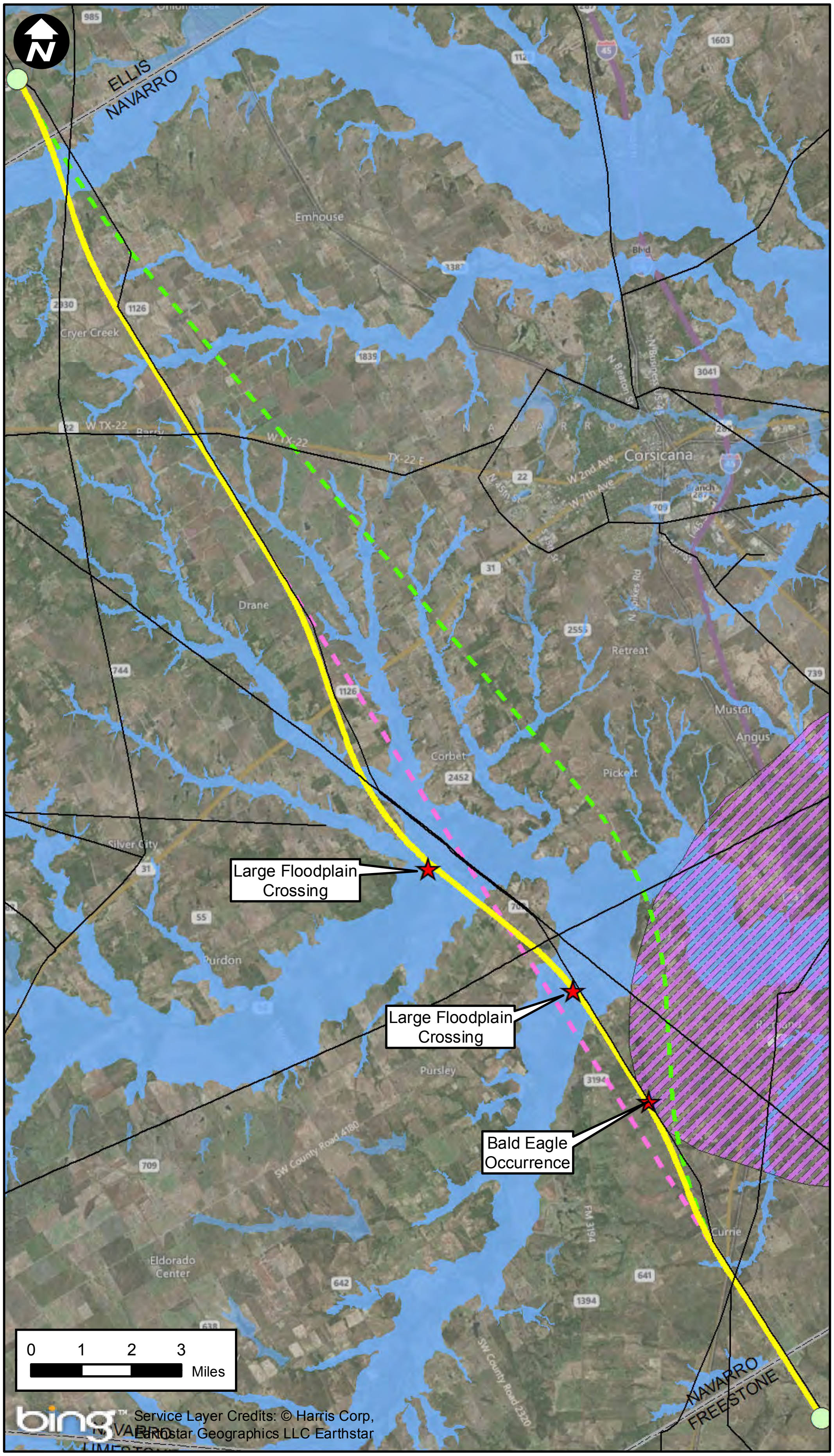
TEXAS CENTRAL RAILWAY

Base UC Alignment Issues	Alternative Approach
Follows UC Multiple curves	Minimizes impacts to large residential areas. No impact on Bardwell Lake. Increased distance from Lancaster Regional Airport.

Alternative Group - Corsicana



Legend

- Environmental Area of Concern
- Common Analysis End Point
- Electrical Transmission Line
- Bald Eagle Occurrence
- FEMA 100-Yr Floodplain

Alignments

- CR Base Alignment
- CR-1 Alignment
- CR-2 Alignment

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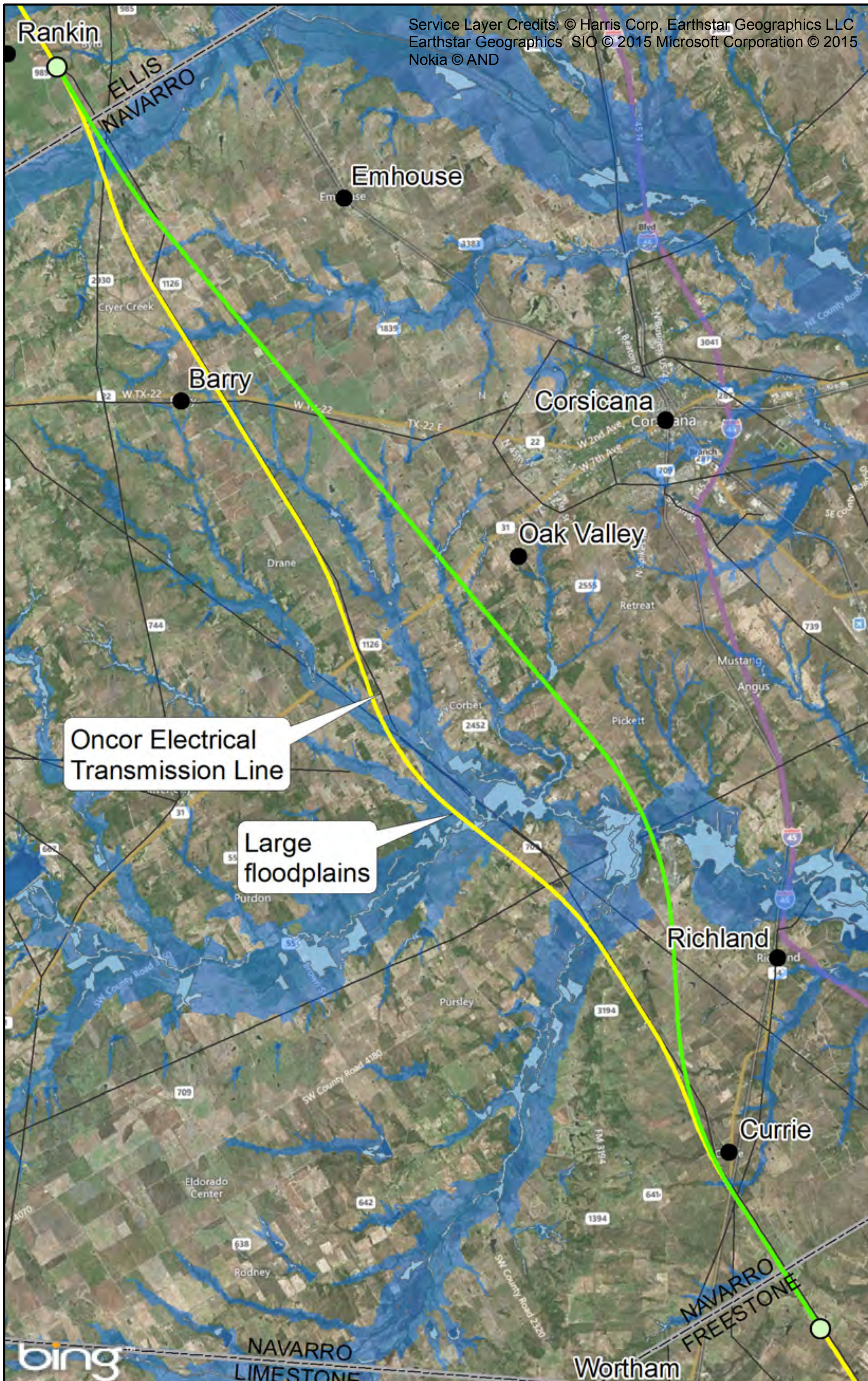
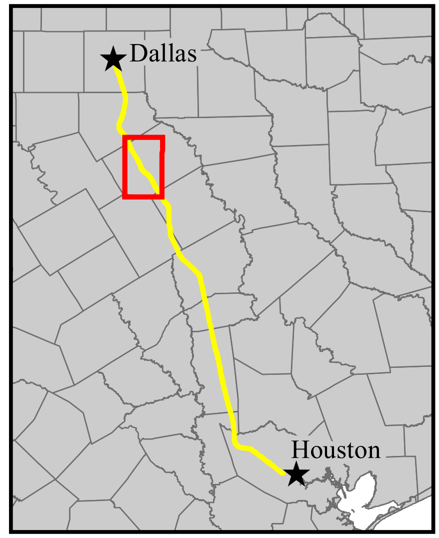
TEXAS CENTRAL RAILWAY

Corsicana - Alternative CR-1

A-16





Common Analysis End Point

Base UC Alignment

CR-1 Alignment

FEMA Floodplain

NWI Wetland

Electrical Transmission Line

0 2 4 6

Miles

Base UC Alignment Issues	Alternative Approach
Close to UC but multiple curves	Reduces floodplain impacts

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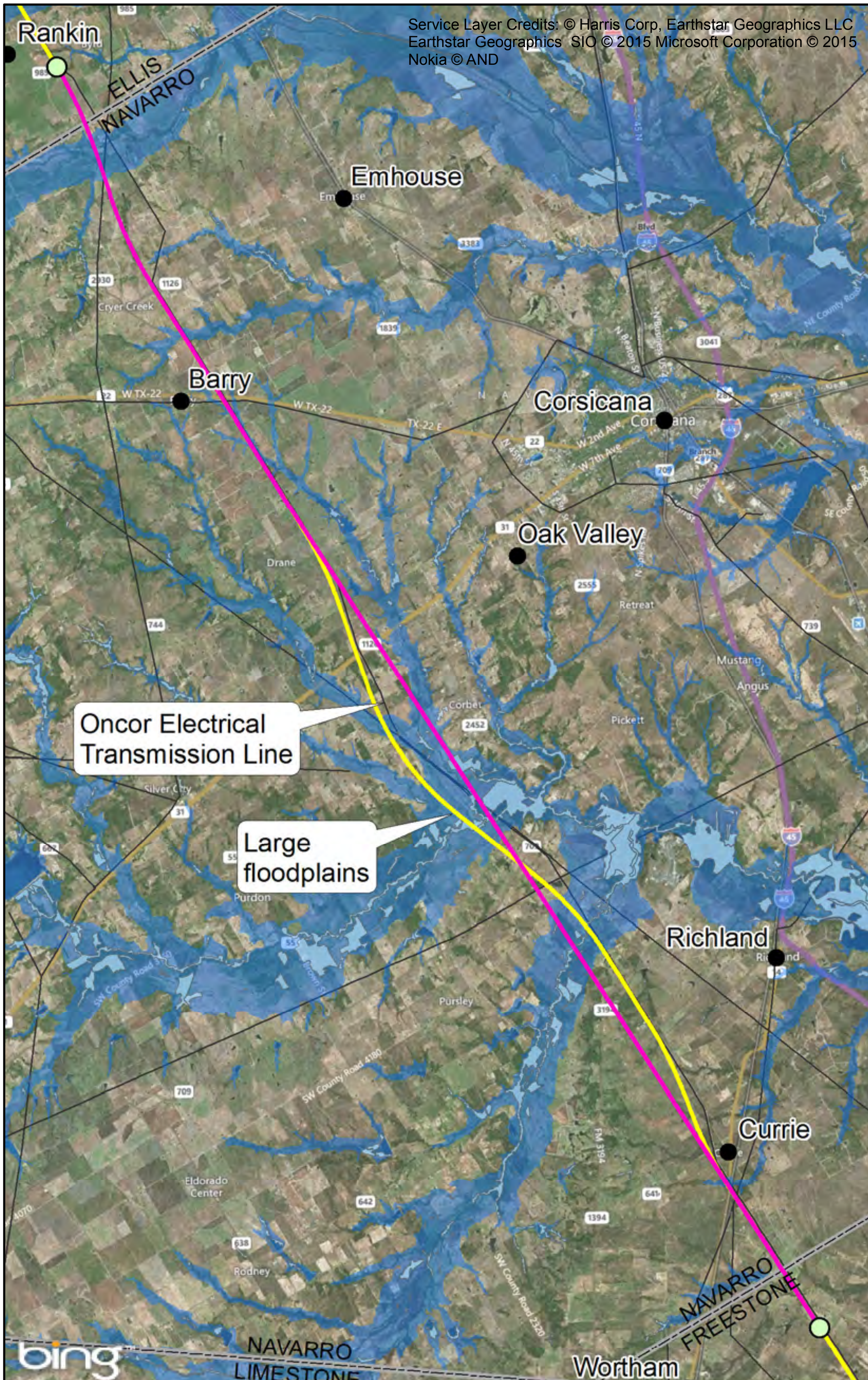
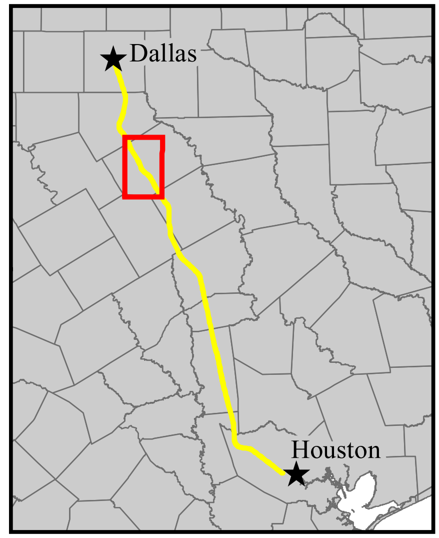
TEXAS CENTRAL RAILWAY

Corsicana - Alternative CR-2

A-17





Common Analysis End Point

Base UC Alignment

CR-2 Alignment

FEMA Floodplain

NWI Wetland

Electrical Transmission Line

0 2 4 6

Miles

Base UC Alignment Issues	Alternative Approach
Close to UC but multiple curves	Improves geometry

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FREESE AND NICHOLS

TEXAS CENTRAL RAILWAY

Appendix B

Evaluation Criteria Tables

Engineering Evaluation Criteria

Downtown Houston Base and Alternative Alignments

Parameter	DH-1		DH-2	
	Data	Score	Data	Score
Alignment Length				
Length (miles)	5.9	3	6.7	1
Parallel to Existing Utility Line (miles)	0.0	2	0.0	2
Average Category Score	2.50		1.50	
Alignment Geometry				
Superelevation	Max 6"	2	Max 6"	2
# of Total Curves	3	3	11	1
# of Curves with Speed Restrictions	NA		NA	
Average Category Score	2.50		1.50	
Viaduct Length & Major Stuctures				
Total Viaduct Length (miles)	5.9	3	6.7	1
# of Complex Structures*	2	1	3	1
Average Category Score	2.00		1.00	
Crossings				
# of Major (Interstate)	2	1	6	1
# of Moderate (State Hwy)	10	1	8	3
# of Minor (Local Roads)	8	2	6	2
# of Freight	4	1	3	1
# of Utility	3	1	3	1
Average Category Score	1.20		1.60	

Engineering Evaluation Criteria

Hockley Base and Alternative Alignments

Parameter	HC Base		HC-1		HC-2		HC-3		HC-4	
	Data	Score	Data	Score	Data	Score	Data	Score	Data	Score
Alignment Length										
Length (miles)	25.6	2	25.1	2	25.8	2	27.0	2	28.1	1
Parallel to Existing Utility Line (miles)	5.0	2	16.7	3	4.0	1	1.1	1	0.0	1
Average Category Score	2.00		2.50		1.50		1.50		1.00	
Alignment Geometry										
Superelevation	Max 6"	2	Max 6"	2	Max 6"	2	Max 7"	1	Max 6"	2
# of Total Curves	3	3	3	3	5	2	5	2	7	1
# of Curves with Speed Restrictions	0	3	2	1	0	3	0	3	0	3
Average Category Score	2.67		2.00		2.33		2.00		2.00	
Viaduct Length & Major Stuctures										
Total Viaduct Length (miles)	10.1	1	13.3	1	6.5	3	5.3	3	6.1	3
# of Complex Structures*	2	1	2	1	2	1	1.0	2	1.0	2
Average Category Score	1.00		1.00		2.00		2.50		2.50	
Crossings										
# of Major (Interstate)	2	1	2	1	2	1	2	1	2	1
# of Moderate (State Hwy)	2	2	2	2	2	2	2	2	2	2
# of Minor (Local Roads)	20	2	21	2	19	2	20	2	16	3
# of Freight	1	2	1	2	1	2	1	2	1	2
# of Utility	5	2	3	3	5	2	6	1	6	1
Average Category Score	1.80		2.00		1.80		1.60		1.80	

Engineering Evaluation Criteria

Middle Base and Alternative Alignments

Parameter	MD Base		MD-1		MD-2		MD-3		MD-4	
	Data	Score	Data	Score	Data	Score	Data	Score	Data	Score
Alignment Length										
Length (miles)	74.4	2	74.5	2	74.0	2	79.8	1	73.7	2
Parallel to Existing Utility Line (miles)	47.5	3	47.5	3	31.1	2	23.1	1	32.5	2
Average Category Score	2.50		2.50		2.00		1.00		2.00	
Alignment Geometry										
Superelevation	Max 5"	3	Max 5"	3	Max 4"	3	Max 4"	3	Max 2"	3
# of Total Curves	18	1	13	2	12	2	10	2	8	3
# of Curves with Speed Restrictions	0	3	0	3	0	3	0	3	0	3
Average Category Score	2.33		2.67		2.67		2.67		3.00	
Viaduct Length & Major Stuctures										
Total Viaduct Length (miles)	32.6	1	26.1	2	30.1	1	31.4	1	19.8	3
# of Complex Structures*	0	3	0	3	0	3	0	3	0	3
Average Category Score	2.00		2.50		2.00		2.00		3.00	
Crossings										
# of Major (Interstate)	0	3	0	3	0	3	0	3	0	3
# of Moderate (State Hwy)	9	2	9	2	9	2	9	2	9	2
# of Minor (Local Roads)	36	2	39	2	40	2	56	1	39	2
# of Freight	3	2	3	2	3	2	3	2	3	2
# of Utility	9	2	9	2	9	2	8	3	14	1
Average Category Score	2.20		2.20		2.20		2.20		2.00	

Engineering Evaluation Criteria

IH-45 Base and Alternative Alignments

Parameter	IH-45 Base		IH45	
	Data	Score	Data	Score
Alignment Length				
Length (miles)	107.6	2	112.0	2
Parallel to Existing Utility Line (miles)	66.5	3	23.03	1
Average Category Score	2.50		1.50	
Alignment Geometry				
Superelevation	Max 5"	3	Max 5"	3
# of Total Curves	25	2	24	2
# of Curves with Speed Restrictions	0	3	0	3
Average Category Score	2.67		2.67	
Viaduct Length & Major Stuctures				
Total Viaduct Length (miles)	50.2	1	32.5	3
# of Complex Structures*	0	3	0	3
Average Category Score	2.00		3.00	
Crossings				
# of Major (Interstate)	0	3	0	3
# of Moderate (State Hwy)	11	3	21	1
# of Minor (Local Roads)	69	3	95	1
# of Freight	3	2	4	2
# of Utility	14	2	12	2
Average Category Score	2.60		1.80	

Engineering Evaluation Criteria

Bardwell Base and Alternative Alignments

Parameter	BA Base		BA-1		BA-2		BA-3	
	Data	Score	Data	Score	Data	Score	Data	Score
Alignment Length								
Length (miles)	57.0	2	56.9	2	56.3	2	54.6	2
Parallel to Existing Utility Line (miles)	51.2	3	26.6	1	51.2	3	11.8	1
Average Category Score	2.50		1.50		2.50		1.50	
Alignment Geometry								
Superelevation	Max 5"	3	Max 2"	3	Max 2.5"	3	Max 2.5"	3
# of Total Curves	12	1	8	2	10	2	5	3
# of Curves with Speed Restrictions	0	3	0	3	0	3	0	3
Average Category Score	2.33		2.67		2.67		3.00	
Viaduct Length & Major Stuctures								
Total Viaduct Length (miles)	20.5	3	27.1	1	25.3	2	19.4	3
# of Complex Structures*	0	3	0	3	0	3	0.0	3
Average Category Score	3.00		2.00		2.50		3.00	
Crossings								
# of Major (Interstate)	0	3	0	3	0	3	2	1
# of Moderate (State Hwy)	17	2	17	2	17	2	21	1
# of Minor (Local Roads)	22	2	23	2	22	2	23	2
# of Freight	3	1	3	1	3	1	4	1
# of Utility	12	2	12	2	14	1	12	2
Average Category Score	2.00		2.00		1.80		1.40	

Engineering Evaluation Criteria

Corsicana Base and Alternative Alignments

Parameter	CR Base		CR-1		CR-2	
	Data	Score	Data	Score	Data	Score
Alignment Length						
Length (miles)	31.5	2	31.8	2	31.2	2
Parallel to Existing Utility Line (miles)	31.5	3	10.1	1	16.6	2
Average Category Score	2.50		1.50		2.00	
Alignment Geometry						
Superelevation	Max 3"	3	Max 3"	3	Max 1.5"	3
# of Total Curves	7	1	3	2	1	3
# of Curves with Speed Restrictions	0	3	0	3	0	3
Average Category Score	2.33		2.67		3.00	
Viaduct Length & Major Stuctures						
Total Viaduct Length (miles)	12.8	2	9.0	3	15.6	1
# of Complex Structures*	0	3	0	3	0	3
Average Category Score	2.50		3.00		2.00	
Crossings						
# of Major (Interstate)	0	3	0	3	0	3
# of Moderate (State Hwy)	9	3	13	1	9	3
# of Minor (Local Roads)	16	2	15	2	17	2
# of Freight	1	2	1	2	1	2
# of Utility	5	3	7	2	7	2
Average Category Score	2.60		2.00		2.40	

Hydrology Evaluation Criteria

Downtown Houston Base and Alternative Alignments

Parameter	DH-1		DH-2	
	Data	Score	Data	Score
Streams, Wetlands, and Water Bodies				
Tier 1A - FEMA Streams	0	**0**	3	**15**
Tier 2A - Major Streams	0	**0**	0	**0**
Tier 2B - Minor Streams	0	**0**	0	**0**
Total	0	**0**	3	**15**
RANKING	**3.00**		**1.00**	
Stream Length within Corridor (mi)				
Tier 1A - FEMA Streams	0.0	**0**	0.9	**5**
Tier 2A - Major Streams	0.0	**0**	0.0	**0**
Tier 2B - Minor Streams	0.0	**0**	0.0	**0**
Total	0.0	**0**	0.9	**5**
RANKING	**3.00**		**1.00**	
Floodplain Length along Alignment (mi)				
Tier 1A - FEMA Zone AE	0.1	**1**	3.0	**15**
Tier 1B - FEMA Approximate Zone A	0.0	**0**	0.0	**0**
Tier 2 - NHD Buffer Approximation	0.0	**0**	0.0	**0**
Total	0.1	**1**	3.0	**15**
RANKING	**3.00**		**1.00**	
Floodplain Area within Corridor (ac)				
Tier 1A - FEMA Zone AE	5	**25**	120	**598**
Tier 1B - FEMA Approximate Zone A	0	**0**	0	**0**
Tier 2 - NHD Buffer Approximation	0	**0**	0	**0**
Total	5	**25**	120	**598**
RANKING	**3.00**		**1.00**	
Average Category Score	**3.00**		**1.00**	

Weighting Factors	
Tier 1	5
Tier 2A	3
Tier 2B	1

Hydrology Evaluation Criteria

Hockley Base and Alternative Alignments

Parameter	HC Base		HC-1		HC-2		HC-3		HC-4	
	Data	Score	Data	Score	Data	Score	Data	Score	Data	Score
Streams, Wetlands, and Waterbodies										
Tier 1A - FEMA Streams	12	**60**	11	**55**	12	**60**	8	**40**	12	**60**
Tier 2A - Major Streams	1	**3**	2	**6**	1	**3**	1	**3**	1	**3**
Tier 2B - Minor Streams	21	**21**	14	**14**	19	**19**	12	**12**	18	**18**
Total	34	**84**	27	**75**	32	**82**	21	**55**	31	**81**
RANKING	**2.00**		**2.00**		**2.00**		**3.00**		**2.00**	
Stream Length within Corridor (mi)										
Tier 1A - FEMA Streams	1.5	**7**	1.1	**5**	1.6	**8**	0.7	**4**	1.0	**5**
Tier 2A - Major Streams	0.1	**0**	0.1	**0**	0.1	**0**	0.1	**0**	0.1	**0**
Tier 2B - Minor Streams	2.8	**3**	1.6	**2**	1.9	**2**	1.7	**2**	1.5	**2**
Total	4.4	**10**	2.8	**7**	3.5	**10**	2.5	**5**	2.6	**7**
RANKING	**1.00**		**2.00**		**2.00**		**3.00**		**2.00**	
Floodplain Length along Alignment (mi)										
Tier 1A - FEMA Zone AE	3.2	**16**	3.8	**19**	2.7	**14**	2.7	**13**	2.4	**12**
Tier 1B - FEMA Approximate Zone A	0.0	**0**	0.0	**0**	0.0	**0**	0.0	**0**	0.0	**0**
Tier 2 - NHD Buffer Approximation	0.0	**0**	0.0	**0**	0.0	**0**	0.0	**0**	0.0	**0**
Total	3.2	**16**	3.8	**19**	2.7	**14**	2.7	**13**	2.4	**12**
RANKING	**2.00**		**1.00**		**2.00**		**2.00**		**3.00**	
Floodplain Area within Corridor (ac)										
Tier 1A - FEMA Zone AE	133	**66**	158	**79**	118	**59**	122	**61**	102	**51**
Tier 1B - FEMA Approximate Zone A	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
Tier 2 - NHD Buffer Approximation	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
Total	133	**66**	158	**79**	118	**59**	122	**61**	102	**51**
RANKING	**3.00**		**1.00**		**2.00**		**2.00**		**3.00**	
Average Category Score	**1.75**		**1.50**		**2.00**		**2.50**		**2.50**	

Weighting Factors	
Tier 1	5
Tier 2A	3
Tier 2B	1

Hydrology Evaluation Criteria

Middle Base and Alternative Alignments

Parameter	MD Base		MD-1		MD-2		MD-3		MD-4	
	Data	Score	Data	Score	Data	Score	Data	Score	Data	Score
Streams, Wetlands, and Waterbodies										
Tier 1A - FEMA Streams	11	**55**	11	**55**	15	**75**	9	**45**	0	**0**
Tier 2A - Major Streams	35	**105**	31	**93**	38	**114**	25	**75**	34	**102**
Tier 2B - Minor Streams	89	**89**	105	**105**	93	**93**	98	**98**	102	**102**
Total	135	**249**	147	**253**	146	**282**	132	**218**	136	**204**
RANKING	**2.00**		**2.00**		**1.00**		**2.00**		**3.00**	
Stream Length within Corridor (mi)										
Tier 1A - FEMA Streams	0.9	**4**	0.9	**4**	1.1	**6**	0.8	**4**	0.0	**0**
Tier 2A - Major Streams	4.1	**12**	3.7	**11**	4.4	**13**	2.5	**8**	3.7	**11**
Tier 2B - Minor Streams	10.1	**10**	10.8	**11**	10.3	**10**	11.0	**11**	10.7	**11**
Total	15.0	**27**	15.4	**26**	15.8	**29**	14.4	**23**	14.4	**22**
RANKING	**2.00**		**2.00**		**1.00**		**2.00**		**3.00**	
Floodplain Length along Alignment (mi)										
Tier 1A - FEMA Zone AE	0.0	**0**	0.0	**0**	0.0	**0**	0.0	**0**	0.0	**0**
Tier 1B - FEMA Approximate Zone A	6.9	**34**	7.1	**36**	8.6	**43**	8.5	**43**	1.9	**9**
Tier 2 - NHD Buffer Approximation	5.5	**17**	5.6	**17**	5.7	**17**	4.8	**15**	6.9	**21**
Total	12.4	**51**	12.8	**53**	14.4	**60**	13.4	**57**	8.7	**30**
RANKING	**2.00**		**2.00**		**2.00**		**2.00**		**3.00**	
Floodplain Area within Corridor (ac)										
Tier 1A - FEMA Zone AE	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
Tier 1B - FEMA Approximate Zone A	294	**147**	298	**149**	367	**184**	375	**187**	76	**38**
Tier 2 - NHD Buffer Approximation	226	**68**	238	**71**	237	**71**	196	**59**	290	**87**
Total	520	**147**	535	**220**	604	**184**	570	**246**	366	**38**
RANKING	**2.00**		**2.00**		**2.00**		**2.00**		**3.00**	
Average Category Score	**2.00**		**2.00**		**1.50**		**2.00**		**3.00**	

Weighting Factors	
Tier 1	5
Tier 2A	3
Tier 2B	1

Hydrology Evaluation Criteria

IH-45 Base and Alternative Alignments

Parameter	IH-45 Base		IH-45 Alt	
	Data	Score	Data	Score
Streams, Wetlands, and Waterbodies				
Tier 1A - FEMA Streams	27	**135**	30	**150**
Tier 2A - Major Streams	37	**111**	35	**105**
Tier 2B - Minor Streams	122	**122**	99	**99**
Total	186	**368**	164	**354**
RANKING	**2.00**		**3.00**	
Stream Length within Corridor (mi)				
Tier 1A - FEMA Streams	2.9	**15**	3.5	**18**
Tier 2A - Major Streams	4.3	**13**	3.6	**11**
Tier 2B - Minor Streams	13.3	**13**	9.7	**10**
Total	20.5	**41**	16.8	**38**
RANKING	**2.00**		**3.00**	
Floodplain Length along Alignment (mi)				
Tier 1A - FEMA Zone AE	0.0	**0**	0.3	**2**
Tier 1B - FEMA Approximate Zone A	14.2	**71**	11.8	**59**
Tier 2 - NHD Buffer Approximation	5.5	**17**	9.8	**29**
Total	19.7	**87**	21.9	**90**
RANKING	**3.00**		**2.00**	
Floodplain Area within Corridor (ac)				
Tier 1A - FEMA Zone AE	0	**0**	6	**3**
Tier 1B - FEMA Approximate Zone A	606	**303**	485	**243**
Tier 2 - NHD Buffer Approximation	226	**68**	419	**126**
Total	832	**371**	910	**371**
RANKING	**2.00**		**2.00**	
Average Category Score	**2.25**		**2.50**	

Weighting Factors	
Tier 1	5
Tier 2A	3
Tier 2B	1

Hydrology Evaluation Criteria

Bardwell Base and Alternative Alignments

Parameter	BA Base		BA-1		BA-2		BA-3	
	Data	Score	Data	Score	Data	Score	Data	Score
Streams, Wetlands, and Waterbodies								
Tier 1A - FEMA Streams	18	**90**	18	**90**	20	**100**	15	**75**
Tier 2A - Major Streams	6	**18**	6	**18**	6	**18**	5	**15**
Tier 2B - Minor Streams	58	**58**	64	**64**	60	**60**	56	**56**
Total	82	**166**	88	**172**	86	**178**	76	**146**
RANKING	**2.00**		**2.00**		**2.00**		**3.00**	
Stream Length within Corridor (mi)								
Tier 1A - FEMA Streams	2.0	**10**	2.1	**10**	2.5	**13**	1.3	**7**
Tier 2A - Major Streams	0.6	**2**	0.5	**1**	0.6	**2**	0.3	**1**
Tier 2B - Minor Streams	6.2	**6**	6.4	**6**	5.9	**6**	7.0	**7**
Total	8.8	**18**	9.0	**18**	9.0	**20**	8.6	**15**
RANKING	**2.00**		**2.00**		**1.00**		**3.00**	
Floodplain Length along Alignment (mi)								
Tier 1A - FEMA Zone AE	1.3	**7**	1.0	**5**	1.2	**6**	1.3	**7**
Tier 1B - FEMA Approximate Zone A	7.9	**40**	8.4	**42**	8.6	**43**	8.7	**44**
Tier 2 - NHD Buffer Approximation	0.3	**1**	0.3	**1**	0.3	**1**	0.3	**1**
Total	9.6	**47**	9.8	**48**	10.2	**50**	10.4	**51**
RANKING	**3.00**		**2.00**		**2.00**		**1.00**	
Floodplain Area within Corridor (ac)								
Tier 1A - FEMA Zone AE	55	**28**	43	**22**	54	**27**	55	**27**
Tier 1B - FEMA Approximate Zone A	341	**170**	359	**179**	370	**185**	375	**187**
Tier 2 - NHD Buffer Approximation	14	**4**	14	**4**	14	**4**	14	**4**
Total	410	**202**	416	**205**	437	**216**	443	**215**
RANKING	**3.00**		**2.00**		**2.00**		**2.00**	
Average Category Score	**2.50**		**2.00**		**1.75**		**2.25**	

Weighting Factors	
Tier 1	5
Tier 2A	3
Tier 2B	1

Hydrology Evaluation Criteria

Corsicana Base and Alternative Alignments

Parameter	CR Base		CR-1		CR-2	
	Data	Score	Data	Score	Data	Score
Streams, Wetlands, and Waterbodies						
Tier 1A - FEMA Streams	8	**40**	5	**25**	8	**40**
Tier 2A - Major Streams	5	**15**	4	**12**	5	**15**
Tier 2B - Minor Streams	34	**34**	31	**31**	43	**43**
Total	47	**89**	40	**68**	56	**98**
RANKING	**2.00**		**3.00**		**2.00**	
Stream Length within Corridor (mi)						
Tier 1A - FEMA Streams	1.2	**6**	0.5	**2**	1.3	**6**
Tier 2A - Major Streams	0.4	**1**	0.3	**1**	0.4	**1**
Tier 2B - Minor Streams	3.4	**3**	3.8	**4**	4.2	**4**
Total	5.0	**11**	4.6	**7**	5.8	**12**
RANKING	**2.00**		**3.00**		**2.00**	
Floodplain Length along Alignment (mi)						
Tier 1A - FEMA Zone AE	0.0	**0**	0.0	**0**	0.0	**0**
Tier 1B - FEMA Approximate Zone A	265.3	**133**	118.6	**59**	313.6	**157**
Tier 2 - NHD Buffer Approximation	13.8	**4**	13.8	**4**	13.8	**4**
Total	279.1	**137**	132.4	**63**	327.3	**161**
RANKING	**2.00**		**3.00**		**2.00**	
Floodplain Area within Corridor (ac)						
Tier 1A - FEMA Zone AE	55	**28**	43	**22**	54	**27**
Tier 1B - FEMA Approximate Zone A	341	**170**	359	**179**	370	**185**
Tier 2 - NHD Buffer Approximation	14	**4**	14	**4**	14	**4**
Total	410	**202**	416	**205**	437	**216**
RANKING	**2.00**		**3.00**		**2.00**	
Average Category Score	**2.00**		**3.00**		**2.00**	

Weighting Factors	
Tier 1	5
Tier 2A	3
Tier 2B	1

Environmental Evaluation Criteria

Downtown Houston Base and Alternative Alignments

Parameter	DH-1 (24 miles)		DH-2 (25 miles)	
	Data	Score	Data	Score
Streams, Wetlands, and Water Bodies				
Stream Crossings (count)	0	3	3	1
Stream Crossings (linear feet)	0	3	4,851	1
Parallel Streams (count)	0	3	1	1
Waterbody Crossings (count)	0	3	1	1
Forested/Scrub Shrub Wetlands (acres)	0	3	0	3
Emergent Wetlands (acres)	0	3	0	3
Hydric Soils (acres)	2.5	1	1.4	3
Average Category Score	**2.71**		**1.86**	
Natural Resources/Land Cover				
Federal and State T & E Species Elements of Occurence (count)	0	3	0	3
National, State, and City Parks and Forests (acres)	0.03	3	6.00	1
Prime Farm Land (acres)	2.5	1	1.4	3
Developed (acres)	262	3	305	1
Average Category Score	**2.50**		**2.00**	
Cultural Resources				
Cemeteries (count)	0	3	0	3
High Probability of Archeology/Cultural Resources (acres)	271	3	301	1
NRHP Sites (count)	1	1	1	1
Historical Markers (count)	0	3	0	3
Archaeological Sites (count)	1	1	1	1
Average Category Score	**2.20**		**1.80**	
Environmental Justice				
Minority Populations (%)	29.65	1	27.84	3
Low Income Families (%)	12.81	3	16.53	1
Minority Populations (count)	947	1	758	3
Low Income Families (count)	509	3	1,002	1
Minority Populations Compared to County Level Data (Blocks)	17	1	11	3
Low Income Families Compared to County Level Data (Block Groups)	4	3	8	1
Schools, Churches, Hospitals (count)	1	1	1	1
Average Category Score	**1.86**		**1.86**	
Hazardous Sites				
Municipal Setting Designation (MSD) Sites (count)	0	3	0	3
Petroleum Storage Tanks (PSTs) and Leaking PSTs (count)	4	1	4	1
Water Supply Wells (count)	0	3	0	3
Municipal Solid Waste Sites (MSWs) and Closed MSWs (count)	0	3	0	3
USEPA Facilities (count)	24	1	18	3
Cleanup Sites (count)	0	3	0	3
USEPA Radioactive Sites (count)	0	3	0	3
Average Category Score	**2.43**		**2.71**	

Environmental Evaluation Criteria

Hockley Base and Alternative Alignments

Parameter	HC Base (26 miles)		HC-1 (26 miles)		HC-2 (27 miles)		HC-3 (28 miles)		HC-4 (29 miles)	
	Data	Score	Data	Score	Data	Score	Data	Score	Data	Score
Streams, Wetlands, and Waterbodies										
Stream Crossings (count)	34	1	27	2	32	2	21	3	31	2
Stream Crossings (linear feet)	23,080	1	14,735	2	18,416	2	12,937	3	13,798	2
Parallel Streams (count)	5	1	1	2	2	2	0	3	2	2
Waterbody Crossings (count)	20	1	17	3	21	1	18	2	17	3
Forested/Scrub Shrub Wetlands (acres)	15	2	8	3	20	1	20	1	14	2
Emergent Wetlands (acres)	126	3	136	1	135	1	127	3	127	3
Hydric Soils (acres)	238	3	253	1	231	3	261	1	242	3
Average Category Score	**1.71**		**2.00**		**1.71**		**2.29**		**2.43**	
Natural Resources/Land Cover										
Federal and State T & E Species Elements of Occurence (count)	0	3	0	3	0	3	0	3	0	3
National, State, and City Parks and Forests (acres)	0	3	21	1	0	3	0.4	2	0	3
Prime Farm Land (acres)	753	2	703	3	1,954	1	911	2	984	2
Developed (acres)	120	1	97	2	83.5	3	125	1	94	2
Average Category Score	**2.25**		**2.25**		**2.50**		**2.00**		**2.50**	
Cultural Resources										
Cemeteries (count)	0	3	1	1	0	3	0	3	0	3
High Probability of Archeology/Cultural Resources (acres)	544	1	538	1	442	2	410	3	423	3
NRHP Sites (count)	0	3	0	3	0	3	0	3	0	3
Historical Markers (count)	0	3	0	3	0	3	0	3	0	3
Archaeological Sites (count)	1	3	1	3	1	3	1	3	2	1
Average Category Score	**2.60**		**2.20**		**2.80**		**3.00**		**2.60**	
Environmental Justice										
Minority Populations (%)	19.48	3	24.38	2	19.92	3	23.91	2	27.55	1
Low Income Families (%)	9.56	1	9.70	1	9.56	1	9.33	1	7.15	3
Minority Populations (count)	513	3	809	1	513	3	760	2	825	1
Low Income Families (count)	591	2	634	1	591	2	604	1	540	3
Minority Populations Compared to County Level Data (Blocks)	4	3	4	3	4	3	8	1	5	2
Low Income Families Compared to County Level Data (Block Groups)	3	1	3	1	3	1	3	1	3	1
Schools, Churches, Hospitals (count)	0	3	0	3	0	3	0	3	0	3
Average Category Score	**2.29**		**1.71**		**2.29**		**1.57**		**2.00**	
Hazardous Sites										
Municipal Setting Designation (MSD) Sites (count)	0	3	0	3	0	3	0	3	0	3
Petroleum Storage Tanks (PSTs) and Leaking PSTs (count)	0	3	0	3	0	3	0	3	0	3
Water Supply Wells (count)	0	3	1	1	0	3	0	3	0	3
Municipal Solid Waste Sites (MSWs) and Closed MSWs (count)	0	3	0	3	0	3	0	3	0	3
USEPA Facilities (count)	0	3	1	1	0	3	1	1	0	3
Cleanup Sites (count)	0	3	0	3	0	3	0	3	0	3
USEPA Radioactive Sites (count)	0	3	0	3	0	3	0	3	0	3
Average Category Score	**3.00**		**2.43**		**3.00**		**2.71**		**3.00**	

Environmental Evaluation Criteria

Middle Base and Alternative Alignments

Parameter	MD Base (74 miles)		MD-1 (74 miles)		MD-2 (74 miles)		MD-3 (80 miles)		MD-4 (72 miles)	
	Data	Score	Data	Score	Data	Score	Data	Score	Data	Score
Streams, Wetlands, and Waterbodies										
Stream Crossings (count)	135	3	147	1	146	1	132	3	136	3
Stream Crossings (linear feet)	79,412	2	81,260	1	83,436	1	75,842	3	76,066	3
Parallel Streams (count)	18	2	15	2	22	1	18	2	14	3
Waterbody Crossings (count)	67	2	77	2	58	3	73	2	82	1
Forested/Scrub Shrub Wetlands (acres)	44	2	46	2	55	2	77	1	40	3
Emergent Wetlands (acres)	13	2	11	2	10	2	5	3	17	1
Hydric Soils (acres)	68	3	66	3	68	3	189	1	76	2
Average Category Score	**2.29**		**1.86**		**1.86**		**2.14**		**2.29**	
Natural Resources/Land Cover										
Federal and State T & E Species Elements of Occurence (count)	2	1	2	1	2	1	1	2	0	3
National, State, and City Parks and Forests (acres)	0	3	0	3	0	3	0	3	0	3
Prime Farm Land (acres)	864	2	916	1	808	3	844	3	874	1
Developed (acres)	162	2	146	3	170	2	172	2	184	1
Average Category Score	**2.00**		**2.00**		**2.25**		**2.50**		**2.00**	
Cultural Resources										
Cemeteries (count)	1	3	1	3	1	3	3	1	1	3
High Probability of Archeology/Cultural Resources (acres)	1,382	1	1,354	1	1,354	1	842	2	794	3
NRHP Sites (count)	0	3	0	3	0	3	0	3	0	3
Historical Markers (count)	0	3	0	3	0	3	1	1	0	3
Archaeological Sites (count)	14	1	12	2	10	2	7	3	9	2
Average Category Score	**2.20**		**2.40**		**2.40**		**2.00**		**2.80**	
Environmental Justice										
Minority Populations (%)	11.35	1	9.90	2	8.23	3	8.14	3	8.34	3
Low Income Families (%)	10.87	3	10.87	3	10.87	3	11.73	1	11.51	1
Minority Populations (count)	180	1	182	1	119	3	158	2	135	2
Low Income Families (count)	214	3	314	2	314	2	579	1	351	2
Minority Populations Compared to County Level Data (Blocks)	11	2	10	2	13	1	12	2	7	3
Low Income Families Compared to County Level Data (Block Groups)	1	3	1	3	1	3	3	1	2	2
Schools, Churches, Hospitals (count)	1	1	0	3	1	1	1	1	0	3
Average Category Score	**2.00**		**2.29**		**2.29**		**1.57**		**2.29**	
Hazardous Sites										
Municipal Setting Designation (MSD) Sites (count)	0	3	0	3	0	3	0	3	0	3
Petroleum Storage Tanks (PSTs) and Leaking PSTs (count)	0	3	0	3	0	3	0	3	0	3
Water Supply Wells (count)	0	3	0	3	0	3	0	3	0	3
Municipal Solid Waste Sites (MSWs) and Closed MSWs (count)	0	3	0	3	0	3	0	3	0	3
USEPA Facilities (count)	2	2	2	2	2	2	1	3	5	1
Cleanup Sites (count)	0	3	0	3	0	3	0	3	0	3
USEPA Radioactive Sites (count)	0	3	0	3	0	3	0	3	0	3
Average Category Score	**2.86**		**2.86**		**2.86**		**3.00**		**2.71**	

Environmental Evaluation Criteria

IH-45 Base and Alternative Alignments

Parameter	IH-45 Base (104 miles)		IH-45 1 (107 miles)	
	Data	Score	Data	Score
Streams, Wetlands, and Waterbodies				
Stream Crossings (count)	186	1	164	3
Stream Crossings (linear feet)	108,387	1	88,581	3
Parallel Streams (count)	22	1	12	3
Waterbody Crossings (count)	118	1	85	3
Forested/Scrub Shrub Wetlands (acres)	53	3	75	1
Emergent Wetlands (acres)	16	1	10	3
Hydric Soils (acres)	179	3	283	1
Average Category Score	**1.57**		**2.43**	
Natural Resources/Land Cover				
Federal and State T & E Species Elements of Occurence (count)	3	1	1	3
National, State, and City Parks and Forests (acres)	0	3	86	1
Prime Farm Land (acres)	1,425	1	1,344	3
Developed (acres)	230	3	1,677	1
Average Category Score	**2.00**		**2.00**	
Cultural Resources				
Cemeteries (count)	1	1	0	3
High Probability of Archeology/Cultural Resources (acres)	2,068	1	1,738	3
NRHP Sites (count)	0	3	0	3
Historical Markers (count)	0	3	0	3
Archaeological Sites (count)	15	1	4	3
Average Category Score	**1.80**		**3.00**	
Environmental Justice				
Minority Populations (%)	12.95	3	14.39	1
Low Income Families (%)	13.70	1	14.22	1
Minority Populations (count)	299	3	503	1
Low Income Families (count)	779	3	1,026	1
Minority Populations Compared to County Level Data (Blocks)	15	1	10	3
Low Income Families Compared to County Level Data (Block Groups)	5	3	7	1
Schools, Churches, Hospitals (count)	1	1	1	1
Average Category Score	**2.14**		**1.29**	
Hazardous Sites				
Municipal Setting Designation (MSD) Sites (count)	0	3	0	3
Petroleum Storage Tanks (PSTs) and Leaking PSTs (count)	0	3	1	1
Water Supply Wells (count)	4	1	2	3
Municipal Solid Waste Sites (MSWs) and Closed MSWs (count)	0	3	0	3
USEPA Facilities (count)	2	3	9	1
Cleanup Sites (count)	0	3	0	3
USEPA Radioactive Sites (count)	0	3	0	3
Average Category Score	**2.71**		**2.43**	

Environmental Evaluation Criteria
Bardwell Base and Alternative Alignments

Parameter	BA Base (57 miles)		BA-1 (57 miles)		BA-2 (56 miles)		BA-3 (55 miles)	
	Data	Score	Data	Score	Data	Score	Data	Score
Streams, Wetlands, and Waterbodies								
Stream Crossings (count)	82	2	88	1	86	1	76	3
Stream Crossings (linear feet)	46,268	1	47,579	1	47,463	1	45,591	1
Parallel Streams (count)	8	2	13	1	8	2	6	3
Waterbody Crossings (count)	67	2	62	3	66	2	96	1
Forested/Scrub Shrub Wetlands (acres)	14	2	17	2	9	3	55	1
Emergent Wetlands (acres)	4.0	3	9.9	1	4.0	3	4.0	3
Hydric Soils (acres)	121	1	127	1	121	1	106	3
Average Category Score	**1.86**		**1.43**		**1.86**		**2.14**	
Natural Resources/Land Cover								
Federal and State T & E Species Elements of Occurence (count)	1	1	1	1	1	1	1	1
National, State, and City Parks and Forests (acres)	0	3	0	3	24	1	0	3
Prime Farm Land (acres)	1,293	1	1,333	1	1,231	2	856	3
Developed (acres)	100	3	98	3	96	3	107	1
Average Category Score	**2.00**		**2.00**		**1.75**		**2.00**	
Cultural Resources								
Cemeteries (count)	0	3	0	3	0	3	0	3
High Probability of Archeology/Cultural Resources (acres)	1,711	3	1,695	3	1,701	3	1,806	1
NRHP Sites (count)	0	3	0	3	0	3	0	3
Historical Markers (count)	0	3	0	3	0	3	0	3
Archaeological Sites (count)	2	1	1	2	2	1	0	3
Average Category Score	**2.60**		**2.80**		**2.60**		**2.60**	
Environmental Justice								
Minority Populations (%)	22.44	1	21.86	1	22.20	1	18.44	3
Low Income Families (%)	13.68	2	13.25	3	13.92	2	14.07	1
Minority Populations (count)	487	2	563	1	448	3	528	2
Low Income Families (count)	773	3	760	3	760	3	1039	1
Minority Populations Compared to County Level Data (Blocks)	14	3	17	2	15	2	19	1
Low Income Families Compared to County Level Data (Block Groups)	6	1	5	3	6	1	6	1
Schools, Churches, Hospitals (count)	0	3	0	3	0	3	0	3
Average Category Score	**2.14**		**2.29**		**2.14**		**1.71**	
Hazardous Sites								
Municipal Setting Designation (MSD) Sites (count)	0	3	0	3	0	3	0	3
Petroleum Storage Tanks (PSTs) and Leaking PSTs (count)	0	3	1	1	0	3	0	3
Water Supply Wells (count)	4	1	4	1	4	1	0	3
Municipal Solid Waste Sites (MSWs) and Closed MSWs (count)	0	3	0	3	0	3	0	3
USEPA Facilities (count)	0	3	1	1	0	3	0	3
Cleanup Sites (count)	0	3	0	3	0	3	0	3
USEPA Radioactive Sites (count)	0	3	0	3	0	3	0	3
Average Category Score	**2.71**		**2.14**		**2.71**		**3.00**	

Environmental Evaluation Criteria

Corsicana Base and Alternative Alignments

Parameter	CR Base (32 miles)		CR-1 (32 miles)		CR-2 (31 miles)	
	Data	Score	Data	Score	Data	Score
Streams, Wetlands, and Waterbodies						
Stream Crossings (count)	47	2	40	3	56	1
Stream Crossings (linear feet)	26,144	2	24,115	3	30,589	1
Parallel Streams (count)	4	1	3	3	3	3
Waterbody Crossings (count)	48	2	45	3	51	1
Forested/Scrub Shrub Wetlands (acres)	7	3	10	2	29	1
Emergent Wetlands (acres)	2	3	3	1	3	1
Hydric Soils (acres)	121	1	57	3	114	2
Average Category Score	**2.00**		**2.57**		**1.43**	
Natural Resources/Land Cover						
Federal and State T & E Species Elements of Occurence (count)	1	1	1	1	0	3
National, State, and City Parks and Forests (acres)	0	3	0	3	0	3
Prime Farm Land (acres)	571	2	539	3	640	1
Developed (acres)	66	1	66	1	41	3
Average Category Score	**1.75**		**2.00**		**2.50**	
Cultural Resources						
Cemeteries (count)	0	3	0	3	0	3
High Probability of Archeology/Cultural Resources (acres)	828	1	644	3	817	1
NRHP Sites (count)	0	3	0	3	0	3
Historical Markers (count)	0	3	0	3	0	3
Archaeological Sites (count)	1	3	3	1	3	1
Average Category Score	**2.60**		**2.60**		**2.20**	
Environmental Justice						
Minority Populations (%)	17.52	1	17.03	1	16.72	1
Low Income Families (%)	16.41	1	15.63	1	15.63	1
Minority Populations (count)	110	2	211	1	100	3
Low Income Families (count)	368	3	425	1	425	1
Minority Populations Compared to County Level Data (Blocks)	4	1	4	1	4	1
Low Income Families Compared to County Level Data (Block Groups)	3	1	3	1	3	1
Schools, Churches, Hospitals (count)	0	3	0	3	0	3
Average Category Score	**1.71**		**1.29**		**1.57**	
Hazardous Sites						
Municipal Setting Designation (MSD) Sites (count)	0	3	0	3	0	3
Petroleum Storage Tanks (PSTs) and Leaking PSTs (count)	0	3	0	3	0	3
Water Supply Wells (count)	4	1	0	3	0	3
Municipal Solid Waste Sites (MSWs) and Closed MSWs (count)	0	3	0	3	0	3
USEPA Facilities (count)	0	3	0	3	0	3
Cleanup Sites (count)	0	3	0	3	0	3
USEPA Radioactive Sites (count)	0	3	0	3	0	3
Average Category Score	**2.71**		**3.00**		**3.00**	

Appendix C

Environmental Sources

Streams, Wetlands, and Waterbodies

Stream Crossings

"National Hydrography Dataset," U.S. Geological Survey, accessed April 2015, http://nhd.usgs.gov/

Parallel Streams

"National Hydrography Dataset," U.S. Geological Survey, accessed April 2015, http://nhd.usgs.gov/

Waterbody Crossings

"National Hydrography Dataset," U.S. Geological Survey, accessed April 2015, http://nhd.usgs.gov/data.html

Forested/Scrub Shrub Wetlands

"National Wetlands Inventory," U.S. Fish and Wildlife Service, accessed April 2015, http://www.fws.gov/Wetlands/NWI/index.html

Emergent Wetlands

"National Wetlands Inventory," U.S. Fish and Wildlife Service, accessed April 2015, http://www.fws.gov/Wetlands/NWI/index.html

100-Year Floodplains

"National Flood Hazard Layer Web Map Service," Federal Emergency Management Agency, accessed April 2015, https://hazards.fema.gov/femaportal/wps/portal/NFHLWMSkmzdownload

"National Flood Hazard Layer," Federal Emergency Management Agency, accessed April 2015, https://www.fema.gov/national-flood-insurance-program-flood-hazard-mapping/national-flood-hazard-layer-nfhl

Hydric Soils

"Natural Resources Conservation Service," United States Department of Agriculture, accessed April 2015, http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

Natural Resources/Land Cover

Federal and State T & E Species EOs Area

"Texas Natural Diversity Database," Texas Parks & Wildlife, accessed April 2015, https://tpwd.texas.gov/huntwild/wild/wildlife_diversity/txndd/

National, State, and City Parks and Forests

"StratMap Boundaries," Texas Natural Resources Information System, accessed April 2015, http://tnris.org/data-catalog/boundary/stratmap-boundaries/

"FSGeodata Clearinghouse," United States Department of Agriculture - Forest Service, accessed April 2015, http://data.fs.usda.gov/geodata/

"State Park Boundary Data", Texas Parks & Wildlife, accessed April 2015, http://tpwd.texas.gov/gis/data

Prime Farm Land

"Natural Resources Conservation Service Soils," United States Department of Agriculture, accessed April 2015, http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053627

Developed Acres

"National Land Cover Database," U.S. Geological Survey, accessed April 2015, http://www.mrlc.gov/nlcd11_data.php

Cultural Resources

Cemeteries

“Texas Archeological Research Laboratory,” Texas Historical Commission, accessed April 2015, http://www.utexas.edu/research/tarl/default.php

High Probability of Archeology/Cultural Resources

“Texas Archeological Research Laboratory,” Texas Historical Commission, accessed April 2015, http://www.utexas.edu/research/tarl/

NRHP Sites

“NRHP Districts and Properties,” National Register of Historic Places, accessed April 2015, http://nrhp.focus.nps.gov/natreg/docs/Download.html

Historical Markers

“Texas Archeological Research Laboratory,” Texas Historical Commission, accessed April 2015, http://www.utexas.edu/research/tarl/

Archaeological Sites

“Texas Archeological Research Laboratory,” Texas Historical Commission, accessed April 2015, http://www.utexas.edu/research/tarl/

Environmental Justice

Minority Populations

“American Fact Finder Download Center, 2010 Decennial Census, by Block,” United State Census Bureau, accessed April 2015, http://factfinder.census.gov/faces/nav/jsf/pages/download_center.xhtml

Low Income Families

“American Fact Finder Download Center, 2009-2013 American Community Survey, by Block Group,” United State Census Bureau, accessed April 2015, http://factfinder.census.gov/faces/nav/jsf/pages/download_center.xhtml

Schools

"Arc Resource Center," ESRI, accessed April 2015, http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#//00qp00000023000000.htm

"U.S. Gazetteer Files, Texas, 2014" United States Census Bureau, accessed April 2015, http://www.census.gov/geo/maps-data/data/gazetteer2014.html

Churches

"Arc Resource Center," ESRI, accessed April 2015, http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#//00qp00000023000000.htm

"U.S. Gazetteer Files, Texas, 2014" United States Census Bureau, accessed April 2015, http://www.census.gov/geo/maps-data/data/gazetteer2014.html

Hospitals

"Arc Resource Center," ESRI, accessed April 2015, http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#//00qp00000023000000.htm

Hazardous Sites

Municipal Setting Designation Sites

"Municipal Setting Designation Boundary," Texas Commission on Environmental Quality, accessed April 2015, http://www.tceq.state.tx.us/agency/data

Petroleum Storage Tanks and Leaking PSTs

"TCEQ Petroleum Storage Tank Locations," Texas Commission on Environmental Quality, accessed April 2015, http://www.tceq.state.tx.us/agency/data

Water Supply Wells

"Public Water Supply Wells," Texas Commission on Environmental Quality, accessed April 2015, http://www.tceq.state.tx.us/agency/data

Municipal Solid Waste Sites and Closed MSWs

"TCEQ Closed Municipal Solid Waste Sites," Texas Commission on Environmental Quality, accessed April 2015, http://www.tceq.state.tx.us/agency/data

"Closed MSW Sites," Texas Commission on Environmental Quality, accessed April 2015, https://www.tceq.texas.gov/assets/.../msw-closed-facilities-texas.xls

"TCEQ Active Municipal Solid Waste Sites," Texas Commission on Environmental Quality, accessed April 2015, http://www.tceq.state.tx.us/agency/data

EPA Facilities

"EPA Registered Facilities," Environmental Protection Agency, accessed April 2015, http://www.epa.gov/envirofw/geo_data.html

EPA Superfund Sites

"Superfund Sites," Texas Commission on Environmental Quality, accessed April 2015, http://www.tceq.state.tx.us/agency/data

EPA Radioactive Sites

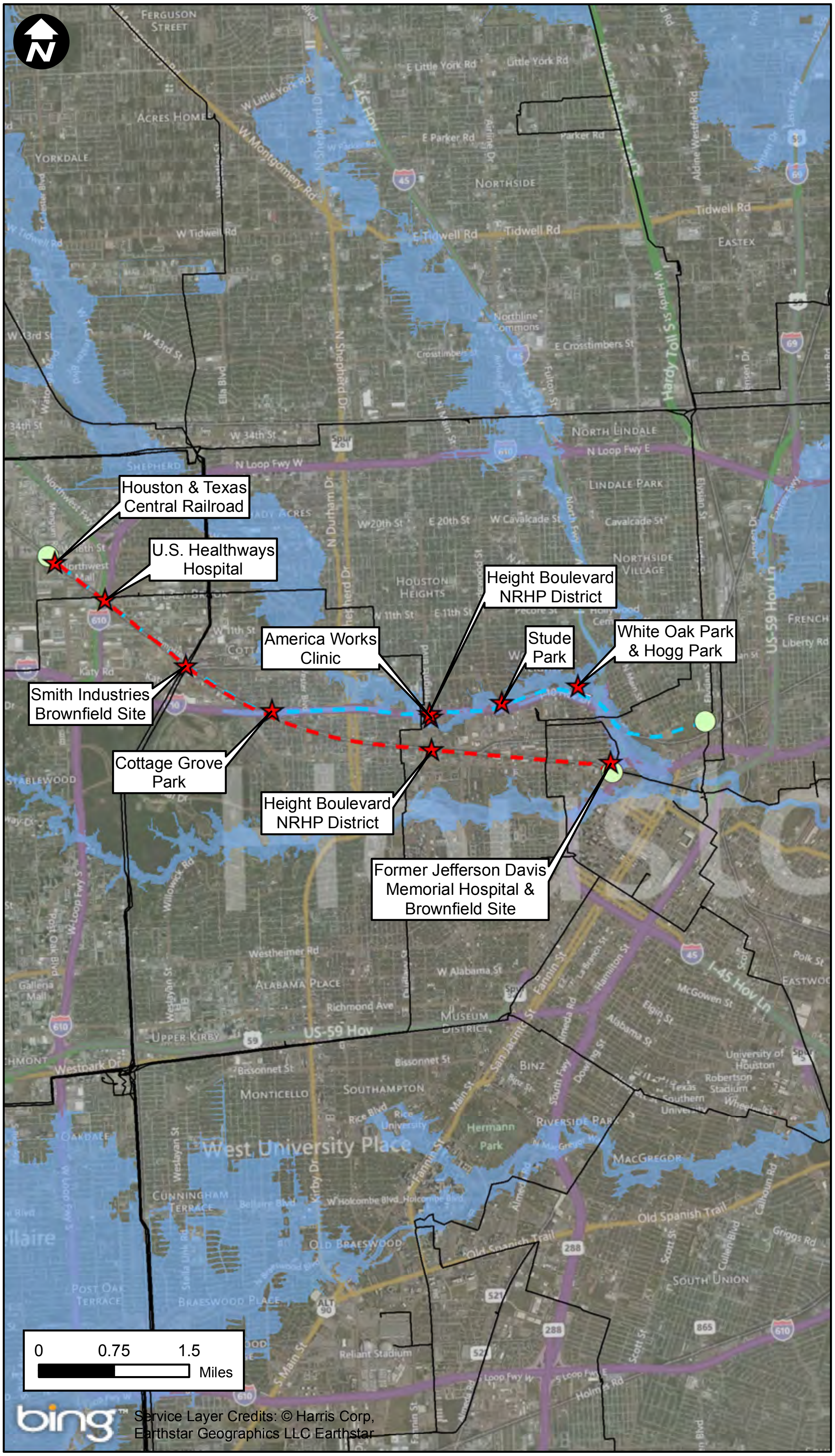
"Radioactive Sites," Texas Commission on Environmental Quality, accessed April 2015, http://www.tceq.state.tx.us/agency/data

Appendix D

Phase 1 Alternative Alignment Figures and Tables

Phase 1 Analysis
Downtown Houston Alternatives

D-1



Key Facts Leading to Elimination

DH-1

1. Greatest impact to minorities.
2. Potential impacts to Jefferson Davis Memorial Hospital and Brownfield Site
3. Greatest impact to USEPA facilities.

DH-2

1. Greatest impact to stream crossings, parallel streams, and waterbody crossings.
2. Greatest impact to low income families.
3. Direct impacts to Hogg, Stude, and White Oak Parks .

Legend

- Environmental Area of Concern
- Common Analysis End Point
- Electrical Transmission Line
- FEMA 100-Yr Floodplain

Eliminated Alignments

- DH-1 Alignment
- DH-2 Alignment

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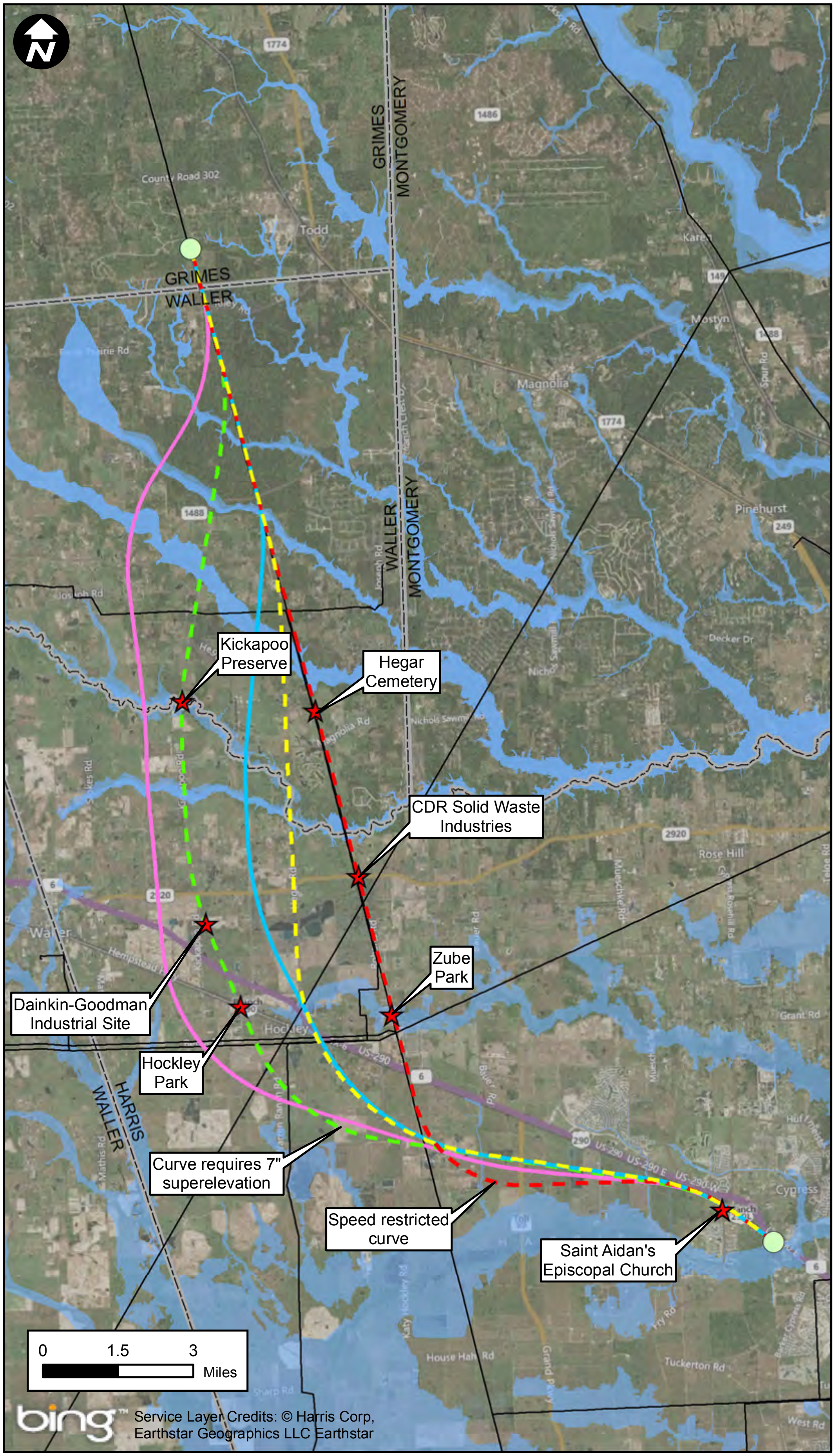
Phase 1 Analysis
Hockley Alternatives

D-2



Key Facts Leading to Elimination
HC Base
1. Greatest impact to stream crossings, parallel streams, and waterbody crossings.
HC-1
1.Direct impacts to Zube Park.
2. Worst overall environmental score.
3. Direct impacts to Hegar Cemetery.
4. Tight alignment curvature.
5. 160 mph speed restriction.
HC-3
1. Crosses planned Kickapoo Preserve housing development.
2. Would require 7 inch superelevation or speed reduction.
3. Greatest number of FEMA floodplain crossings.
4. Would directly impact Hockley Park.

Legend

- Environmental Area of Concern
- Common Analysis End Point
- Electrical Transmission Line
- FEMA 100-Yr Floodplain

Retained Alignments

- HC-2 Alignment
- HC-4 Alignment

Eliminated Alignments

- HC Base Alignment
- HC-1 Alignment
- HC-3 Alignment

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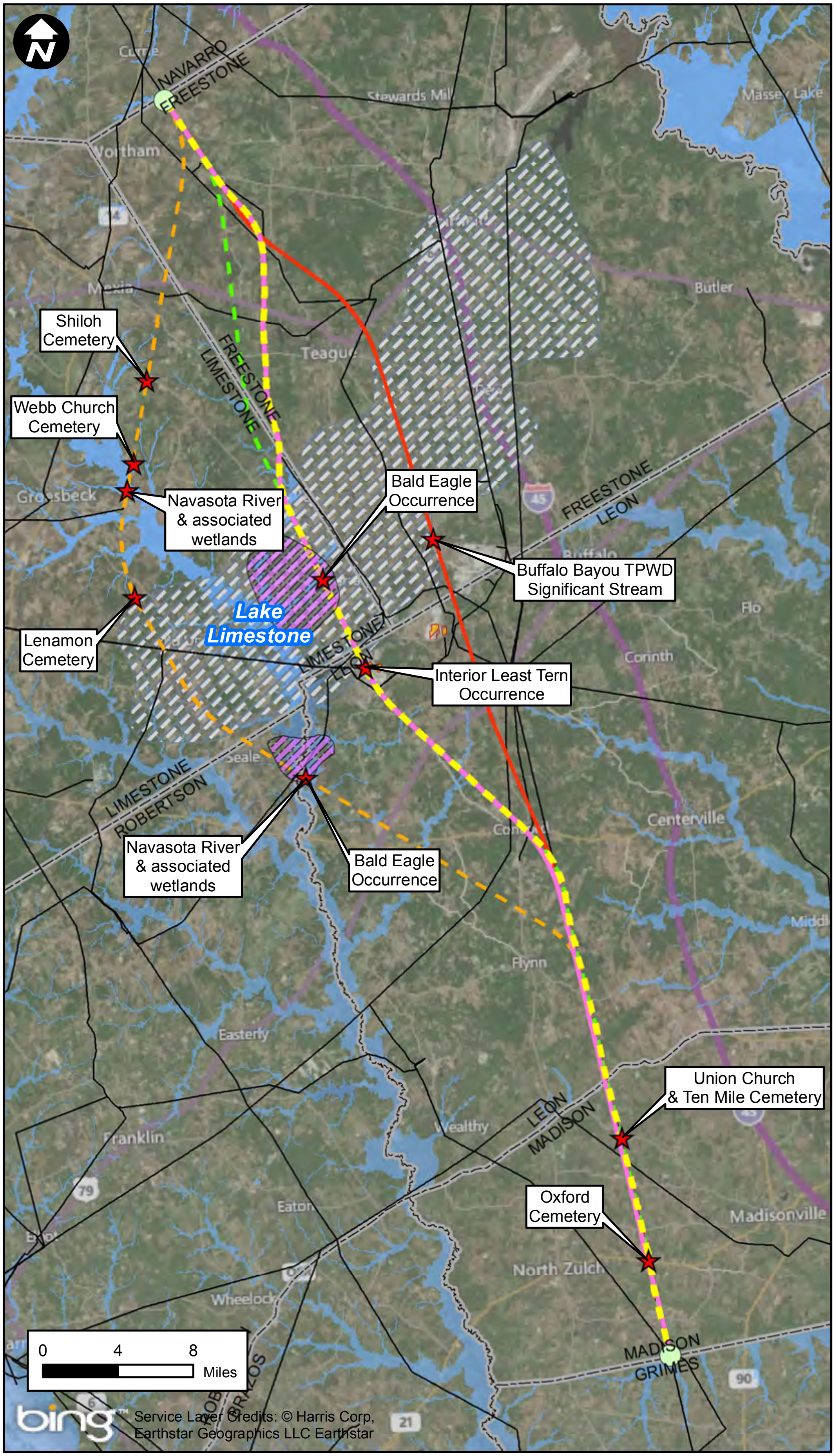
Phase 1 Analysis
Middle Alternatives

D-3



Key Facts Leading to Elimination
MD Base
1. Direct impact to Union Church.
2. Direct impact to Ten Mile Cemetery.
MD-2
1. Direct impact to Union Church.
2. Direct impact to Ten Mile Cemetery.
MD-3
1. Direct impacts to Lenamon, Shiloh, and Ten Mile Cemeteries.
2. Direct impact to Union Church.
3. Fails to avoid impacts to oil field infrastructure.
4. Greatest number of FEMA floodplain crossings.
5. Greatest length of viaduct requried for construction.
6. Greatest overall alignment length.

Legend

- Environmental Area of Concern
- Common Analysis End Point
- Electrical Transmission Line
- Bald Eagle Occurrence
- Interior Least Tern Occurrence
- FEMA 100-Yr Floodplain
- Oil & Gas Fields

Retained Alignments

- MD-1 Alignment
- MD-4 Alignment

Eliminated Alignments

- MD Base Alignment
- MD-2 Alignment
- MD-3 Alignment

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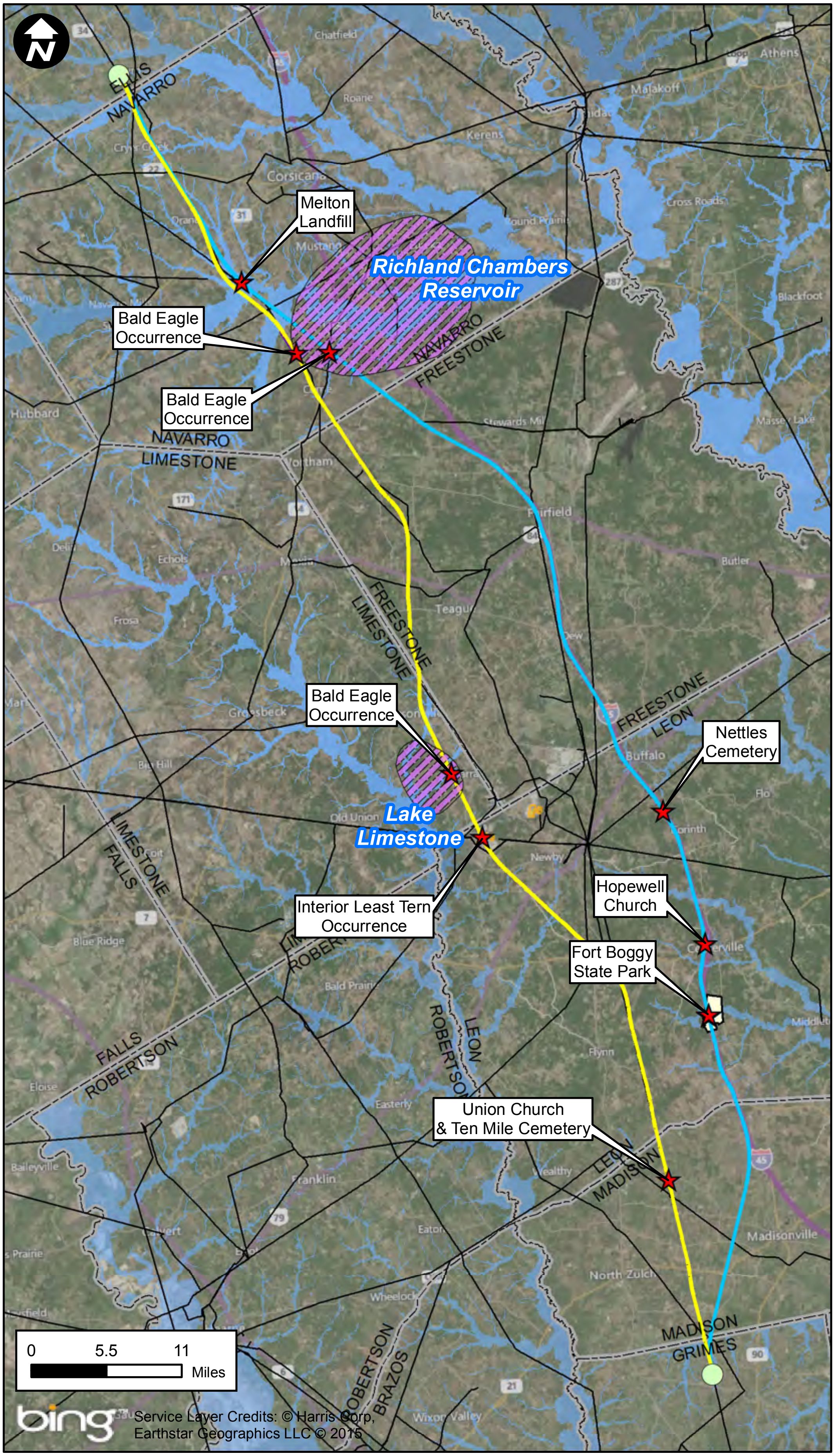
Phase 1 Analysis
Interstate IH-45 Alternatives

D-4



Key Facts to Compare IH-45 Base to IH-45 Alt.
IH-45 Base
1. Close proximity to closed Melton Landfill site.
2. Direct impact to Union Church.
3. Direct impact to Ten Mile Cemetery.
4. Worse overall environmental score.
5. Greater impact to stream crossings, parallel streams, and waterbody crossings.
6. Higher number of threatened and endangered species occurrences.

Legend

- Environmental Area of Concern
- Common Analysis End Point
- Electrical Transmission Line
- Bald Eagle Occurrence
- Interior Least Tern Occurrence
- FEMA 100-Yr Floodplain
- Fort Boggy State Park

Retained Alignments

- IH-45 Base Alignment
- IH-45 Alt. Alignment

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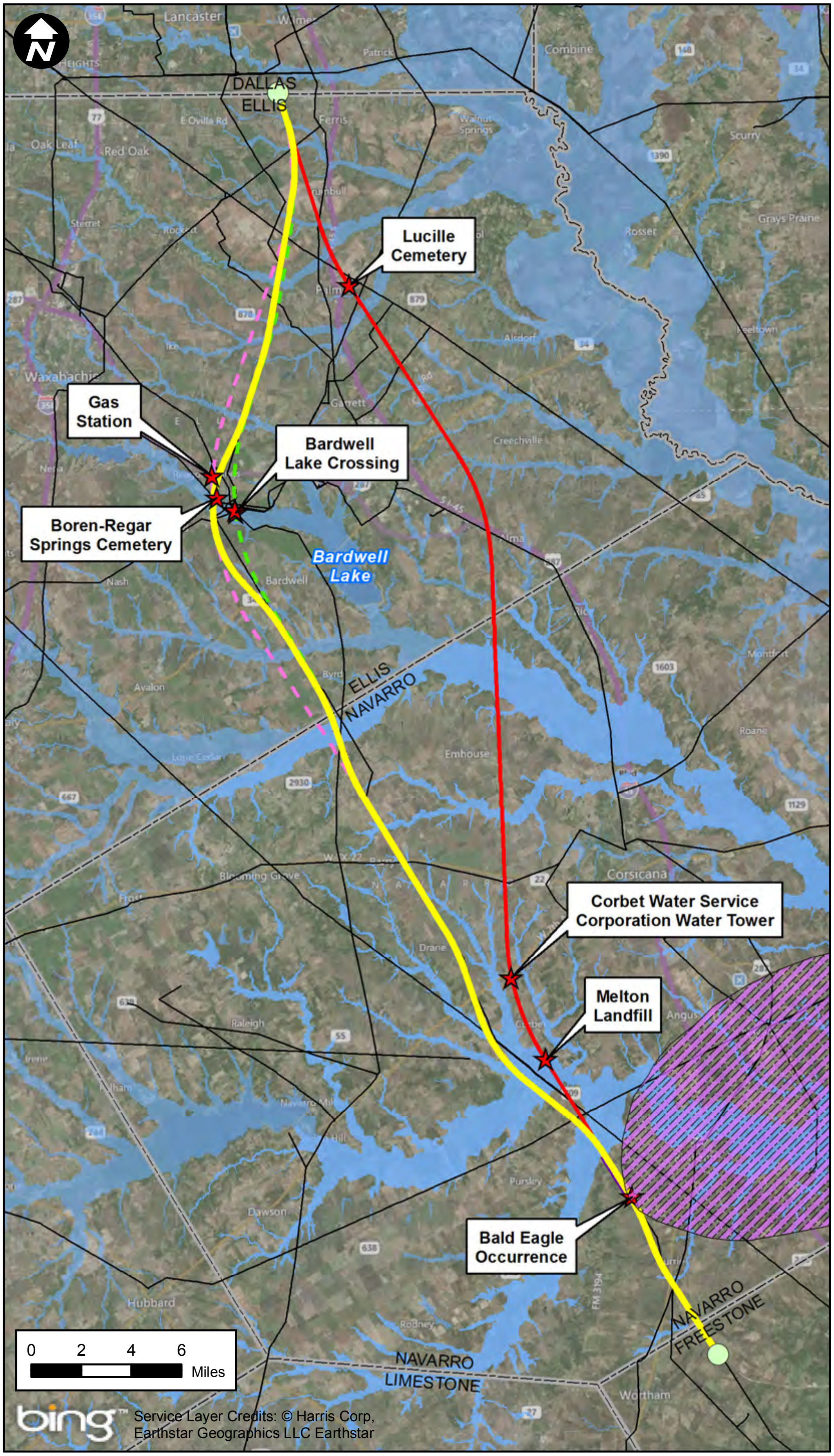
Phase 1 Analysis
Bardwell Alternatives

D-5



Key Facts Leading to Elimination

BA-1

1. Direct impact to registered USEPA facility with a petroleum storage tank (gas station).
2. Worst overall environmental score.

BA-2

1. Crossing on Lake Bardwell would require lengthy permitting process to obtain U.S. Army Corps of Engineers easement.

Legend

- Environmental Area of Concern
- Common Analysis End Point
- Electrical Transmission Line
- Bald Eagle Occurrence
- FEMA 100-Yr Floodplain

Retained Alignments

- BA Base Alignment
- BA-3 Alignment

Eliminated Alignments

- BA-1 Alignment
- BA-2 Alignment

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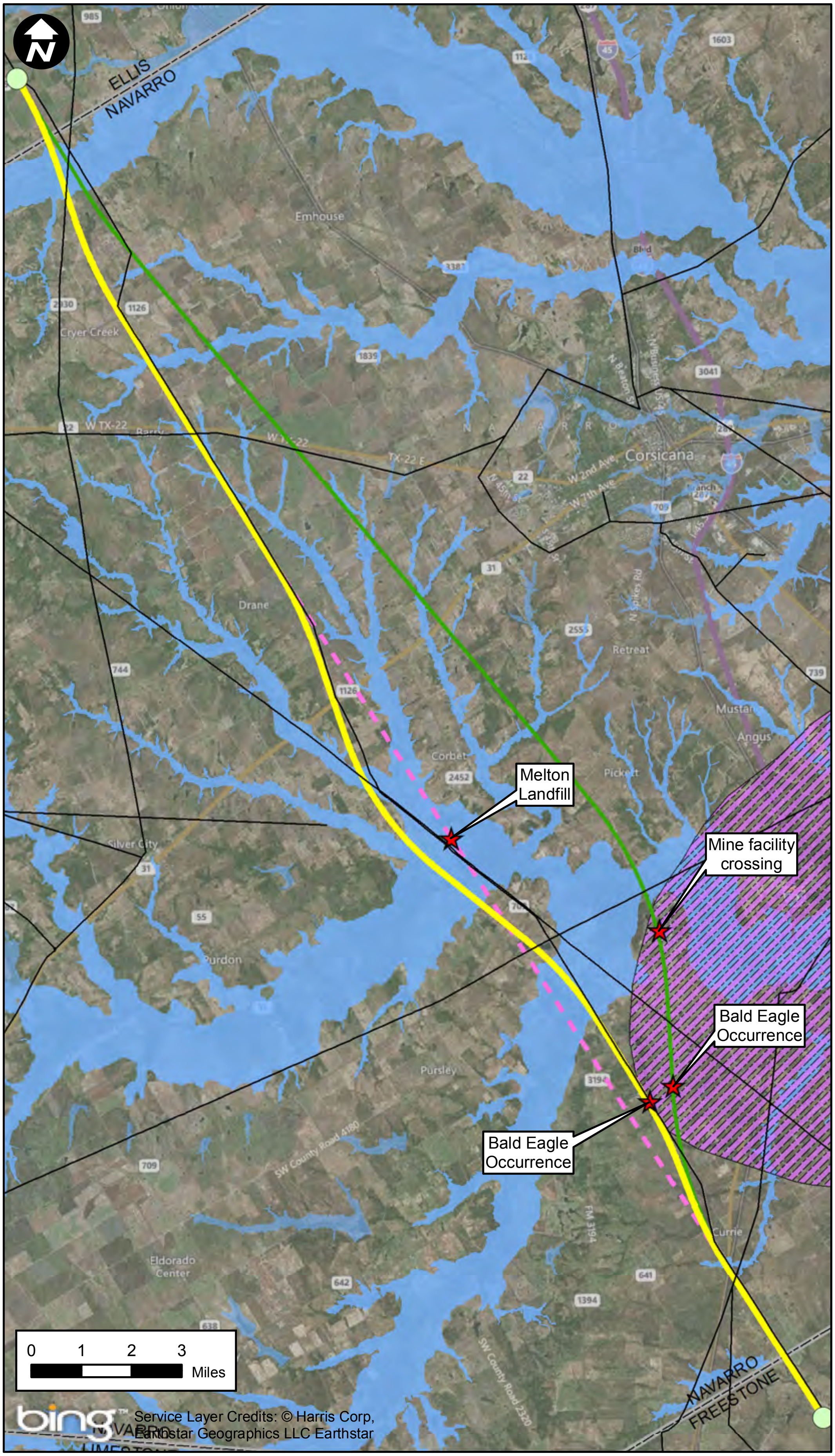
Phase 1 Analysis
Corsicana Alternatives

D-6



Key Facts Leading to Elimination
CR-2
1. Greatest number of FEMA floodplain crossings.
2. Worst overall environmental score.
3. Close proximity to closed Melton Landfill site.

Legend

Environmental Area of Concern

Common Analysis End Point

Electrical Transmission Line

Bald Eagle Occurrence

FEMA 100-Yr Floodplain

Retained Alignments

CR Base Alignment

CR-1 Alignment

Eliminated Alignments

CR-2 Alignment

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TEXAS CENTRAL RAILWAY

Table D-1 - Complete Listing of Environmental Areas of Concern

Bardwell		
Type	**Alignment**	**Description**
Natural Resource/Land Cover	BA Base	Threatened and Endangered Species - Bald Eagle Occurrence
Cultural Resource	BA Base	Boren-Regar Springs Cemetery
Natural Resource/Land Cover	BA-1	Threatened and Endangered Species - Bald Eagle Occurrence
Cultural Resource	BA-1	Boren-Regar Springs Cemetery
Hazardous Site	BA-1	USEPA Registered Facility - Gas Station
Natural Resource/Land Cover	BA-2	Threatened and Endangered Species - Bald Eagle Occurrence
Streams, Waterbodies, and Wetlands	BA-2	Bardwell Lake Crossing
Cultural Resource	BA-3	Lucille Cemetery
Hazardous Site	BA-3	Municipal Solid Waste Site (Closed) - Melton Landfill
Natural Resource/Land Cover	BA-3	Threatened and Endangered Species - Bald Eagle Occurrence
Hazardous Site	BA-3	Corbet Water Service Corporation Water Tower

Corsicana		
Type	**Alignment**	**Description**
Natural Resource/Land Cover	CR Base	Threatened and Endangered Species - Bald Eagle Occurrence
Natural Resource/Land Cover	CR-1	Threatened and Endangered Species - Bald Eagle Occurrence
Hazardous Site	CR-1	Mine Facility Crossing
Hazardous Site	CR-2	Municipal Solid Waste Site (Closed) - Melton Landfill

Middle		
Type	**Alignment**	**Description**
Natural Resource/Land Cover	MD Base	Threatened and Endangered Species - Bald Eagle Occurrence
Natural Resource/Land Cover	MD Base	Threatened and Endangered Species - Interior Least Tern Occurrence
Environmental Justice	MD Base	Union Church
Cultural Resource	MD Base	Ten Mile Cemetery
Natural Resource/Land Cover	MD-1	Threatened and Endangered Species - Bald Eagle Occurrence
Natural Resource/Land Cover	MD-1	Threatened and Endangered Species - Interior Least Tern Occurrence
Cultural Resource	MD-1	Oxford Cemetery
Natural Resource/Land Cover	MD-2	Threatened and Endangered Species - Bald Eagle Occurrence
Natural Resource/Land Cover	MD-2	Threatened and Endangered Species - Interior Least Tern Occurrence
Environmental Justice	MD-2	Union Church
Cultural Resource	MD-2	Ten Mile Cemetery
Cultural Resource	MD-3	Shiloh Cemetery
Cultural Resource	MD-3	Webb Church Cemetery
Cultural Resource	MD-3	Lenamon Cemetery
Natural Resource/Land Cover	MD-3	Threatened and Endangered Species - Bald Eagle Occurrence
Streams, Waterbodies, and Wetlands	MD-3	Navasota River and Associated Wetlands
Streams, Waterbodies, and Wetlands	MD-3	Navasota River and Associated Wetlands
Environmental Justice	MD-3	Union Church
Cultural Resource	MD-3	Ten Mile Cemetery
Streams, Waterbodies, and Wetlands	MD-4	Buffalo Bayou TPWD Significant Stream
Cultural Resource	MD-4	Oxford Cemetery

Table D-1 - Complete Listing of Environmental Areas of Concern

IH-45		
Type	**Alignment**	**Description**
Natural Resource/Land Cover	IH-45 Base	Threatened and Endangered Species - Bald Eagle Occurrence
Natural Resource/Land Cover	IH-45 Base	Threatened and Endangered Species - Bald Eagle Occurrence
Natural Resource/Land Cover	IH-45 Base	Threatened and Endangered Species - Interior Least Tern Occurrence
Environmental Justice	IH-45 Base	Union Church
Cultural Resource	IH-45 Base	Ten Mile Cemetery
Hazardous Site	IH-45 Alt	Municipal Solid Waste Site (Closed) - Melton Landfill
Natural Resource/Land Cover	IH-45 Alt	Threatened and Endangered Species- Bald Eagle Occurrence
Cultural Resource	IH-45 Alt	Nettles Cemetery
Environmental Justice	IH-45 Alt	Hopewell Church
Natural Resource/Land Cover	IH-45 Alt	Fort Boggy State Park

Hockley		
Type	**Alignment**	**Description**
Environmental Justice	HC Base	Saint Aidan's Episcopal Church
Cultural Resource	HC-1	Hegar Cemetery
Hazardous Site	HC-1	CDR Solid Waste Industries
Natural Resource/Land Cover	HC-1	Zube Park
Environmental Justice	HC-1	Saint Aidan's Episcopal Church
Environmental Justice	HC-2	Saint Aidan's Episcopal Church
Natural Resource/Land Cover	HC-3	Developed Acres - Kickapoo Preserve
Hazardous Site	HC-3	Daikon-Goodman Industrial Site
Environmental Justice	HC-3	Saint Aidan's Episcopal Church
Environmental Justice	HC-4	Saint Aidan's Episcopal Church

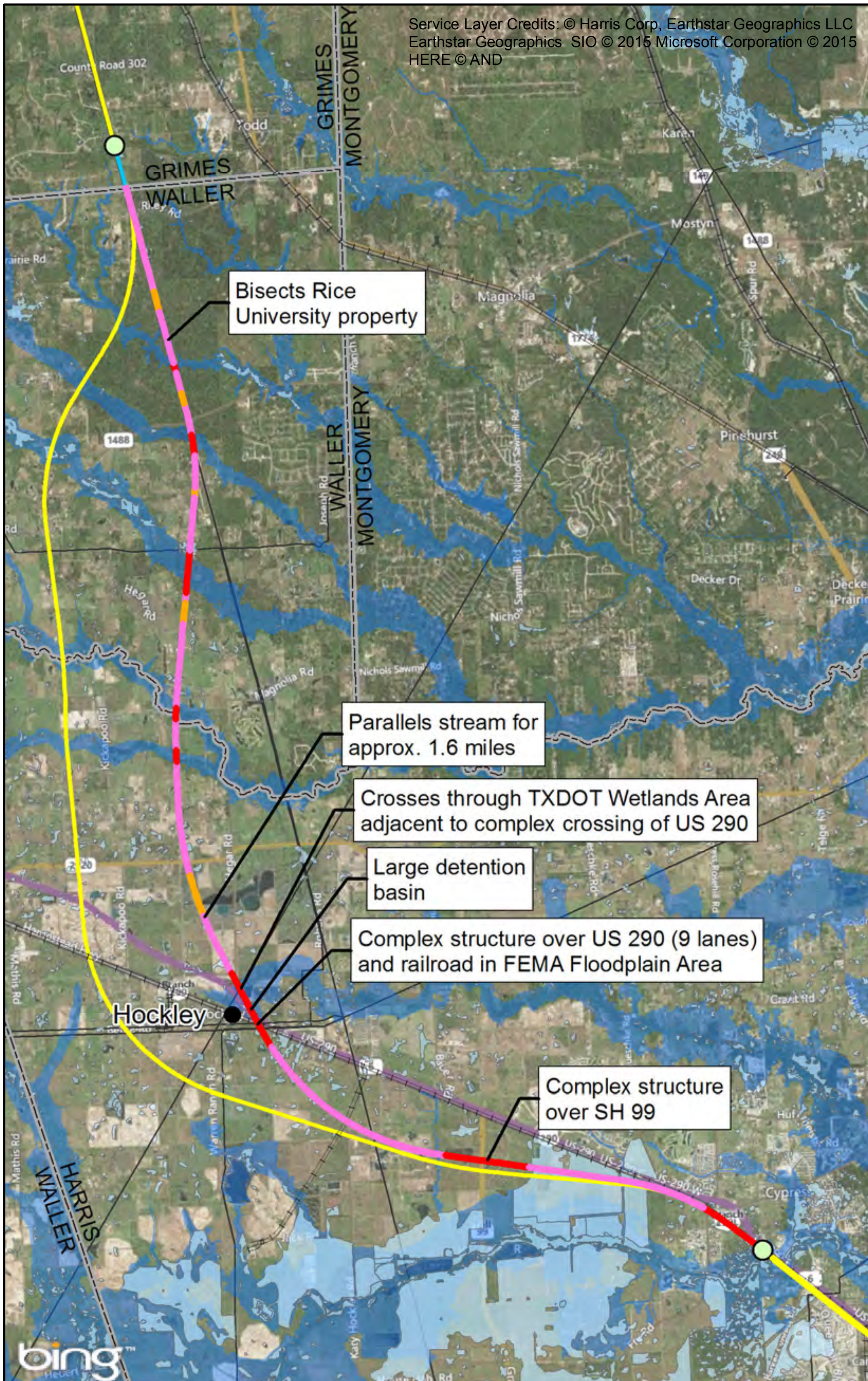
Downtown Houston		
Type	**Alignment**	**Description**
Cultural Resource	DH-1	Cypress Historical Railroad
Environmental Justice	DH-1	Carlton Pre Vocational Center
Hazardous Site	DH-1	City of Houston Transfer Facility
Environmental Justice	DH-1	Pentecostal Church
Environmental Justice	DH-1	U. S. Healthways Hospital
Hazardous Site	DH-1	Smith Industries Brownfield Site
Cultural Resource Hazardous	DH-1	Height Boulevard NRHP District
Site	DH-1	Former Jefferson Davis Memorial Hospital & Brownfield Site
Cultural Resource	DH-2	Cypress Historical Railroad
Environmental Justice	DH-2	Carlton Pre Vocational Center
Hazardous Site	DH-2	City of Houston Transfer Facility
Environmental Justice	DH-2	Pentecostal Church
Environmental Justice	DH-2	U. S. Healthways Hospital
Hazardous Site	DH-2	Smith Industries Brownfield Site
Cultural Resource	DH-2	Height Boulevard NRHP District
Environmental Justice	DH-2	America Works Clinic
Natural Resource/Land Cover	DH-2	White Oak Park

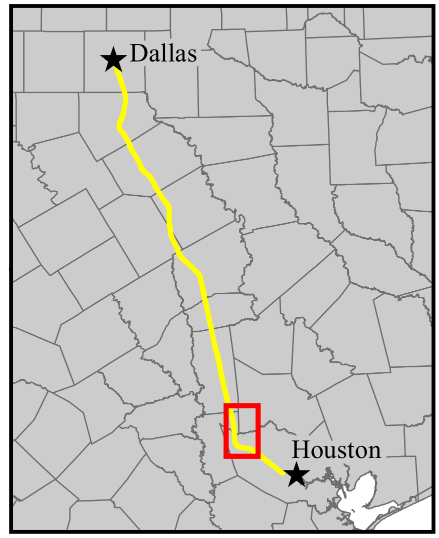
Appendix E

Phase 2 Alternative Alignment Figures and Tables

Phase 2 Analysis
Hockley - Alternative HC-2

E-1





Common Analysis End Point

HC-4 Alignment

FEMA Floodplain

NWI Wetland

Electrical Transmission Line

Railroad

HC-2 Construction Type

Cut

Embankment

Viaduct

0 2 4 6

Miles

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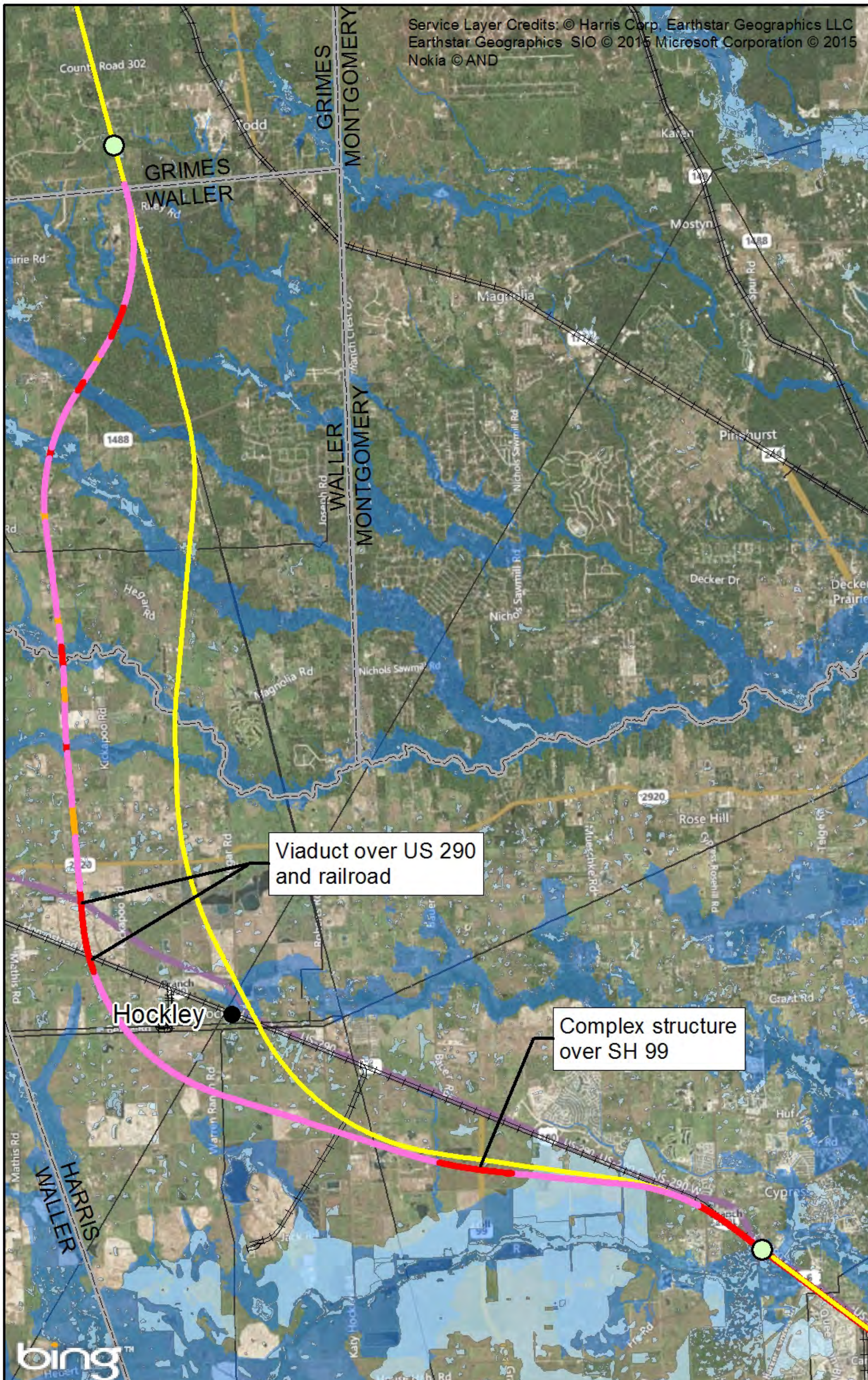
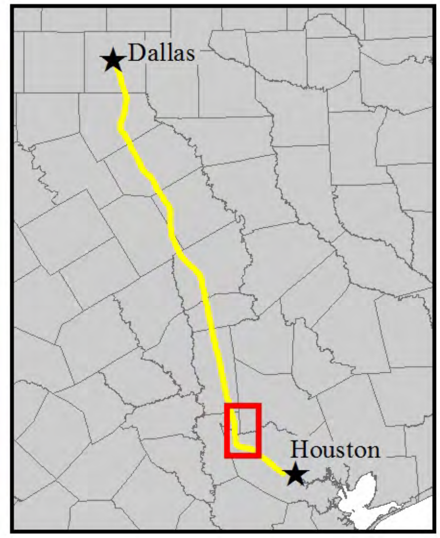
TEXAS CENTRAL RAILWAY

Key Facts	Complex structure over US 290 and SH 99 Crosses adjacent to large detention basin Crosses TXDOT wetland area Parallels stream in vincity of construction for 1.6 miles

Phase 2 Analysis
Hockley - Alternative HC-4

E-2





Common Analysis End Point

HC-2

FEMA Floodplain

NWI Wetland

Electrical Transmission Line

Railroad

HC-4 Construction Type

Cut

Embankment

Viaduct

0 2 4 6

Miles

Key Facts

Complex structure over SH 99
Small amount of viaduct
TxDOT coordination
Power company coordination

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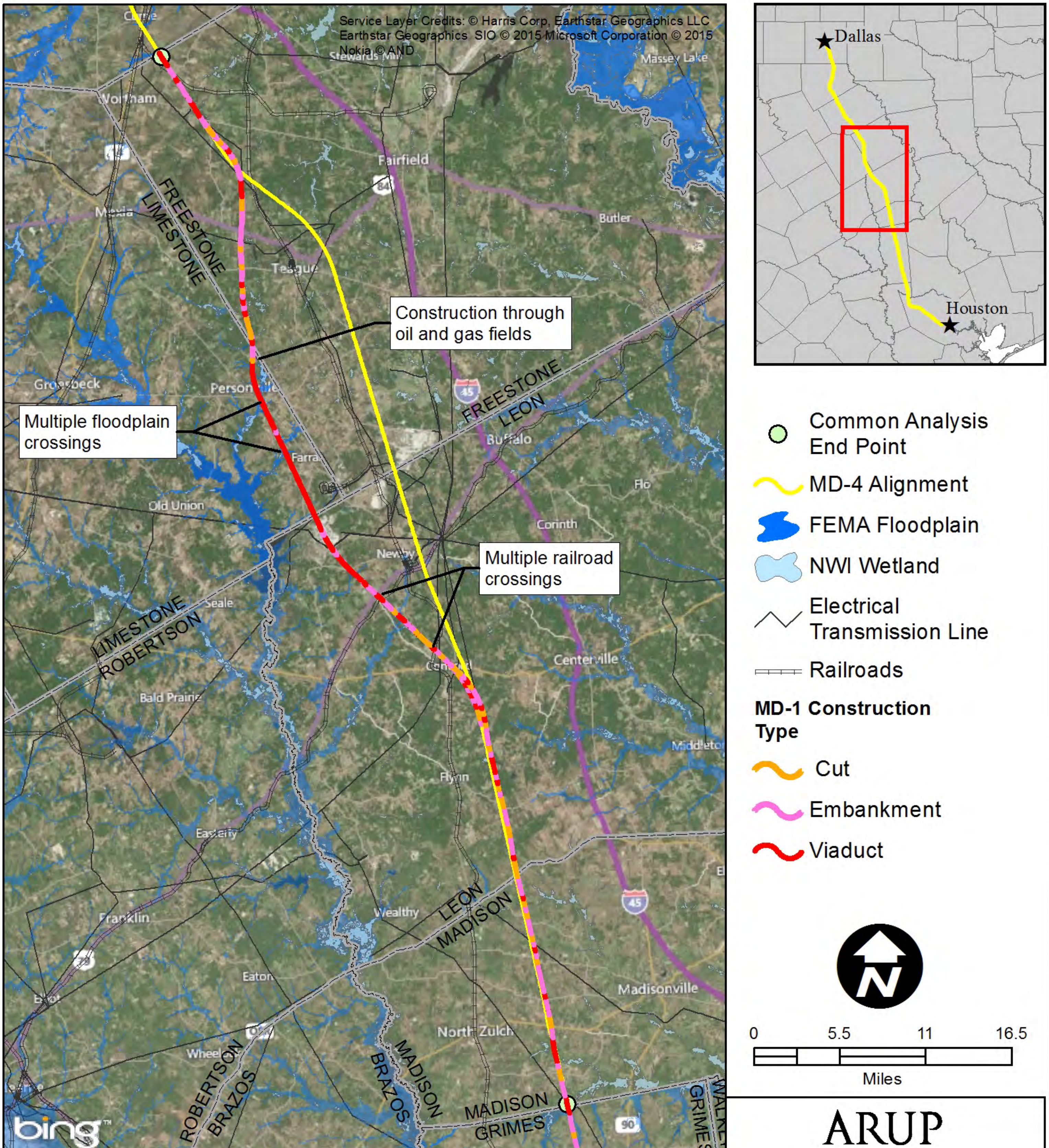
Phase 2 Analysis
Middle - Alternative MD-1

E-3



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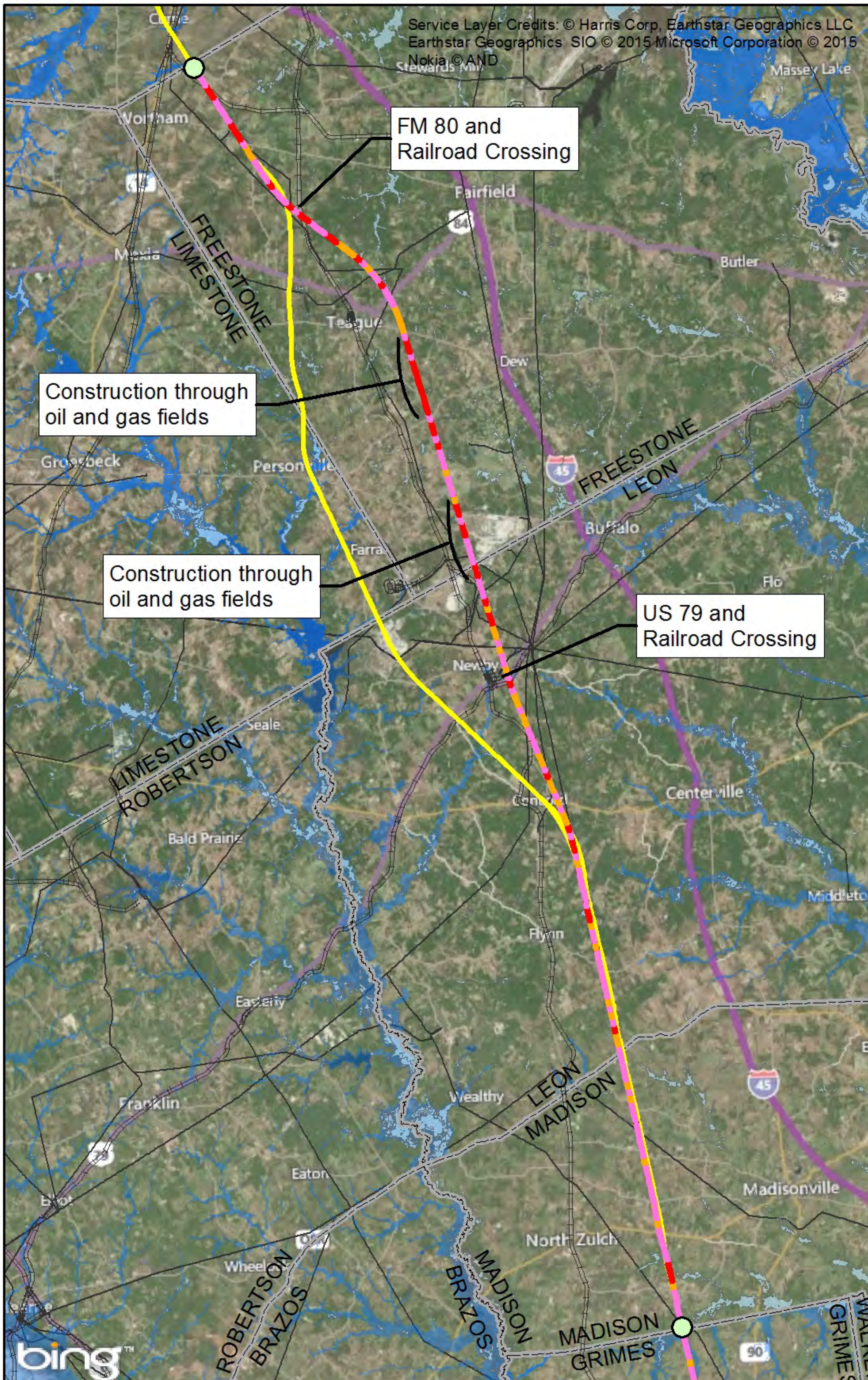
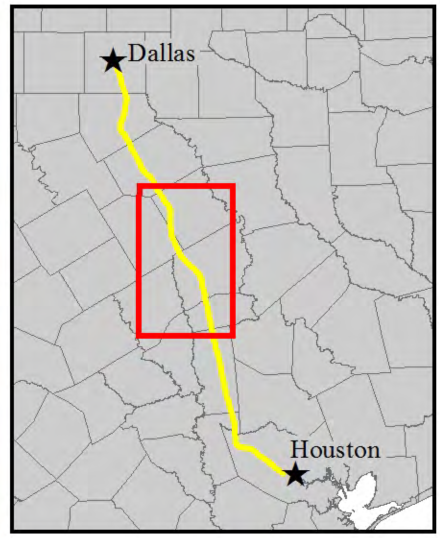
TEXAS CENTRAL RAILWAY

Key Facts	Multiple floodplain crossings Multiple railroad crossings Oil and Gas company coordination Power company coordination

Phase 2 Analysis
Middle - Alternative MD-4

E-4





Common Analysis End Point

MD-1 Alignment

FEMA Floodplain

NWI Wetland

Electrical Transmission Line

Railroad

MD-4 Construction Type

Cut

Embankment

Viaduct

0 5.5 11 16.5

Miles

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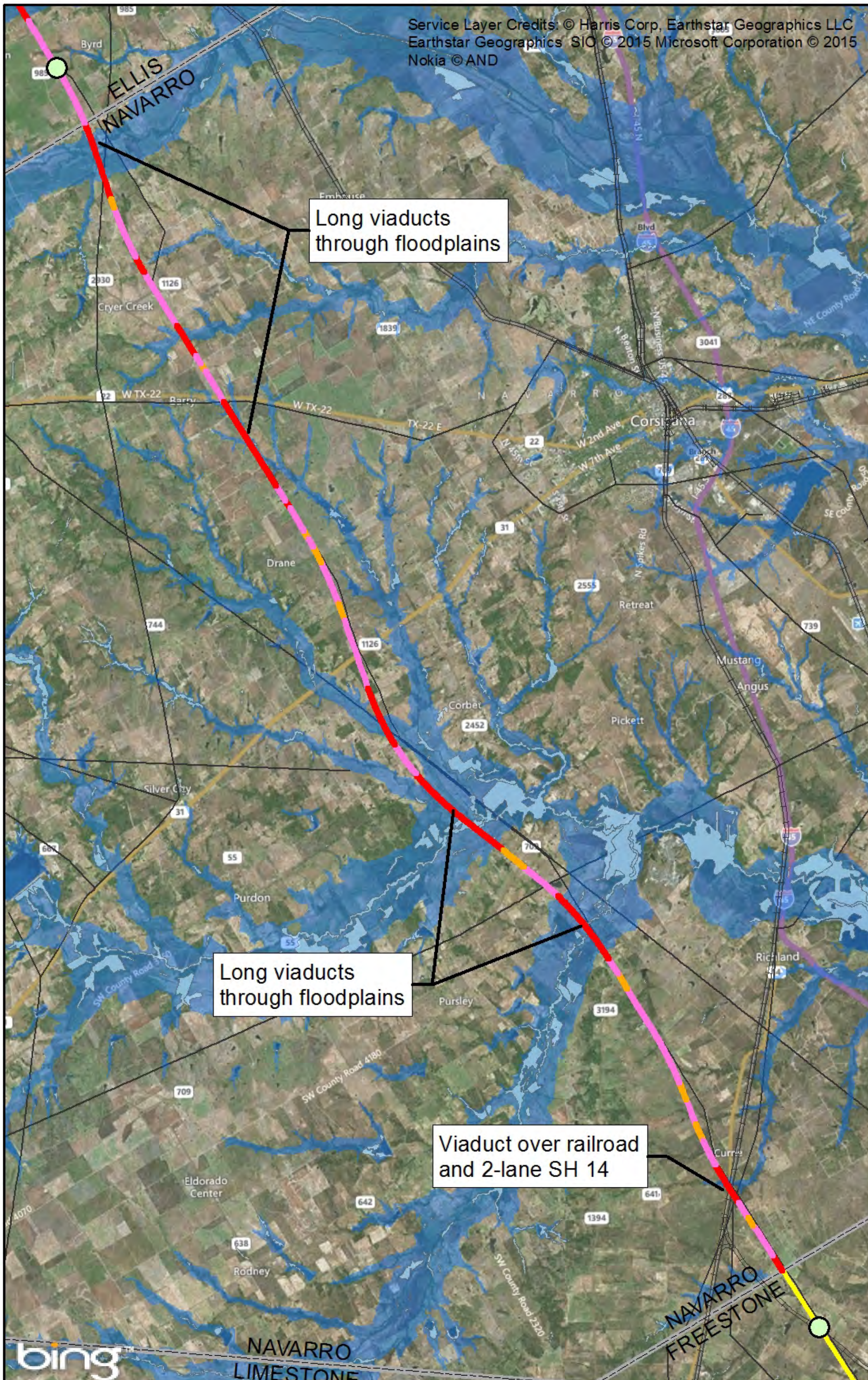
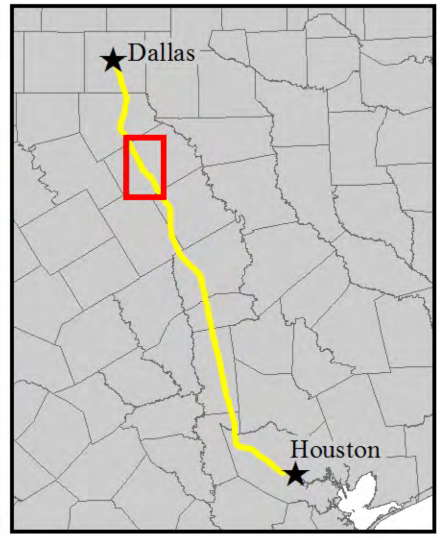
TEXAS CENTRAL RAILWAY

Key Facts	Multiple railroad crossings Oil and gas company coordination Power company coordination

Phase 2 Analysis
Corsicana - Base Alignment

E-5





Common Analysis End Point

Base UC

FEMA Floodplain

NWI Wetland

Electrical Transmission Line

Railroad

CR Base Construction Type

Cut

Embankment

Viaduct

0 2 4 6

Miles

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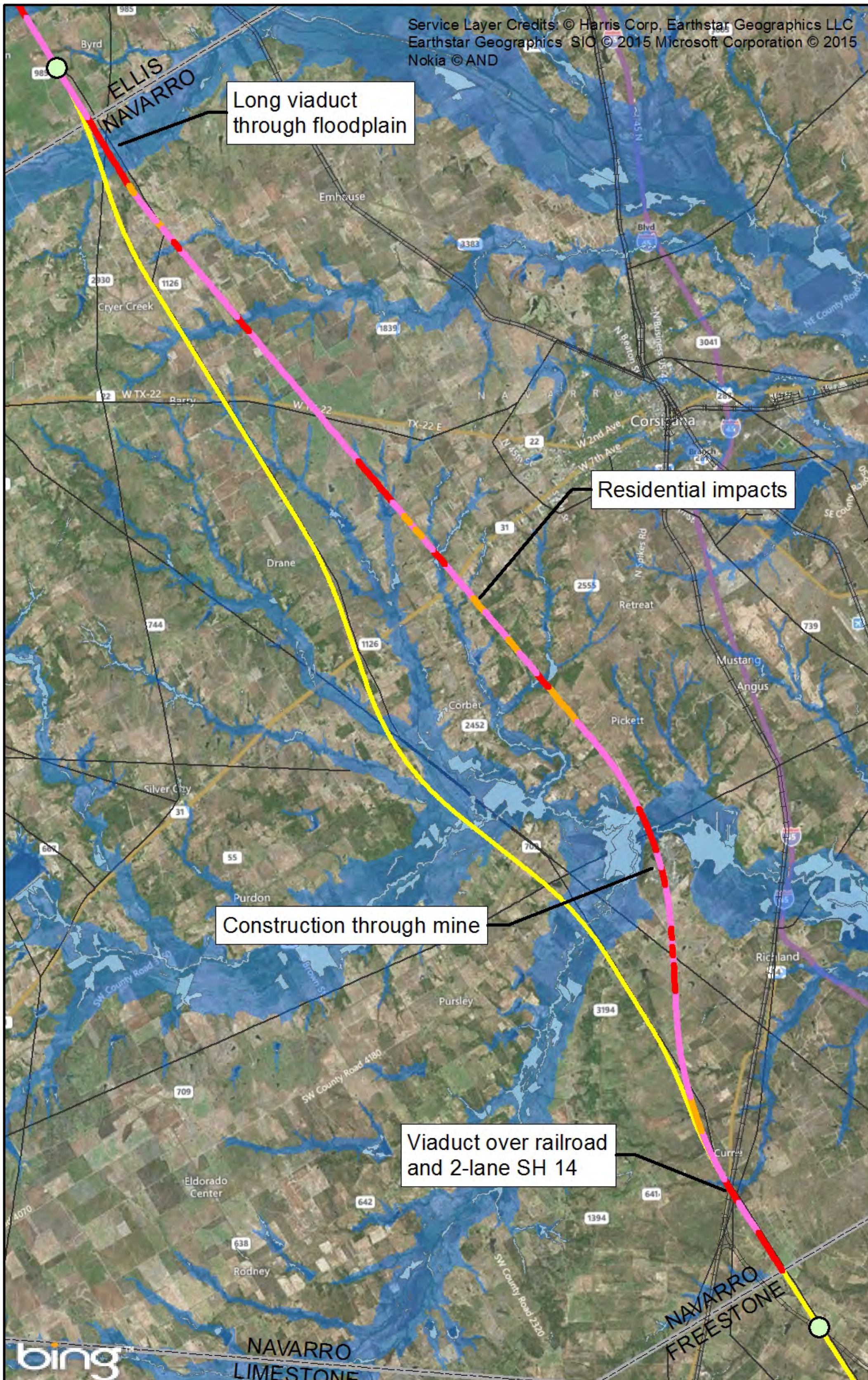
FREESE AND NICHOLS

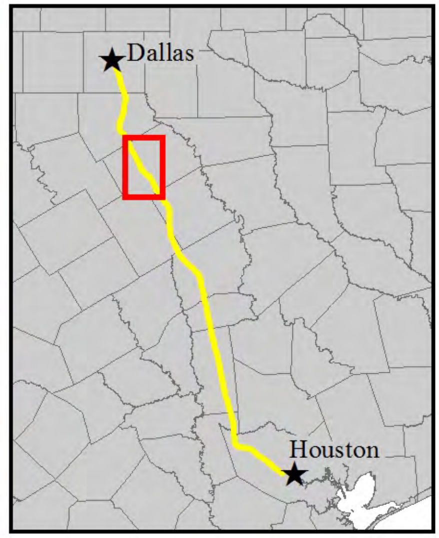
TEXAS CENTRAL RAILWAY

Key Facts	Construction of long viaducts through floodplains 5 Transmission line crossings

Phase 2 Analysis
Corsicana - Alternative CR-1

E-6





Common Analysis End Point

Base UC Alignment

FEMA Floodplain

NWI Wetland

Electrical Transmission Line

Railroad

CR-1 Construction Type

Cut

Embankment

Viaduct

0 2 4 6

Miles

Key Facts

1.4 miles of construction through a mine
7 Transmission line crossings
Residential impacts near Oak Valley

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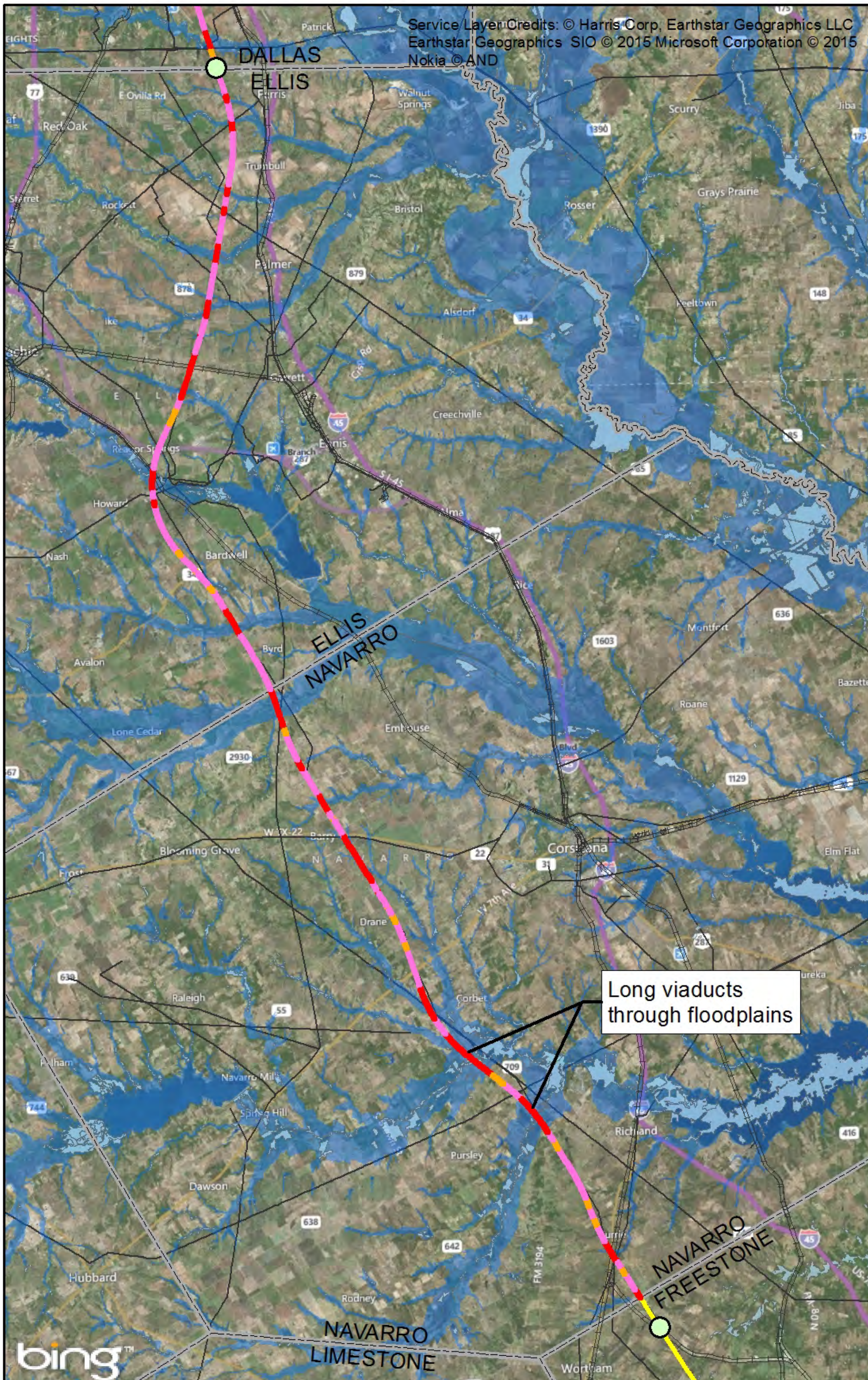
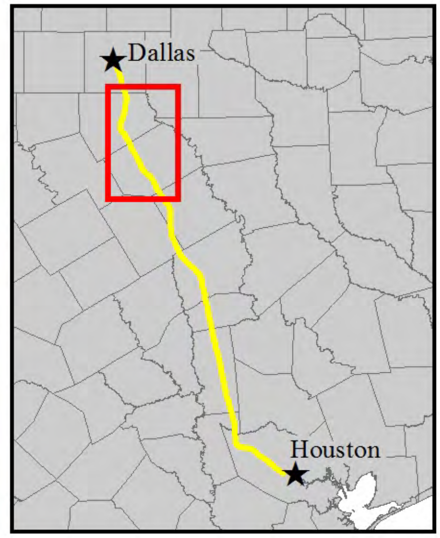
TEXAS CENTRAL RAILWAY

Phase 2 Analysis
Bardwell - Base Alignment

E-7





Common Analysis End Point

Base UC Alignment

FEMA Floodplain

NWI Wetland

Electrical Transmission Line

Railroad

BA Base Construction Type

Cut

Embankment

Viaduct

0 4 8 12

Miles

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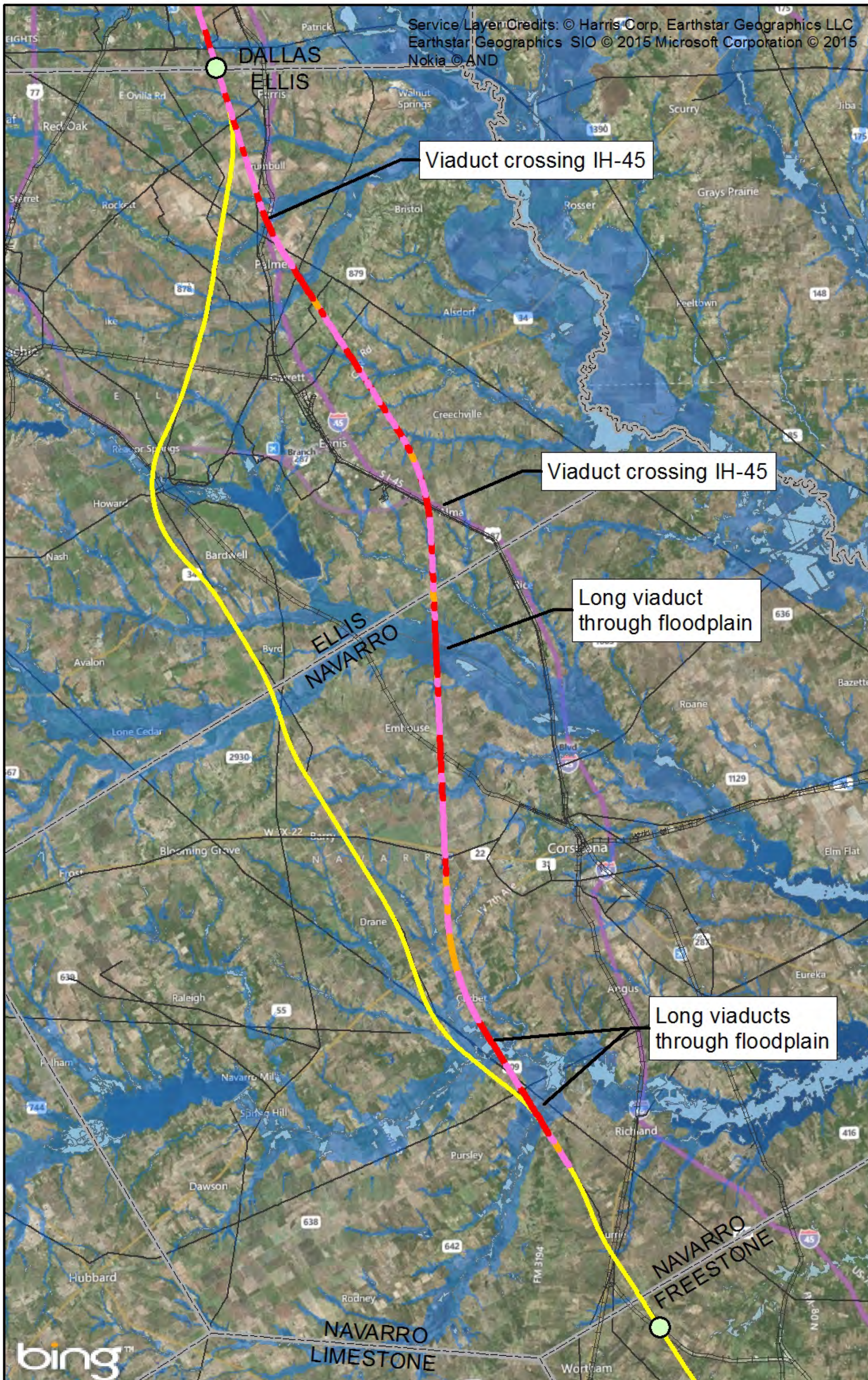
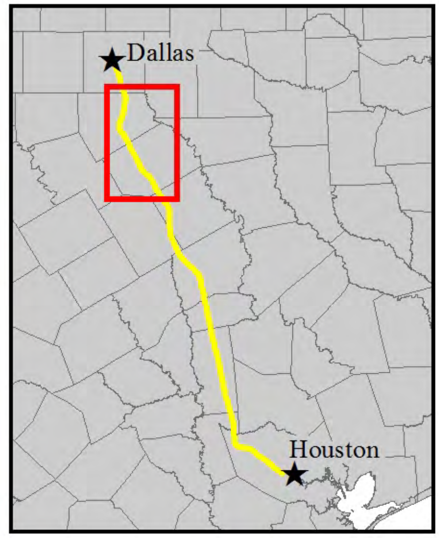
TEXAS CENTRAL RAILWAY

Key Facts	Alignment avoids major roadways

Phase 2 Analysis
Bardwell - Alternative BA-3

E-8





Common Analysis End Point

Base UC

FEMA Floodplain

NWI Wetland

Electrical Transmission Line

Railroad

BA-3 Construction Type

Cut

Embankment

Viaduct

0 4 8 12

Miles

ARUP

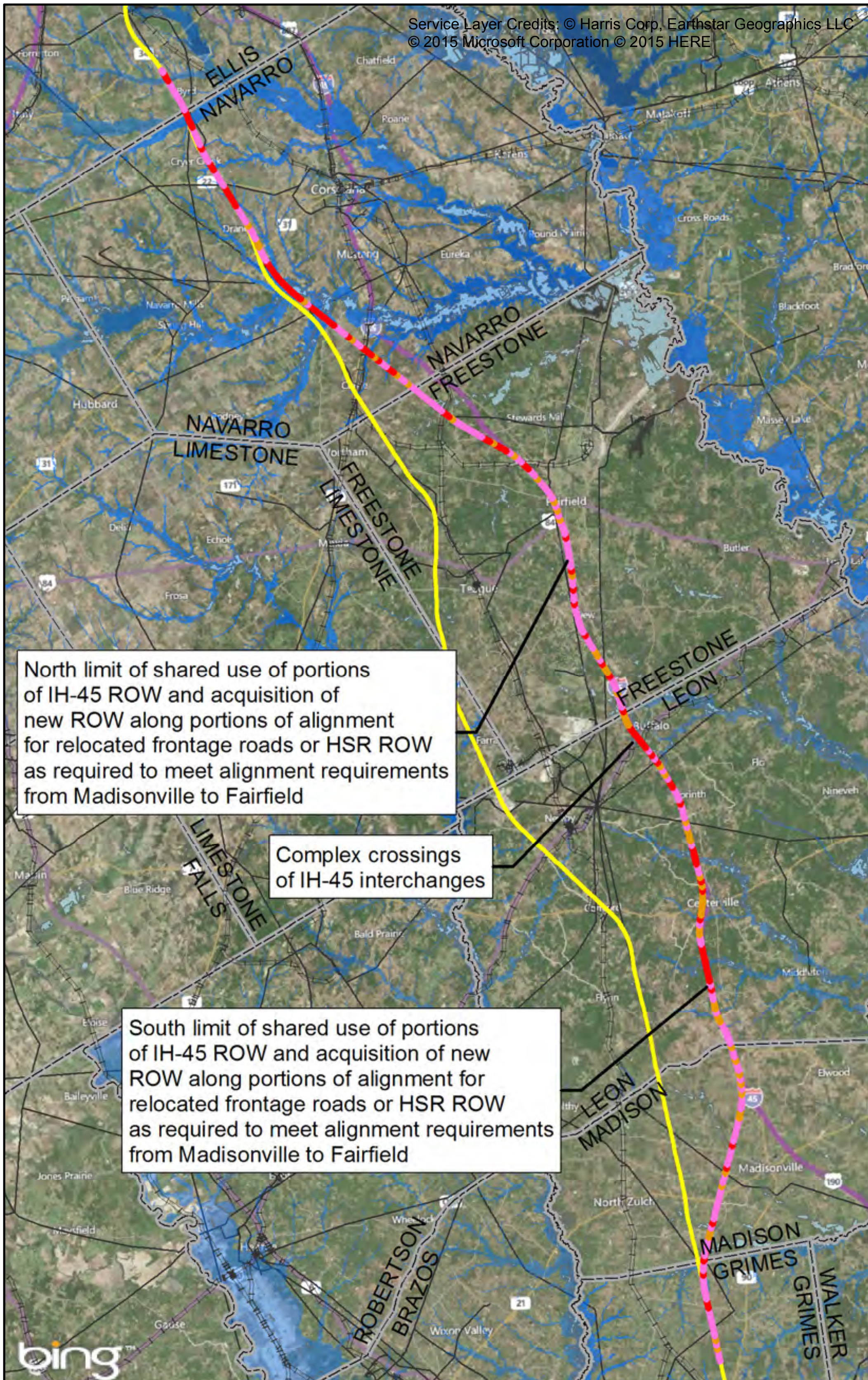
FREESE AND NICHOLS

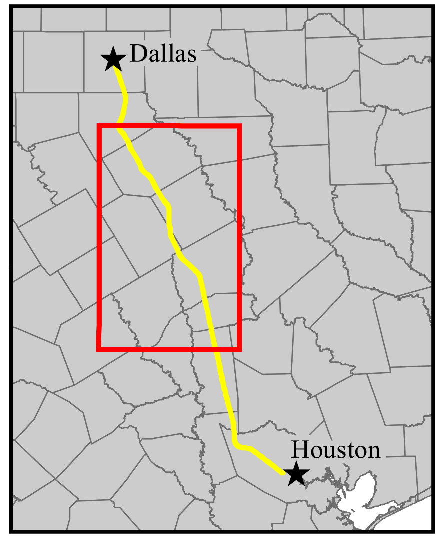
TEXAS CENTRAL RAILWAY

Key Facts	Construction of long viaducts through floodplains Viaduct crossings of IH-45 TxDOT coordination

Phase 2 Analysis
Interstate 45 - Alternative IH-45

E-9





Common Analysis End Point

Base UC Alignment

FEMA Floodplain

NWI Wetland

Electrical Transmission Line

Railroad

IH-45 Construction Type

Cut

Embankment

Viaduct

0 8 16 24

Miles

ARUP

FREESE NICHOLS

TEXAS CENTRAL RAILWAY

Key Facts	IH-45 Frontage road to be constructed intermittently Frequent road crossings Complex crossings of IH-45 interchanges Shared use of portions of IH-45 ROW TxDOT coordination

Phase 2 Constructability Analysis - Hockley				
Constructability	**HC-2**	**HC-3**	**HC-4**	**Justification**
Accessibility	✓	✓	✓	All alignments have easy access. Minor issues.
Pre-Construction Activities	✓	✓	✓	All alignments are located near US 290 and local roads. Minor issues.
Floodplain Crossings	✓	✓	✓	Lengths within floodplain are between 2.4 and 2.7 miles. No major floodplain crossings.
Roadway Crossings			✓	HC-2 and HC-3 have slightly more roadway crossings.
Railroad Crossings	✓	✓	✓	All alignments have one railroad crossing.
Complex Structures			✓	All alignments cross SH 99 and US 290. The crossing for HC-2 and HC-3 over US 290 is more complex than HC-4 because of the skew of the alignment and the proximity of the existing railroad at that location.
Utility Crossings	✓			HC-2 has five utility crossings while HC-3 and HC-4 have six utility crossings.
Right-of-Way			✓	HC-3 impacts Daikin Industries Industrial Development North of US 290 (from Kickapoo East to Kermier). HC-2 and HC-3 have greater residential and development impacts than HC-4.
Permitting				Crossing of US 290 will require a TxDOT permit. Railroad crossing agreements required.
Overall Score	5.0	4.0	7.0	

Phase 2 Constructability Analysis - Middle				
Constructability	**MD-Base**	**MD-1**	**MD-4**	**Justification**
Accessibility				All alignments are located a great distance away from major roadways.
Pre-Construction Activities				All alignments are located a great distance away from major roadways.
Floodplain Crossings			✓	MD-Base and MD-1 have over 15% of its length of alignment within floodplain.
Roadway Crossings	✓	✓	✓	All alignments have comparable number of roadway crossings that are not a major constructability concern.
Railroad Crossings				Both alignments have three railroad crossings.
Complex Structures	✓	✓	✓	No complex structures.
Utility Crossings				Both alignments have numerous utility crossings.
Right-of-Way				All alignments have Right-of-Way full of oil wells.
Permitting				Railroad crossing agreements required.
Overall Score	2.0	2.0	3.0	

Phase 2 Constructability Analysis - Corsicana			
Constructability	**CR Base**	**CR-1**	**Justification**
Accessibility	✓	✓	Both alignments are accessible.
Pre-Construction Activities	✓	✓	No preconstruction activities are required.
Floodplain Crossings		✓	CR Base has higher length of floodplain crossings.
Roadway Crossings	✓	✓	Low number of roadway crossings.
Railroad Crossings	✓	✓	One crossing for both CR Base and CR-1.
Complex Structures	✓	✓	None
Utility Crossings			Seven transmission line crossings for CR-1 and five crossings for CR Base. High number for relatively shorter alignment.
Right-of-Way	✓		Oak Valley residential area and mine located along CR-1.
Permitting	✓	✓	None
Overall Score	7.0	7.0	

Phase 2 Constructability Analysis - Bardwell					
Constructability	**BA Base**	**BA-1**	**BA-2**	**BA-3**	**Justification**
Accessibility	✓	✓	✓	✓	No issues expected.
Pre-Construction Activities				✓	BA Base, BA-1, and BA-2 are located a greater distance away from major roadway networks.
Floodplain Crossings	✓	✓			BA-2, and BA-3 have over 10 miles of floodplain crossing.
Roadway Crossings	✓	✓	✓		Roadway crossings are limited for all alignments. BA-3 has two crossings of IH-45.
Railroad Crossings					BA Base, BA-1, and BA-2 cross the railroad three times and BA-3 crosses four times.
Complex Structures	✓	✓	✓	✓	No complex structures.
Utility Crossings					High number of crossings for all alignments.
Right-of-Way	✓	✓	✓	✓	Majority of all alignments travel through vacant property. Limited ROW issues are expected.
Permitting	✓	✓	✓		BA-3 will require TxDOT coordination.
Overall Score	6.0	6.0	5.0	4.0	

Phase 2 Constructability Analysis - IH-45			
Constructability	**IH-45 Base**	**IH-45 Alt**	**Justification**
Accessibility	✓	✓	Accessibility for construction within IH-45 may be problematic.
Pre-Construction Activities	✓		IH-45 frontage road will need to be reconstructed intermittently to accommodate HSR.
Floodplain Crossings			Over 20% of both alignments are within floodplain.
Roadway Crossings	✓		Number of roadway crossings is greater for IH-45 Alt
Railroad Crossings	✓	✓	Limited number of crossings compared to length of alignment
Complex Structures	✓		Complex crossings of IH-45 interchanges
Utility Crossings		✓	Greater number of utility crossings for IH-45 Base
Right-of-Way			Acquisition of ROW along IH-45 will require a greater effort to obtain. There will be a similar issue for the oil and gas well area of IH-45 Base.
Permitting			TxDOT coordination or coordination with oil wells
Overall Score	5.0	3.0	

Appendix F

Report References

Report References

Notice of Intent – Published June 25, 2014

Draft Alternatives Analysis Report (Version 2.0) – Issued May 2013

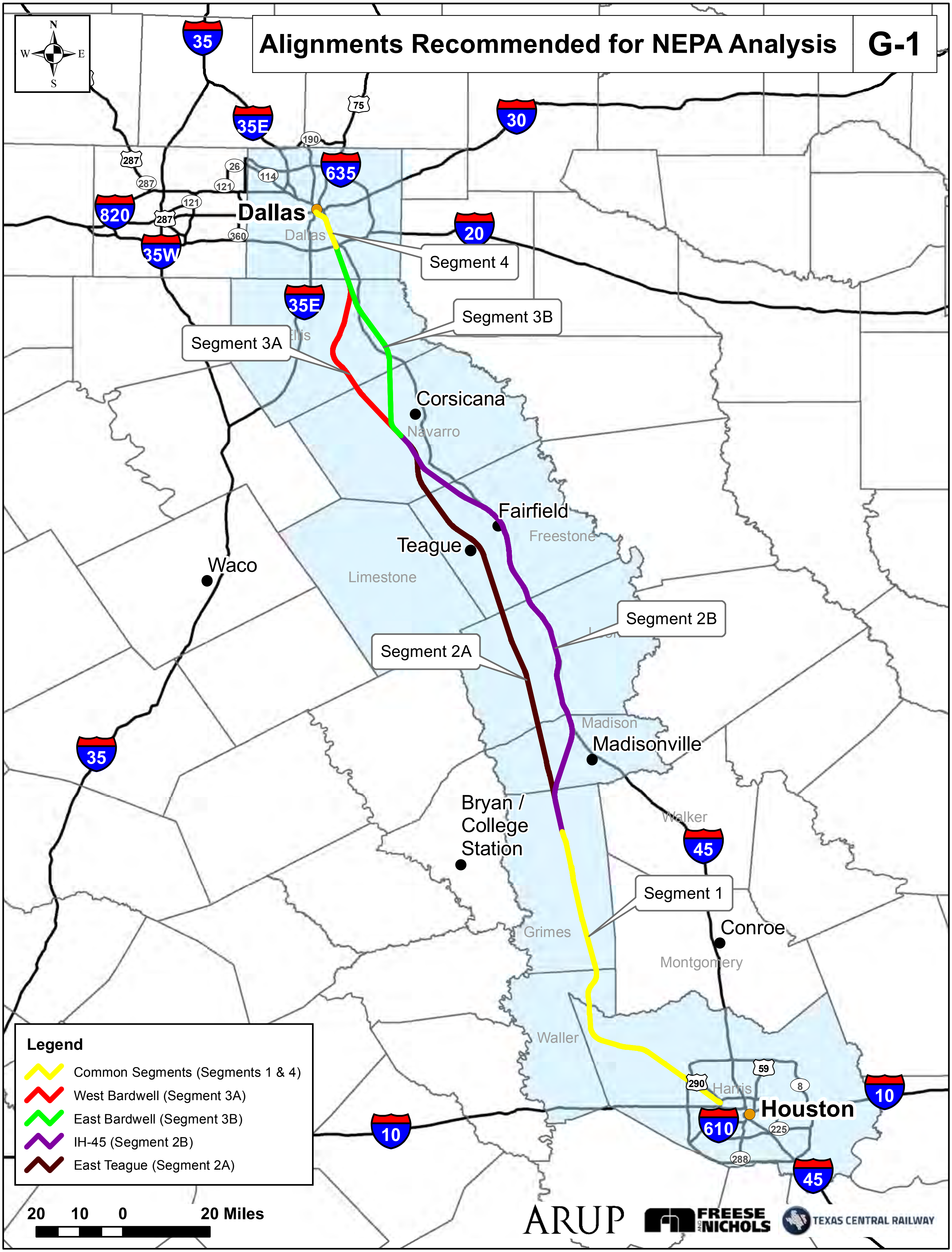
Step 1 Screening of Alternatives Report (Issue) – Issued March 22, 2015

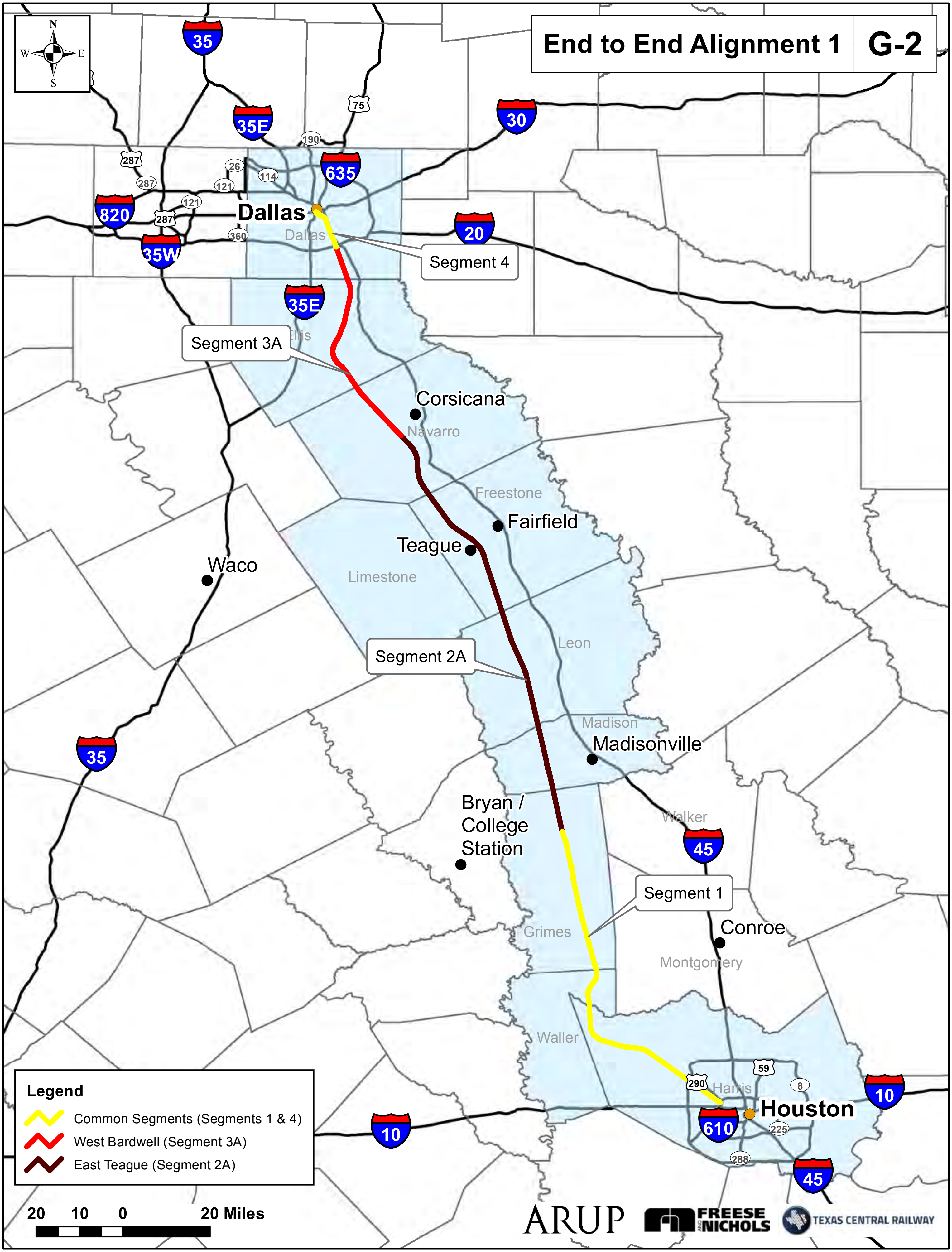
Last Mile Analysis Report (Issue) – Issued March 27, 2015

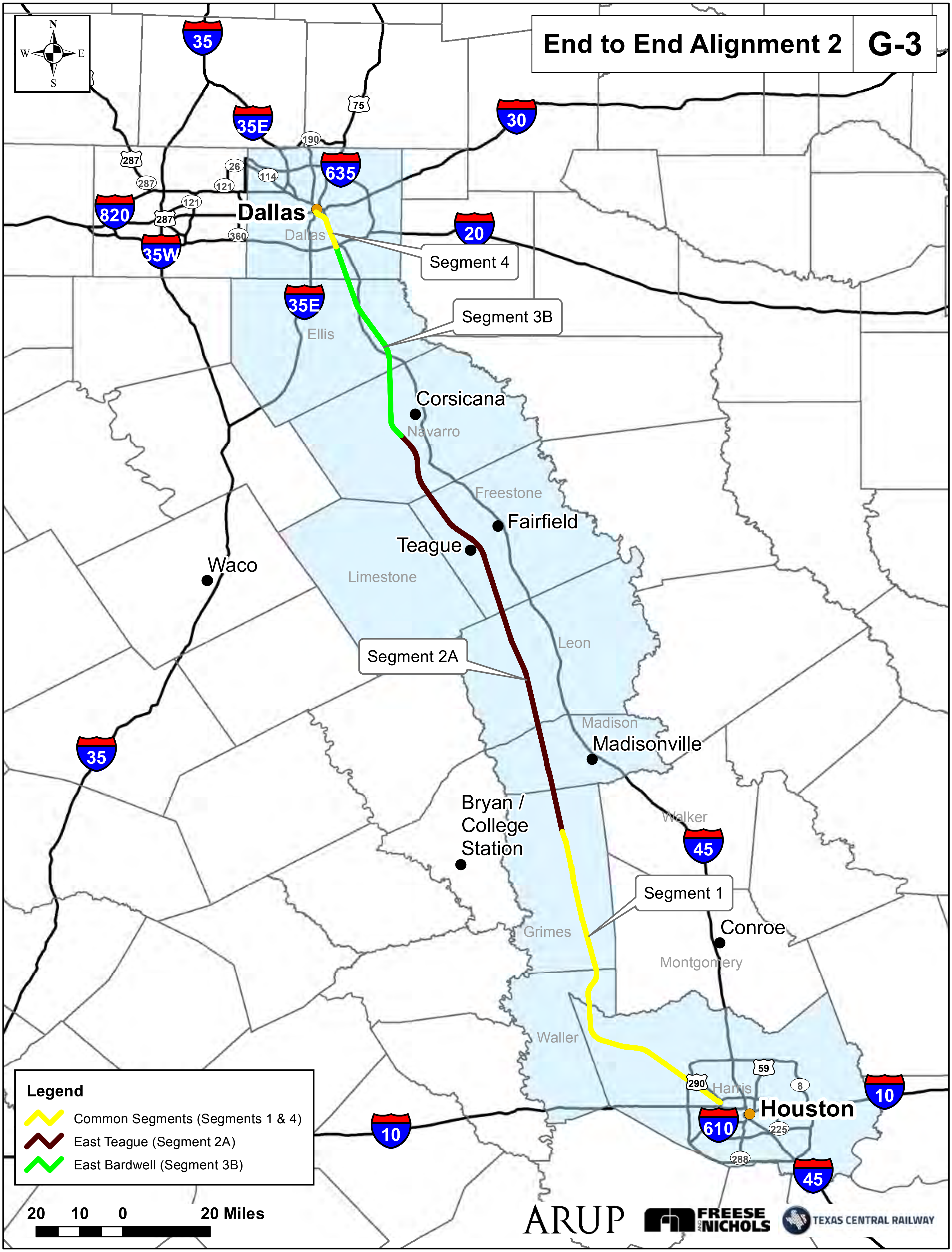
Appendix G

End to End Alignments

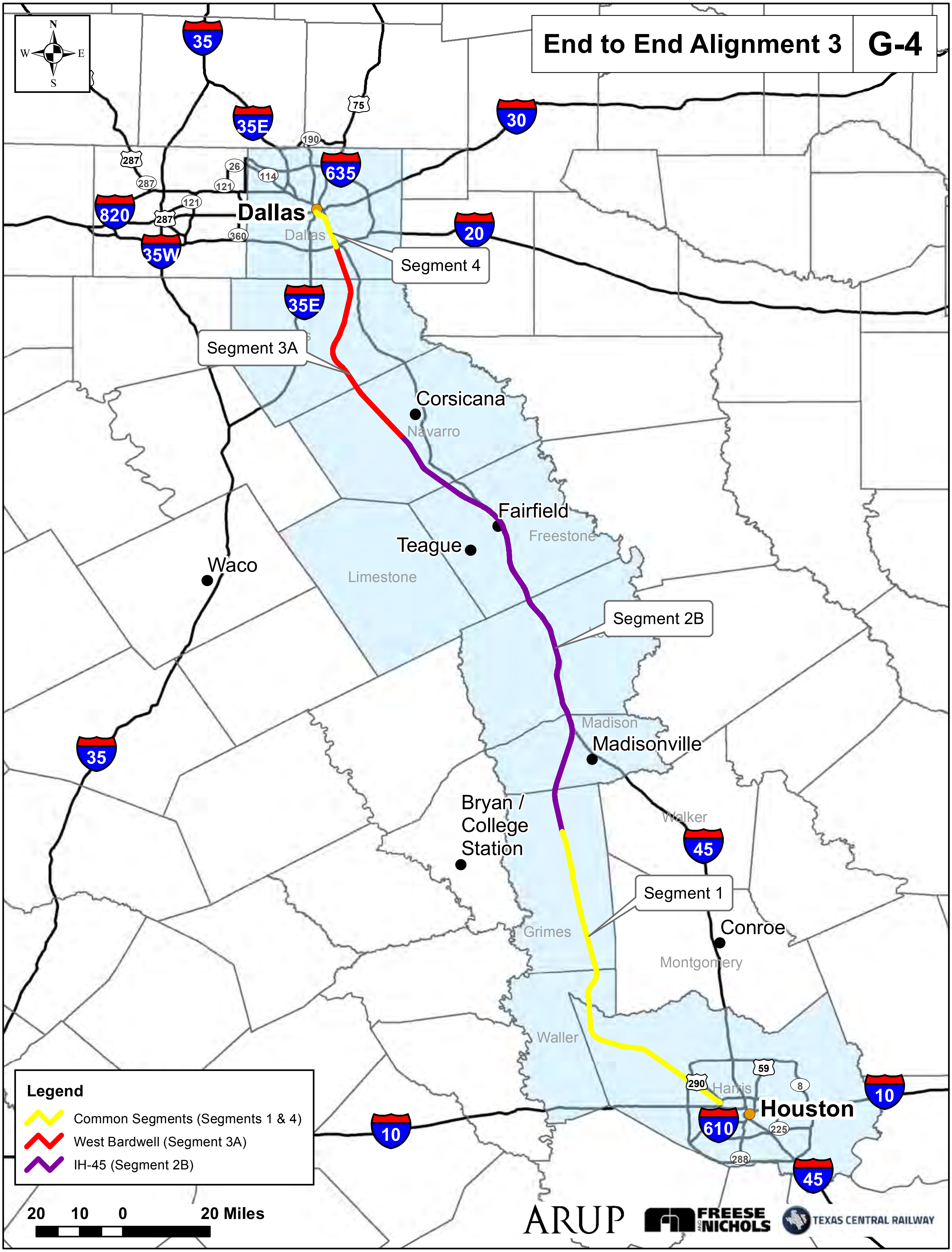
Alignments Recommended for NEPA Analysis G-1

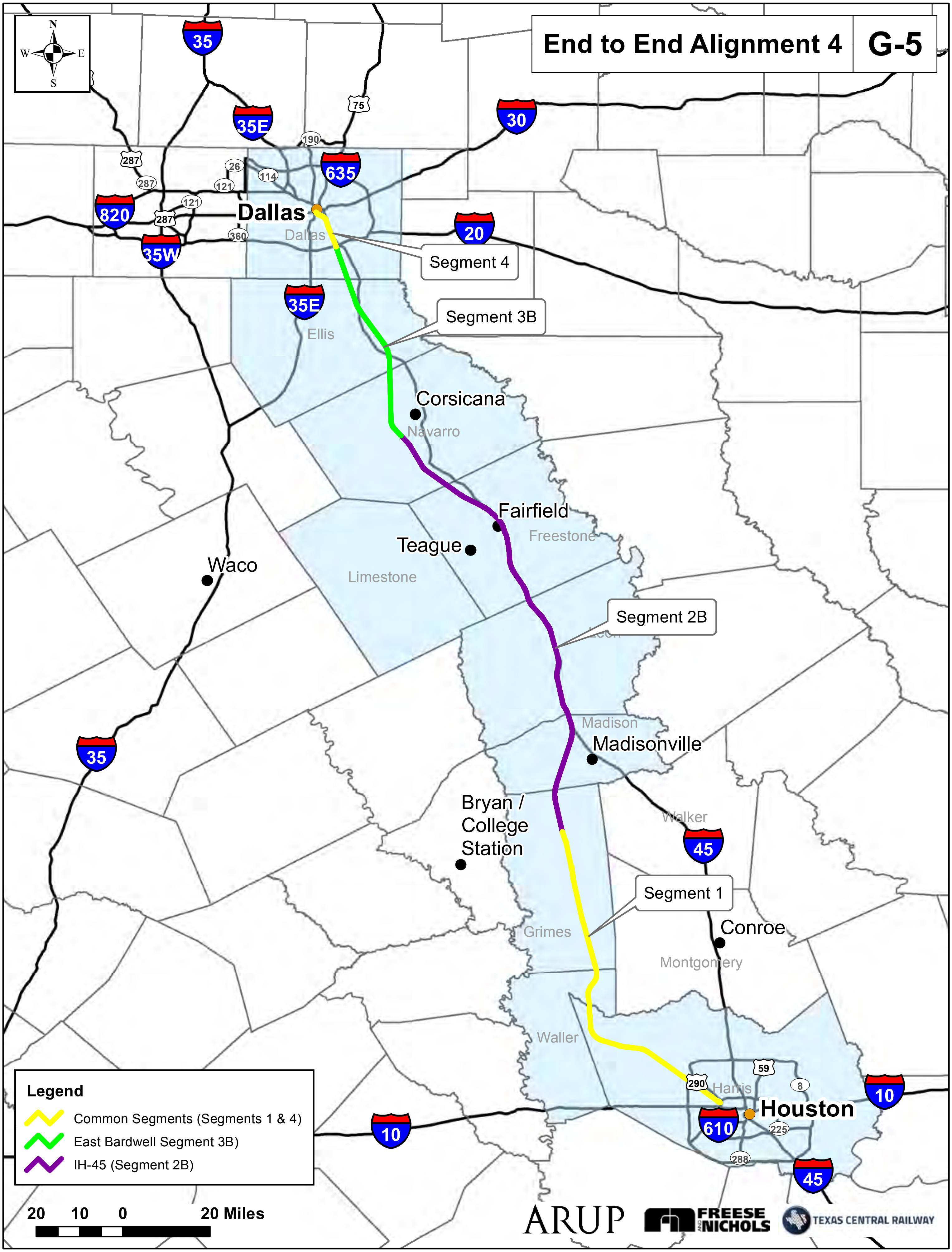



End to End Alignment 1
G-2
N
S
E
W
Dallas
Segment 4
Segment 3A
Corsicana
Navarro
Freestone
Fairfield
Teague
Waco
Limestone
Segment 2A
Leon
Madison
Madisonville
Walker
Bryan / College Station
Segment 1
Conroe
Montgomery
Grimes
Waller
Harris
Houston
Ellis
35
35E
35W
30
20
820
635
45
10
610
75
190
287
26
114
121
360
290
59
8
225
288
Legend
Common Segments (Segments 1 & 4)
West Bardwell (Segment 3A)
East Teague (Segment 2A)
20 10 0 20 Miles
ARUP
FREESE AND NICHOLS
TEXAS CENTRAL RAILWAY



End to End Alignment 2
G-3
N
S
E
W
Dallas
Corsicana
Fairfield
Teague
Waco
Madisonville
Bryan / College Station
Conroe
Houston
Dallas
Ellis
Navarro
Freestone
Limestone
Leon
Madison
Walker
Grimes
Montgomery
Waller
Harris
Segment 4
Segment 3B
Segment 2A
Segment 1
35
35E
35W
30
20
635
820
45
10
610
75
190
287
26
114
121
360
59
290
8
225
288
Legend
Common Segments (Segments 1 & 4)
East Teague (Segment 2A)
East Bardwell (Segment 3B)
20 10 0 20 Miles
ARUP
FREESE AND NICHOLS
TEXAS CENTRAL RAILWAY


End to End Alignment 3
G-4
N
S
E
W
Dallas
Segment 4
Segment 3A
Corsicana
Navarro
Fairfield
Freestone
Teague
Limestone
Waco
Segment 2B
Madison
Madisonville
Bryan / College Station
Walker
Segment 1
Conroe
Grimes
Montgomery
Waller
Harris
Houston
35
35E
35W
30
635
820
20
45
10
610
75
190
287
26
114
121
360
290
59
8
225
288
Legend
Common Segments (Segments 1 & 4)
West Bardwell (Segment 3A)
IH-45 (Segment 2B)
20 10 0 20 Miles
ARUP
FREESE AND NICHOLS
TEXAS CENTRAL RAILWAY


End to End Alignment 4
G-5
N
W
E
S
Dallas
Dallas
Segment 4
Segment 3B
Ellis
Corsicana
Navarro
Fairfield
Freestone
Teague
Limestone
Waco
Segment 2B
Madison
Madisonville
Bryan / College Station
Walker
Segment 1
Conroe
Grimes
Montgomery
Waller
Harris
Houston
35
35E
35W
820
635
30
20
10
45
610
75
190
287
26
114
121
360
290
59
8
225
288
Legend
Common Segments (Segments 1 & 4)
East Bardwell Segment 3B)
IH-45 (Segment 2B)
20 10 0 20 Miles
ARUP
FREESE AND NICHOLS
TEXAS CENTRAL RAILWAY

Appendix H

Phase 2 Plan and Profile Roll Plots

ELECTRONIC PDF FILES PROVIDED

Step 2 Ph2 Utility Corridor Base Alignment.pdf

Step 2 Ph2 Alignment Alternatives.pdf

NOTE:

Phase 2 Plan and Profile Roll Plots were produced to facilitate the Step 2 Screening Phase 2 Analysis.

The *Step 2 Ph2 Utility Corridor Base Alignment.pdf* file contains an end to end alignment utilizing the Base Utility Corridor common segments, the "Base" alternative alignments (BA Base and CR Base) passing through the Phase 1 anaylsis, and highest rated alternative alignments (HC-4 and MD-4) where the "Base" alternative alignments were not recommended in the Phase 1 analysis.

The *Step 2 Ph2 Alignment Alternatives.pdf* file contains all other alignment alternatives (HC-2, IH-45 Alt, BA-3, and CR-1) passing through the Phase 1 analysis and studied in the Phase 2 analysis.