Phase 1 Alternative Analysis Final Report Volume II

Dallas-Fort Worth High-Speed Transportation Connections Study

May 2023





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> Appendix II-E 5 Percent Design



Conceptual Options Development (5 Percent Design) Summary Report

Dallas-Fort Worth High-Speed Transportation Connections Study

September 2021









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1.0 INTRODUCTION

The North Central Texas Council of Governments (NCTCOG), in cooperation with the Federal Railroad Administration (FRA) and Federal Transit Administration (FTA), is conducting engineering and environmental studies for the high-speed passenger service between downtown Dallas and downtown Fort Worth; a distance of approximately 31 miles. Locally, the project is known as the Dallas-Fort Worth High-Speed Transportation Connections Study.

The Dallas-Fort Worth High-Speed Transportation Connections Study is evaluating high-speed options in the Dallas-Arlington-Fort Worth corridor by analyzing potential routes, technology alternatives, operations/service planning, and preparing preliminary engineering and environmental documentation for high-speed passenger service. Conventional, higher speed, and high-speed passenger rail, magnetic levitation (maglev), next generation magnetic levitation (e.g., hyperloop), and other emerging technologies were considered. The project scope of work consists of two phases. Phase 1, the subject of this report, developed and evaluated transportation technologies and alignments. Phase 2 will refine and evaluate the reasonable alternatives recommended in Phase 1 and document these efforts in the National Environmental Policy Act process.

During Phase 1, a three-level screening process was used to evaluate potential alignment options and transportation modes. To support the evaluation of the alignment options in the Level 3 screening, the alignments were developed to a 5 percent design to inform the evaluation. The purpose of this report is to summarize the development of the 5 percent design. Further details on all three levels of the screening process and results are in the Phase 1 Alternative Analysis Final Report.



2.0 STUDY AREA

The study area is approximately bounded by Interstate Highway (I-) 35E, I-35W, State Highway (SH) 183, and US 287/Spur 303/Loop 12. The study area traverses Dallas and Tarrant counties and the cities of Dallas, Irving, Cockrell Hill, Grand Prairie, Arlington, Pantego, Dalworthington Gardens, Hurst, Euless, Bedford, Richland Hills, North Richland Hills, Haltom City, and Fort Worth. Figure 1 shows the study area that covers over 230 square miles.

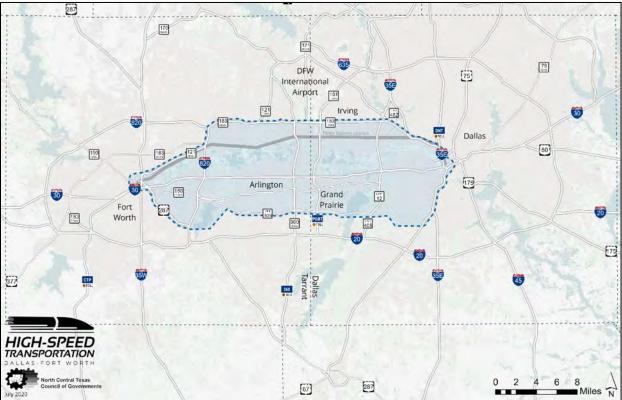


Figure 1: Study Area

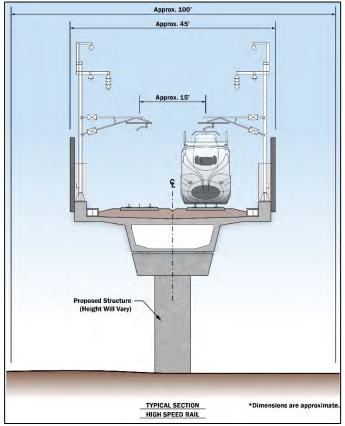
3.0 MODES OF TRANSPORTATION

Through the Level 1 and Level 2 screening process, the transportation modes of conventional rail, higher-speed rail, and emerging technologies were eliminated as viable options for this study. The three modes progressing into Level 3 screening are described in the following sections. Refer to the DFWHSTC Alternatives Analysis Final Report for additional information regarding the alternative screening process and the screening results.



3.1 High-Speed Rail

Figure 2: High-Speed Rail Typical Section



Mode Description: High-speed rail is the designation given to trains that operate at speeds significantly faster than conventional trains. High-speed rail rolling stock is powered through electricity supplied by overhead catenary.

Operating Speed: Operating speed ranges for high-speed rail varies between various industry standards. For this study, the maximum anticipated operating speed for high-speed rail is designated as 250 mph. The minimum operating speeds for high-speed rail and the maximum operating speed for higherspeed rail may overlap, but is generally around 150 mph. The highest recorded speed for a high-speed rail is 357 mph by the TVG train operated by SNCF.

Infrastructure: High-speed rail trains operate in dedicated grade-separated

corridors in aerial (viaducts or bridges), at-grade, or below grade (trench or tunnel) configurations. High-speed rail infrastructure includes trackwork, overhead catenary systems on the guideway infrastructure and includes wayside features such as traction power substations, communications houses, and signals houses. Refer to Figure 2 to view the High-Speed Rail Typical Section.

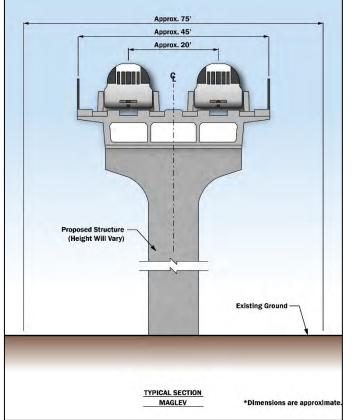
High-speed rail stations are located adjacent to a tangent (straight) section of the mainline track and often incorporate multiple platforms to accommodate passenger access. Station facilities function similarly to airport terminals from a security and passenger flow perspective and are usually integrated with adjacent commercial development. High-speed rail maintenance facilities require a footprint large enough to accommodate a rail yard and maintenance building with a sufficient number of bays to meet the operational needs of the system. The substantial length of high-speed rail train sets necessitates relatively long rail yards and supporting facilities.

Design Criteria: High-speed rail is a well-established mode of transportation in Europe and Asia and is currently under construction in California. Design-criteria for high-speed rail has been developed and implemented by multiple industry and governmental entities. See Appendix K to view summary design criteria for high-speed rail.



3.2 Magnetic Levitation





Mode Description: Magnetic levitation or maglev is a train propelled by magnetic force generated by the attraction or repulsion forces of superconducting electromagnets configured as a linear motor. Maglev is powered through electricity supplied to the electromagnets housed within the infrastructure.

Operating Speed: For the purpose of this study, the maximum anticipated operating speed for maglev is designated as 300 mph. The highest recorded speed for a maglev train is 374 mph by the Central Japan Railway Company.

Infrastructure: Maglev trains operate in dedicated grade-separated corridors in aerial (viaducts or bridges) or below grade (trench or tunnel) configurations. Most maglev system are configured on aerial viaduct structures. Maglev

infrastructure includes superconducting electromagnets located within the guideway infrastructure, and includes wayside features such as traction power substations, communications houses, and signals houses. Refer to Figure 3 to view the Maglev Typical Section.

Maglev stations are located adjacent to the corridor infrastructure and may include multiple platforms for passenger access. The size and configuration of stations vary dependent upon the age and location of the system. Maglev vehicle maintenance facilities are similar in configuration to facilities for high-speed rail and are equipped to support maintenance operations on maglev vehicle components, to include to electromagnetic propulsion system.

Design Criteria: Maglev systems currently operate in Japan, South Korea, and China. There is less than 100 miles of maglev in operation throughout the world today and there are no industry established design standards for this technology. Design criteria were developed for each project. See Appendix K to view summary design criteria for maglev.



3.3 Hyperloop

<complex-block>

Figure 4: Hyperloop Typical Section

Mode Description: Hyperloop is a mode of high-speed transportation where pods travel within a low-pressure tube using electromagnet propulsion similar to maglev. The low-pressure environment provides reduced drag on the pod, allowing it to achieve very high operating speeds.

Operating Speed: For the purpose of this study, the maximum anticipated operating speed for hyperloop is designated as 650 mph. The highest published speed achieved by a hyperloop scale test model is 621 mph by the South Korea Railroad Research Institute.

Infrastructure: Hyperloop operates in low pressure tubes configured in dedicated grade-separated corridors along aerial structures (viaducts or bridges) or below grade in tunnels. Most hyperloop developers incorporate the majority of the propulsion, electrification,

and communications components into the passenger pod itself as opposed to being incorporated into the guideway infrastructure. Hyperloop infrastructure includes wayside features such as traction power substations, vacuum stations, communications houses, and signals houses. Refer to Figure 4 to view the Hyperloop Typical Section.

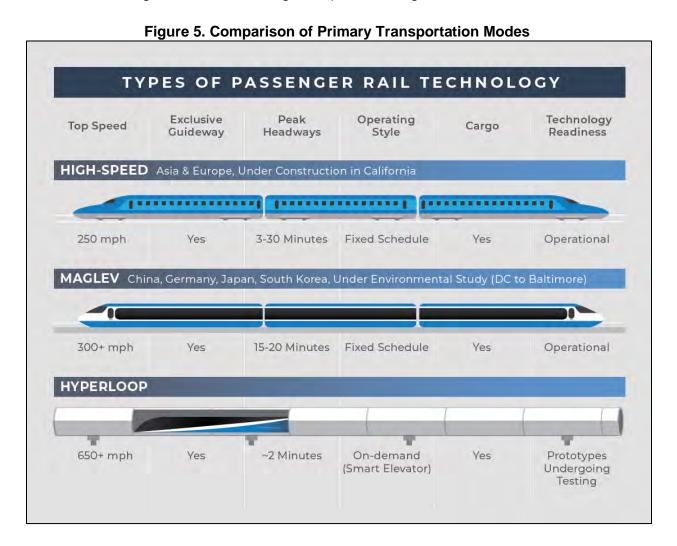
Hyperloop station and maintenance facilities can be located adjacent to mainline tubes or on non-adjacent properties accessed from secondary tubes connected to the mainline tube network. Stations provide multimodal access and multiuse commercial development opportunities to the surrounding community. Facility sizes are scalable based upon the operational needs of the system and can be added at any location along the corridor with slight infrastructure modifications to incorporate secondary access tubes at the proposed facility site.

Design Criteria: Design criteria is under development by each hyperloop provider and is uniquely tailored for the specific features of each independent hyperloop system. Efforts are underway to develop a unified hyperloop standard in Europe. See Appendix K to view summary design criteria for hyperloop.



3.4 Overview of Transportation Modes

A comparison of fundamental high-speed transportation characteristic is shown in Figure 5 for the three technologies considered during the 5 percent design.



4.0 ALTERNATIVE ALIGNMENTS



Figure 6: Study Area with Initial Alternative Alignments

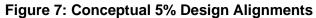
This study builds upon work completed for previous high-speed transportation studies in the study area. Based on technology requirements and previous studies, new alignments and previously considered alignments with some revisions were developed. Additionally, public and stakeholder input was obtained through public and stakeholder meetings prior to finalizing the initial set of alternatives. The alignments identified in Figure 6 were grouped into five corridor families Trinity Railway Express alignments, West Fork Trinity River alignments, IH-30 alignments, SH 180 alignments, and SH 303 alignments. See Appendix A to view the initial set of alternatives and the alignments advancing through Level 1, Level 2, and Level 3 of the screening process.



4.1 Alignments Advancing to 5 Percent Design

The number of viable alternatives was reduced to 10 alignments through the Level 2 screening process. Alignments advancing into Level 3 screening formed the basis for the concepts developed through the 5 percent design process. Refer to Figure 7 to view these alignments.





4.2 Development Process

Throughout the design concept development process, the Project Team collaborated with project stakeholders such as TxDOT Dallas District, TxDOT Fort Worth District, North Texas Tollway Authority, and Union Pacific Railroad (UPRR) through one-on-one meetings. NCTCOG also invited representatives from all local municipalities, transit providers, and jurisdictional authorities to participate in Technical Work Group meetings to provide input on all aspects of concept development. Additionally, meetings with federal and state resource agencies and public meetings were held to solicit input. Two major considerations for the advancement of the 5 percent design concept were design coordination with UPRR along the SH 180 alignments and design coordination with TxDOT along the I-30 alignments.

UPRR provided the "Union Pacific High and Higher Speed Passenger Rail Access Principles" as guideline for designing high-speed transportation infrastructure in the vicinity of the UPRR corridor (see Appendix B). These guidelines include a 102-foot buffer from the UPRR right-of-way line to the centerline of the adjacent high-speed corridor trackway. When applying this buffer to the DFWHSTC alignments along UPRR right-of-way, substantial impacts to private property along the UPRR corridor were identified. As a result, considerations were made to adjust the SH 180 alignments to existing roadway right-of-way in Fort Worth and Arlington.

TxDOT Dallas District stated the I-30 corridor in Dallas County has been reconstructed and is primarily in its ultimate configuration. However, the TxDOT Fort Worth District will soon begin efforts to redesigned and reconstructed a significant portion of the I-30 corridor in Tarrant



County. NCTCOG and the TxDOT Fort Worth District are working closely together to develop an integrated design solution that would incorporate the high-speed transportation infrastructure into the reconfigured I-30 corridor in Tarrant County.

Alignments along I-30 were placed primarily within the existing roadway right-of-way when possible. The I-30 corridor includes several major roadway interchanges such as I-30/I-820, I-30/State Highway 360, I-30/President George Bush Turnpike (State Highway 161), and I-30/Loop 12. Initial review of the horizontal and vertical alignments was conducted to determine the feasibility of corridors aligning through these interchange areas. Options reviewed included:

- Use of existing managed lanes in the center of I-30.
- Horizontal alignment adjustments around the interchanges based on vertical constraints.
- Potential depressed/trench/underground options through and around interchanges

The Project Team will continue to coordinate infrastructure design with TxDOT during design concept advancement throughout Phase 2 of the study.

4.3 Design Assumptions

The following general design assumptions were applied to concepts developed for each alternative alignment.

- Maintain the conceptual intent of the alignment concepts as presented during the Level 2 screening analysis. Avoid deviating significantly from these alignment concepts during the 5 percent design.
- Adjust alignments as needed to achieve priorities such as maintain the use of public transportation right-of-way, and avoiding critical infrastructure, private properties, and sensitive environmental areas when reasonable. Examples of environmentally sensitive areas include features such as wetlands, wildlife habitats, areas of historical or cultural significance, biological resources, and parks.
- Guideway will be 100 percent elevated.
- Double track (or double tube) along the entire length of corridor with centerline line spacing that complies with design criteria for each mode of transportation.
- Placement of high-speed transportation operational infrastructure, such as crossovers, turnouts, and hyperloop equivalents were not evaluated but will be considered in future design phases.

4.4 Alignments Details

The alignments in the conceptual 5 percent design are within the general vicinity of the I-30 and SH 180 corridors. As engineering principles were applied to the alignments, refinements were made resulting in the 5 percent design concepts. Plan layouts of the alignments can be seen in the 5 percent design drawings.

The 5 percent design was intended to support the application of evaluation criteria from the Level 3 screening process to help determine primary corridor alignments. To supplement the



level three alignment screening evaluation, the project team began developing initial concepts for urban center connections of the alignments for both downtown Dallas and downtown Fort Worth (see Section 4.4.1.10). These urban center connection concepts were developed independent of the Level 3 alignments due to the minimal available access points for a high-speed facility to the downtown areas and the complex nature of dense existing and planned infrastructure surrounding each downtown station. The urban center connection concepts will be developed during the 15 percent design process through collaboration with stakeholders and jurisdictional authorities.

4.4.1 Horizontal Alignment Review

Each horizontal alignment that continued from the Level 2 screening process was reviewed from a high-level engineering perspective with adjustments and variations made as needed to accommodate right-of-way and other constraints identified during the engineering and environmental review. The following subsections describe each alignment with additional information in Appendix C.

4.4.1.1 Alignment 12

Alignment 12 follows the I-30 corridor between downtown Fort Worth to just east of Legends Way. It then heads northeast to East Lamar Boulevard/Avenue H, crosses State Highway 360, and then southeast back to the I-30 corridor near Great Southwest Parkway. From there, the alignment continues along the I-30 corridor to Loop 12 where it transitions to follow next to UPRR right-of-way to downtown Dallas. Details of Alignment 12 include:

- North side of I-30 from downtown Fort Worth to Cooper Street in Arlington
- South side of I-30 from Cooper Street to Legends Way
- North side of I-30/State Highway 360 interchange
- South side of I-30 from Great Southwest Parkway to Carrier Parkway
- North side of I-30 from Carrier Parkway to the Loop 12 interchange
- Follows north side of UPRR Dallas Subdivision corridor (outside of right-of-way) from Loop 12 to the Trinity River

Refinement from the Level 2 concept included a shift of the alignment north of East Lamar Boulevard at State Highway 360 to avoid the West Fork Cemetery.

4.4.1.2 Alignment 13

Alignment 13 follows the I-30 corridor from downtown Fort Worth to Loop 12. At Loop 12 it transitions to follow next to UPRR right-of-way to Dallas. Details of Alignment 13 include:

- North side of I-30 from downtown Fort Worth to Cooper Street in Arlington
- South side of I-30 from Cooper Street to Carrier Parkway
- North side of I-30 from Carrier Parkway to the Loop 12 interchange
- Follows north side of UPRR Dallas Subdivision corridor (outside of right-of-way) from Loop 12 to the Trinity River



4.4.1.3 Alignment 14

Alignment 14 follows the I-30 corridor between downtown Fort Worth and east of Ballpark Way. It then heads southeast to follow along Avenue E/Tarrant Road, crosses State Highway 360, and then northeast back to the I-30 corridor near Carrier Parkway. From there, the alignment continues along the I-30 corridor to Loop 12 where it transitions to follow next to UPRR right-of-way to Dallas. Details of Alignment 14 include:

- North side of I-30 from downtown Fort Worth to Cooper Street in Arlington
- South side of I-30 from Cooper Street to East Copeland Road
- South side of I-30/State Highway 360 interchange onto Avenue E/Tarrant Road
- North side of I-30 from Carrier Parkway to the Loop 12 interchange
- Follows north side of UPRR Dallas Subdivision corridor (outside of right-of-way) from Loop 12 to the Trinity River

4.4.1.4 Alignment 15

Alignment 15 follows the I-30 corridor from downtown Fort Worth to Hampton Road in Dallas where it transitions to follow next to the UPRR right-of-way to Dallas. Details of Alignment 15 include:

- North side of I-30 from downtown Fort Worth to Cooper Street in Arlington
- South side of I-30 from Cooper Street to Carrier Parkway
- North side of I-30 from Carrier Parkway to Hampton Road
- Follows north side of UPRR Dallas Subdivision corridor (outside of right-of-way) from west of Sylvan Avenue to the Trinity River

4.4.1.5 Alignment 17

Alignment 17 follows the I-30 corridor between downtown Fort Worth and east of Ballpark Way. It then heads southeast to follow along Avenue E/Tarrant Road, crosses State Highway 360, and then northeast back to the I-30 corridor near Carrier Parkway. From there, the alignment continues along the I-30 corridor to Hampton Road where it transitions to follow next to UPRR right-of-way to Dallas. Details of Alignment 17 include:

- North side of I-30 from downtown Fort Worth to Cooper Street in Arlington
- South side of I-30 from Cooper Street to East Copeland Road
- South side of I-30/State Highway 360 interchange onto Avenue E/Tarrant Road
- North side of I-30 from Carrier Parkway to Hampton Road
- Follows south side of UPRR Dallas Subdivision corridor (outside of right-of-way) from west of Sylvan Avenue to the Trinity River

4.4.1.6 Alignment 18

Alignment 18 follows the I-30 corridor between downtown Fort Worth and east of Legends Way. It then heads northeast to East Lamar Boulevard/Avenue H, crosses State Highway 360, and



then southeast back to the I-30 corridor near Great Southwest Parkway. From there, the alignment continues along the I-30 corridor to Hampton Road where it transitions to follow next to UPRR right-of-way to Dallas. Details of Alignment 12 include:

- North side of I-30 from downtown Fort Worth to Cooper Street in Arlington
- South side of I-30 from Cooper Street to Legends Way
- North side of I-30/State Highway 360 interchange
- South side of I-30 from Great Southwest Parkway to Carrier Parkway
- North side of I-30 from Carrier Parkway to Hampton Road
- Follows north side of UPRR Dallas Subdivision corridor (outside of right-of-way) from west of Sylvan Avenue to the Trinity River

Refinement from Level 2 included a shift of the alignment north of East Lamar Boulevard at State Highway 360 to avoid the West Fork Cemetery.

4.4.1.7 Alignment 30

Alignment 30 follows the I-30 corridor between downtown Fort Worth and Collins Street, and then heads southeast to follow Randol Mill Road to Great Southwest Parkway. It continues further southeast to follow Dalworth Street to Jefferson Boulevard. At Hensley Field Drive, the alignment transitions to follow next to the UPRR right-of-way to Dallas. Details of Alignment 30 include:

- North side of I-30 from Fort Worth to Collins Street in Arlington
- Crosses I-30 and heads southeast across Legends Way and Ballpark Way before following Randol Mill Road.
- Connects with Dalworth Street and then onto Jefferson Boulevard
- Follows south side of UPRR Dallas Subdivision corridor (outside of right-of-way) to Trinity River

4.4.1.8 Alignment 31

Alignment 31 follows the State Highway 180 corridor from downtown Fort Worth to west of Davis Drive where it then transitions to follow next to the UPRR right-of-way and Front Street. The alignment transitions northeast back to State Highway 180 from Collins Street to east of Great Southwest Parkway where it crosses over the UPRR right-of-way to Jefferson Street. The alignment follows along Jefferson Street to Hensley Field Drive where the alignment transitions to the UPRR right-of-way to Dallas. Details of Alignment 31 include:

- Follow State Highway 180 from downtown Fort Worth to west of Davis Drive
- Crosses to south side of UPRR corridor onto Jefferson Street until east of Great Southwest Parkway
- Follows south side of UPRR Dallas Subdivision corridor (outside of right-of-way) to Trinity River



Refinements from Level 2 include:

- From I-30 interchange to east of I-820: the alignment was revised from 102-foot north of the UPRR right-of-way to the State Highway 180 alignment.
- From Green Oaks Boulevard to South Fielder Road: the alignment was revised from 102-foot north of the UPRR right-of-way to the State Highway 180 alignment. The shift also included optimizing the alignment from Green Oaks Boulevard to approximately North Bowen Road. Optimizing the alignment does not fall within public right-of-way.
- From North Mesquite Street to General Motors Plant (southwest quadrant of SH 360 and Division Street): the alignment was shifted from 102-foot north of the UPRR alignment to the State Highway 180 alignment. To make this shift, the revised alignment does not follow public right-of-way from North Mesquite Street to Collins Street.
- From North Great Southwest Parkway to East Main Street: the alignment was shifted from the north side of UPRR to the south side of UPRR to follow Jefferson Street.
- From East Main Street (State Highway 180) to North Westmoreland Road: the alignment follows the south side of the UPRR instead of the north side.

4.4.1.9 I-30 Managed Lanes/Median Concept

One possible alternative for the I-30 alignments is to repurpose the managed lanes along I-30 for a high-speed transportation corridor. A conceptual alignment using the existing managed lanes (between Ballpark Way and Sylvan Avenue) and median was developed to explore the alternative. Additionally, two typical sections were developed to visualize a high-speed corridor down the middle of I-30. These sections can be seen in Appendix D. The Figure D-1 shows high-speed transportation in the managed lanes at a grade separation location with a cross street going over I-30. This section demonstrates that to achieve the required vertical clearance and not reconstruct existing bridges, the high-speed facility would need to be depressed. The Figure D-2 shows the high-speed facility if it were in the middle of I-30 on an elevated structure.

A high-speed transportation corridor located within the current I-30 managed lanes would have minimal impact and displacement of adjacent communities, could be constructed predominately in existing transportation right-of-way, and would have a reduced conflict with existing highway interchanges. Due to the stack arrangement on the I-30/SH 161 highway interchange, there would be a conflict between the interchange and a high-speed corridor. Some challenges to using the I-30 managed lanes for a high-speed corridor include limited construction access, limited maintenance access, limited emergency egress, limited space for wayside features, vertical clearance is restricted at grade separations, width of existing managed lanes (varies from 25 to 48 feet and 40 to 45 feet) available for a two track high-speed facility, horizontal and vertical geometry restrictions, and station infrastructure and access complicated by the middle-of-highway location.

4.4.1.10 Urban Center Connections

The 5 percent alignments were developed from Beach Street, east of downtown Fort Worth, to Beckley Avenue, west of the Trinity River/downtown Dallas. During the development of the 5 percent alignments the design team began to look at potential connections into downtown Fort Worth and Dallas (see Appendix E). Appendix E also contains an initial review of each



connection documenting pros and cons for each concept. Connecting to the urban centers at each end of the corridor is a complex challenge with many potential conflicts with existing infrastructure and buildings and environmental sensitive areas. It will require coordination and input from all stakeholders to develop a solution that best fits each urban center. During the 15 percent and 30 percent plan development the team will coordinate with stakeholders for feedback and input about the urban center connection concepts and for ideas about other connection concepts to explore.

4.4.2 Vertical Alignment Review

For the purposes of the 5 percent design, it was assumed that vertical alignment concepts would only be developed to support the evaluation of alignment options at major transportation infrastructure locations. A conceptual vertical review of strategic locations was included in this evaluation to validate the feasibility of certain horizontal alignment options. See Appendix F for details on these vertical alignment concepts.

4.4.2.1 I-30/I-820 Interchange

High-speed technology profiles were evaluated for I-30/I-820 interchange. A profile for going over the interchange was developed and shown in Figure F-1 in Appendix F. Additionally, the interchange was evaluated to determine if a high-speed alignment and profile could weave through the interchange. A potential concept is presented in Figure F-2 in Appendix F. This concept would require the relocation of the Bridgewood Drive bridge north abutment and reconstruction of two spans. Additionally, the I-820 main lanes and frontage roads would need to be lowered, the west to south direct connector would need a pier replaced with a straddle bent, and the east to north direct connector would need to be raised.

4.4.2.2 I-30/State Highway 360 Interchange

High-speed technology profiles were evaluated for I-30/State Highway 360 interchange. Several scenarios were considered. A profile going over the interchange, an alignment and profile going around the interchange and, an alignment and profile using the managed lanes to get through the interchange were developed and presented on Figures F-3 through F-5 in Appendix F. The managed lane concept removes the existing managed lanes and replaces it with the high-speed technology. The high-speed technology may need to be placed in a trench to achieve vertical clearance under existing structures.

4.4.2.3 I-30/President George Bush Turnpike (State Highway 161) Interchange

High-speed technology profiles were evaluated for I-30/PGBT interchange. A profile for going over the interchange and an alignment and profile going around the interchange were developed and presented on Figures F-6 and F-7 in Appendix F. Going around the interchange has some potential impacts to homes and going over the interchange would put the guideway approximately 90 feet above existing ground.

Developing a high-speed alignment in and around the I-30 interchanges will continue to be studied in as the design advances towards 15 percent. Coordination and input from



stakeholders will be crucial to developing and alternative that meets the needs of the highspeed technology and adjacent communities.

5.0 STATIONS

Potential station locations were generally identified to provide connectivity with other potential high-speed transportation modes within the region.

5.1 Design Assumptions

Assumptions for development of station locations and platforms include:

- Platform lengths are 706 feet in length based on preliminary design criteria for the Houston-Dallas High-Speed Rail corridor. This station platform length provides sufficient space to accommodate maglev train sets, which often run in 500-foot train sets on existing maglev systems. Hyperloop station are configured to accommodate the length of individual passenger pods and will not require platforms to accommodate long train sets like high-speed rail and maglev.
- Each station location used a site 26 acres or greater for an existing major station location. The footprint size of 26 acres is based upon the Texas Central Railroad station footprint side identified in the preliminary engineering design for the high-speed rail corridor from Dallas to Houston.

The terminal station in the Dallas area is assumed to be at the proposed Houston-Dallas High-Speed Rail station for connectivity purposes for a high-speed corridor. It is still to be determined if the transfer will be at the same platform as the Houston-Dallas corridor or if it will require a separate platform depending on mode and vehicle compatibility.

Potential midpoint station locations in the Arlington area were reviewed based on available property and appropriate platform length the alignments. An earlier study for Arlington station locations was used as a starting point for this evaluation.

The terminal station in Fort Worth was assumed at the existing Central Station for connectivity to Trinity Railway Express, TEXRail, and Amtrak as well as other transportation modes and potential high-speed corridor along I-35W. However, this location could change based on the urban connection selected.

5.2 Development Process

Alignment access to the station locations was not fully developed during the Level 3 screening. During Phase 2, coordination with NCTCOG and jurisdictional authorities will help fine-tune various elements of the design concepts. There were preliminary evaluations of station locations in Fort Worth, Arlington, and Dallas based on the alignments in the Level 3 screening. There are still numerous constraints within these urban areas that may be challenging for connectivity to the station locations including highway interchanges, existing buildings, existing railroads, and proposed developments that will be considered during the next phase.



5.2.1 Fort Worth Station Location

A Fort Worth High-Speed Rail Station Area Planning study was performed in 2017 to analyze the feasibility and location preference for the Fort Worth station while considering multimodal regional connectivity and mobility. Seven potential station site locations were evaluated and ranked. The recommended station location was the existing Fort Worth Central Station (previously Intermodal Transportation Center) in downtown Fort Worth.

The DFWHSTC study took the Fort Worth Central Station location into consideration and also considered an alternative station option located at Butler Place just east of downtown. For the Fort Worth Central Station location, three scenarios were developed and considered where access came from the i) north via aerial structure; ii) south via aerial structure; and iii) south via tunnel. See Appendix G for plan views of these three options. All three scenarios as well as the Butler Place location have their challenges and as the study progresses to Phase 2, these will be evaluated in further detail.

5.2.2 Arlington Station Location

In 2017, an Arlington High-Speed Rail Station Area Planning Study was performed to analyze the feasibility and location preference for the Arlington station with one of the goals of creating a second urban center to support the current entertainment district activities in the City of Arlington. This entertainment district is bounded generally by I-30 to the north, State Highway 360 to the east, Division Street to the south, and Collins Street to the west. Eight station site locations were evaluated and ranked. The recommended station location was along the southside of I-30 adjacent to the Arlington Convention Center.

The DFWHSTC study took that location into consideration as well other potential station location sites along the Level 3 alignments. As the study progresses to Phase 2, these locations will be evaluated in further detail. See Appendix H to view preliminary locations of station in the City of Arlington.

5.2.3 Dallas Station Location

The terminal station in the Dallas area is assumed to be at the proposed location for the Dallas high-speed rail station from the Dallas to Houston high-speed rail project. Multiple alignment entry points to the proposed station location are under consideration as the DFWHSTC study progresses to Phase 2. These alignments will be evaluated in further detail during Phase 2. NCTCOG and Texas Central Railroad are in agreement that the DFWHSTC corridor will connect to the Texas Central Railroad high-speed rail system via a cross platform connection. In the event the Texas Central Railroad high-speed rail technology is identified for use on the DFWHSTC corridor, a one-seat ride could be available for passengers traveling through Dallas with a final destination of other stations location further south on the Texas Central Railroad for the Dallas high-speed rail station.



6.0 MAINTENANCE FACILITY

A minimum of one maintenance facility would be needed along the high-speed transportation corridor between Fort Worth and Dallas. A high-level review of potential maintenance facility locations identified areas for further review and refinement in future design development. See Appendix J to view the potential locations identified for maintenance facilities.

6.1 Design Assumptions

Assumptions for development of potential maintenance facility locations include:

- Maintenance facilities should be located adjacent or near one of the corridors when reasonable.
- Parcels under consideration should be vacant or with minimal development.
- Preferred adjacent land use would be industrial or commercial.
- Maintenance facility locations are, at a minimum, between 30 and 50 acres.
 Maintenance facility size and layout could vary significantly between all modes of high-speed transportation.

6.2 Development Process

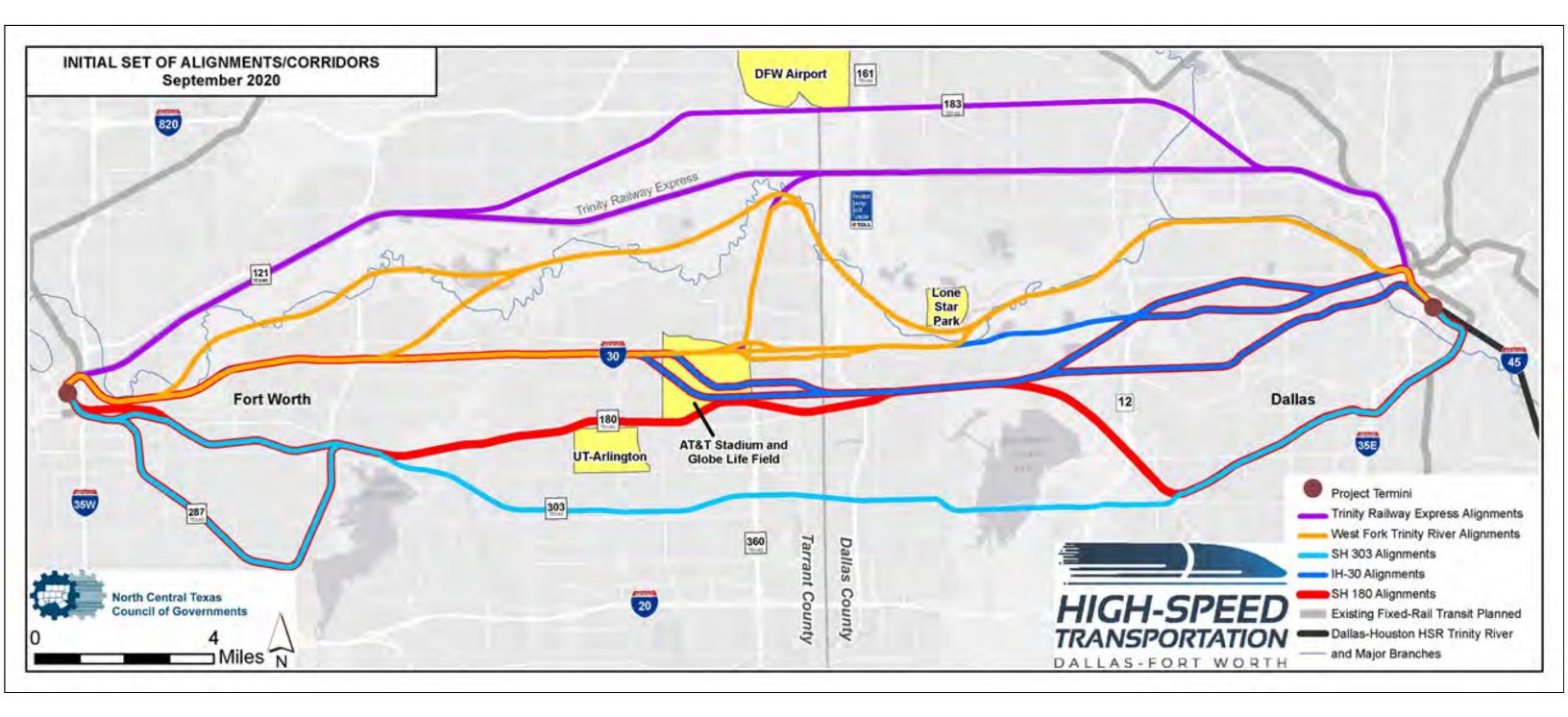
Based on the design assumptions noted in Section 6.1, locations were identified as potential maintenance facility locations for each corridor. As shown in the 5 percent Design, the potential maintenance locations are:

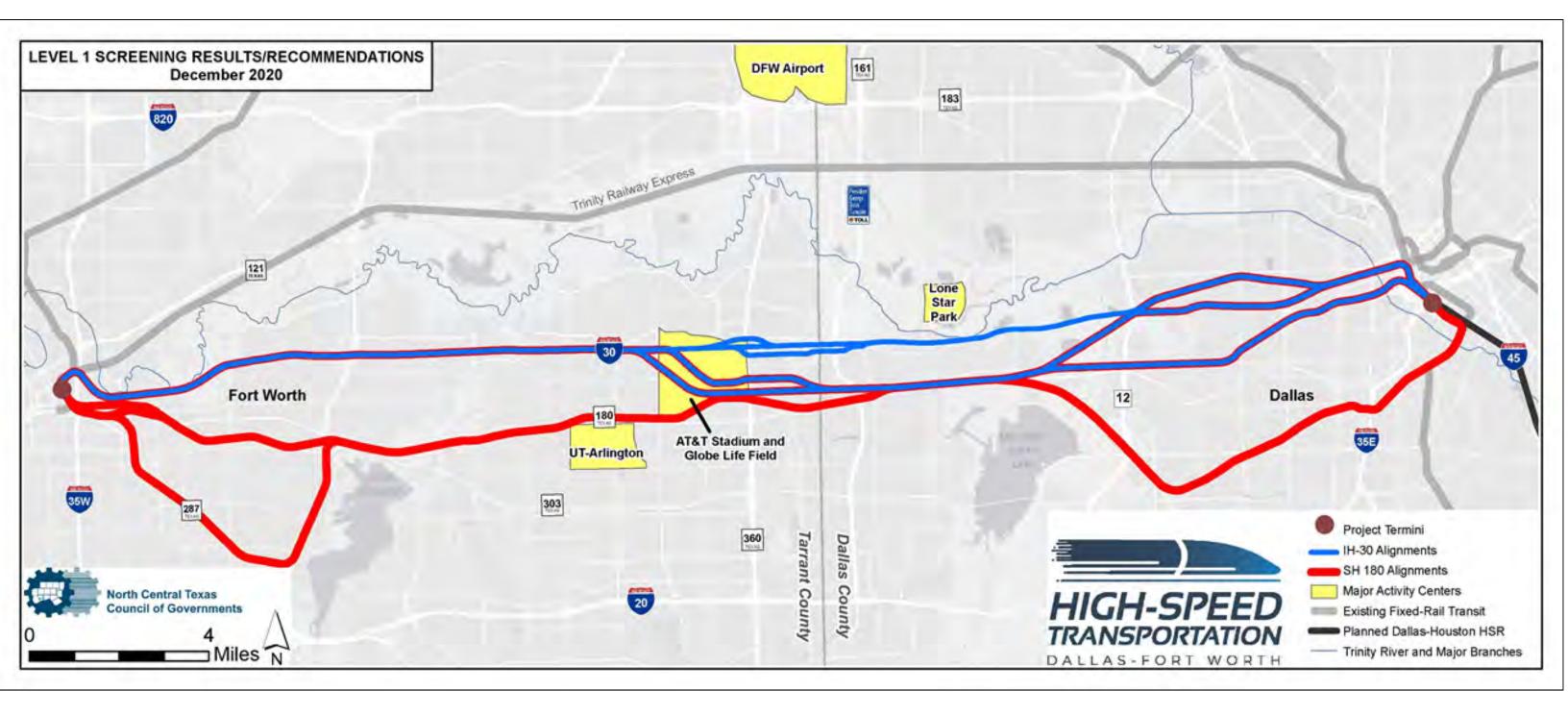
- A. I-30 northeast of I-820
- B. I-30 near Cooks Lane
- C. I-30 near Belt Line Road
- D. I-30 north of Carrier Place
- E. I-30 east of W Hunter Ferrell Road
- F. I-30 southeast of Hampton Road
- G. Singleton Boulevard/N Westmoreland Road area
- H. Bernal Drive / Norwich Street area
- I. SH 180 west of Green Oaks Boulevard
- J. SH 180 west of Hensley Field Drive
- K. SH 180 west of Loop 12

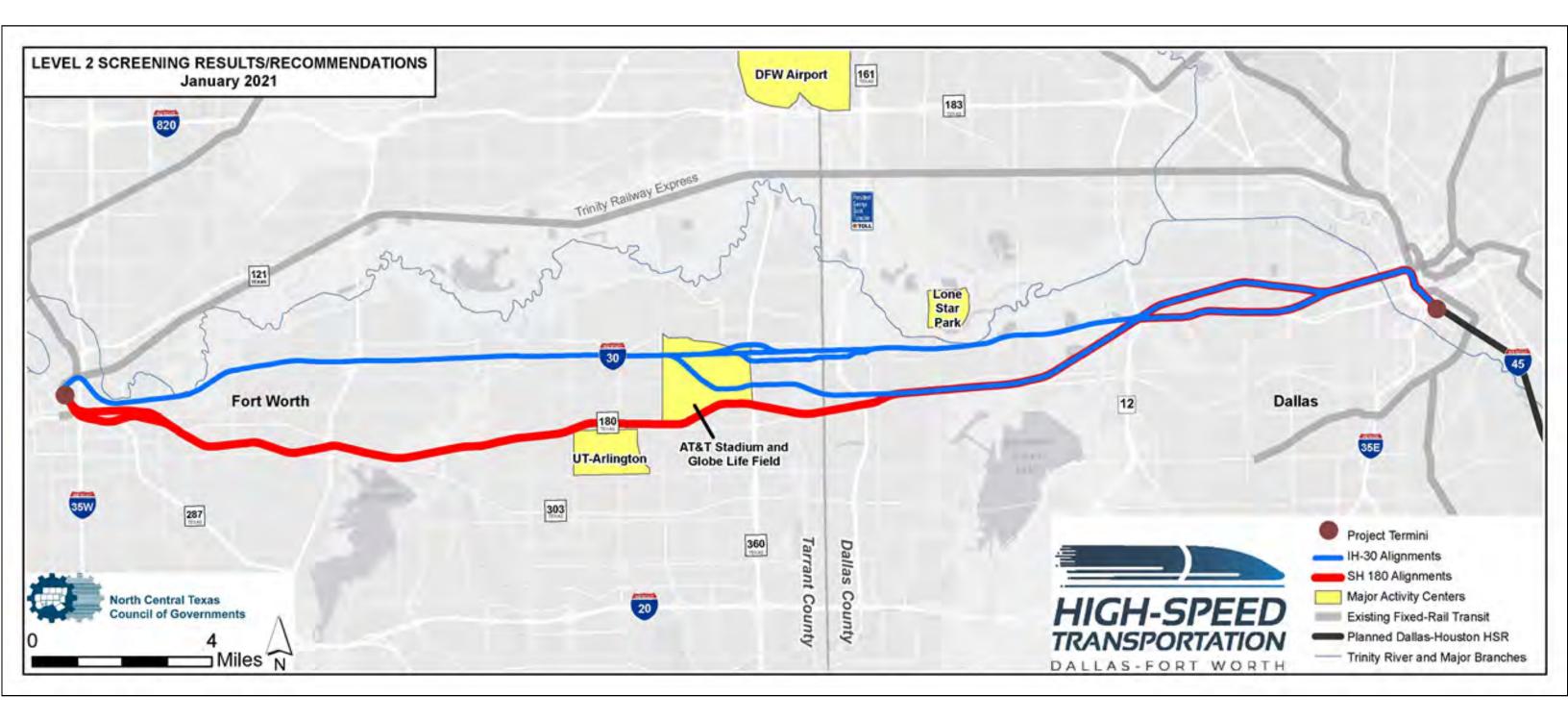
See Appendix J to view these potential maintenance facility locations.

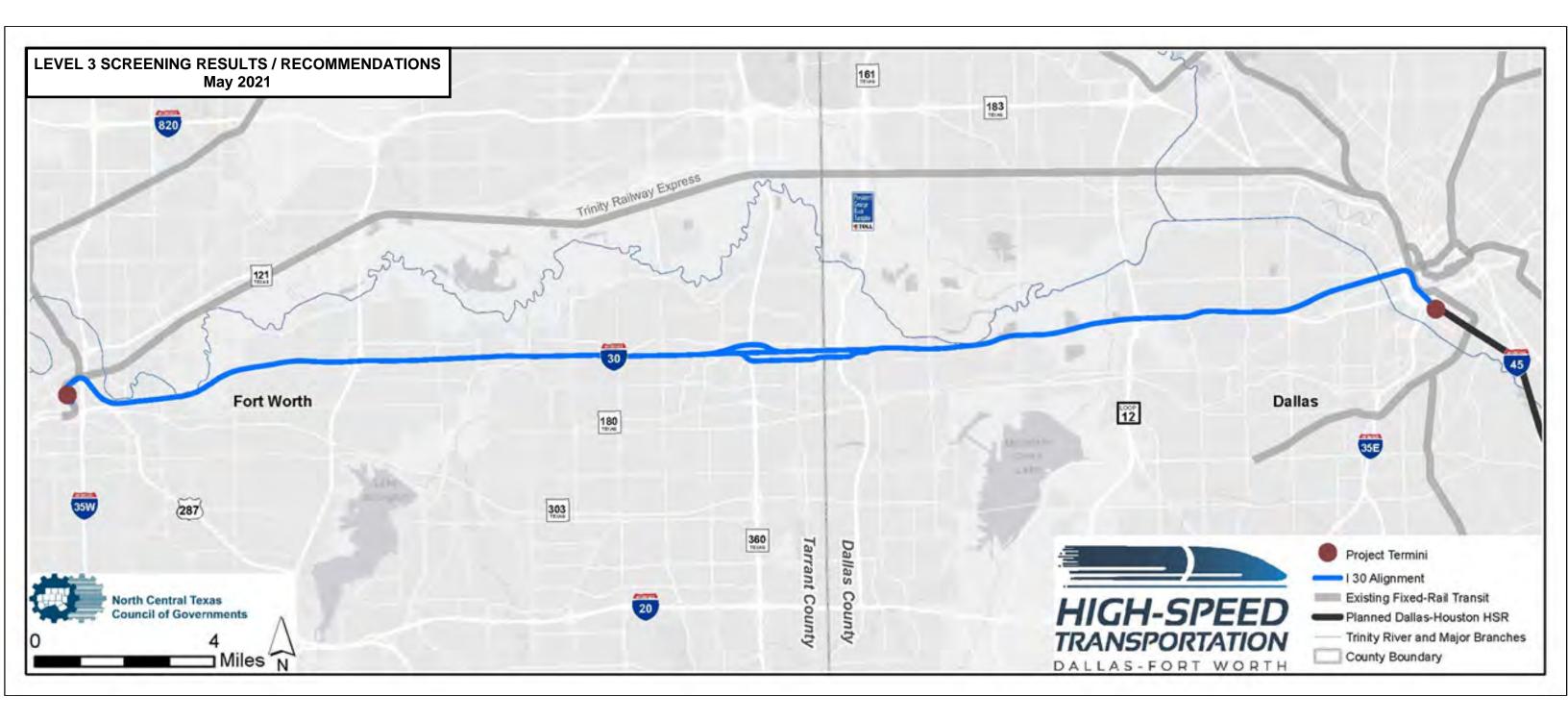


Appendix A Alignment Maps for Level 1, Level 2, and Level 3 Screening











Appendix B Union Pacific Railroad High-Speed and Higher-Speed Passenger Rail Access Principles

Union Pacific High and Higher Speed Passenger Rail Access Principles

Union Pacific offers the following information to guide passenger rail planners and agencies in working with Union Pacific to develop new High Speed Rail passenger service. Union Pacific defines "Higher Speed" as passenger trains that operate in excess of 90mph, but less than or equal to 110mph. "High Speed" are passenger trains that operate in excess of 110mph.

Intercity rail service can provide substantial benefits to the public, including reducing traffic congestion and avoiding expensive highway construction. At the same time, Union Pacific has a responsibility to the nation and to its customers to protect the public benefits of freight transportation - energy efficiency, lower emissions, cost-effective cargo transportation for shippers and consumers, and private investment in the nation's infrastructure.

Union Pacific will consider reasonable proposals for High and Higher Speed passenger rail service that appear to be viable and adequately funded. Future agreements must balance the nation's desire for additional passenger services with Union Pacific's ongoing, critical role in carrying freight that otherwise would likely compete for space on the crowded and underfunded highway network.

Separate freight and passenger corridors are desired

- Many critical freight corridors are already full and will require capacity improvements soon. UP
 will not consider proposals that share tracks with freight trains in such corridors or sell property
 that would compromise our ability to add capacity in the future. Passenger rail planners should
 develop a separate right of way for services in these corridors.
- Passenger safety is best protected by separating freight and passenger tracks by 50 feet or more. Despite UP's enormous progress in preventing freight train derailments, derailments will occur and could strike or be struck by passenger trains. Research demonstrates that most freight train derailments will remain within a 100-foot corridor.
- One way to achieve separation is to move the majority of freight trains out of urban corridors entirely. UP will consider publicly funded relocations of freight operations that preserve UP's customer service, competitive position, and access to current and future freight customers.

Where separation or relocation is not feasible, and freight densities are light, UP will consider proposals to share our tracks with Higher Speed Passenger trains. We intend to apply the following principles in evaluating proposals by passenger agencies:

<u>Safety</u>

- As in all our activities, safety must come first.
- Under federal law, all trains and tracks must in the future be equipped with interoperable Positive Train Control (PTC) systems if passenger trains are present. The passenger operator must fund PTC if UP would not otherwise install it on the affected track, or contribute the operator's share of equipment and wayside costs if UP would install PTC on the affected track.
- Passenger operators should fund all incremental safety requirements attributable to its service, including grade crossing warning signal improvements, new grade separations, and fencing.
- Passenger stations must meet Union Pacific and FRA design requirements to protect passengers from nearby freight operations.
- UP will require existing track to be rebuilt, and new track to be built, at the high track construction standards where passenger trains will run at higher speeds. This includes concrete ties.
- Passenger vehicles must, at a minimum, meet FRA crash standards.
- On UP tracks and/or right-of-way passenger trains must utilize conventional locomotive equipment.
- UP will not permit the installation of any electrical lines or equipment for the purposes of providing power to non-diesel powered locomotives on, over or beneath UP tracks or right-of-way.

Service

• Service to Union Pacific's freight customers must also be reliable and protected and should not be compromised by a new passenger service. UP cannot agree to curfews or other restrictions that would impact the quality or reliability of our freight service.

- New infrastructure construction must preserve both the ability to operate freight trains on demand and the opportunity to expand freight capacity.
- New infrastructure design must protect UP's ability to serve existing customers and locate new freight customers on our lines.
- In order to preserve service quality for all types of customers, UP will retain dispatching and maintenance control over its lines. The parties must agree on standards for reliability.
- Passenger operations must provide the flexibility to accommodate efficient track maintenance. This includes a requirement that any new track must be constructed at 20 foot track centers.

Liability

- UP cannot accept exposure to any additional liability associated with allowing High or Higher Speed passenger service near our freight tracks that would not exist "but for" those operations.
- Passenger operators should be prepared to carry and provide evidence of insurance covering liability exposure up to \$200 million, the limit of liability under federal law. Union Pacific expects to be indemnified for or protected against any and all liability resulting from the presence of passenger service.

Capacity

- All projections call for rail freight growth to exceed rail capacity in the future. Passenger agencies should understand that existing capacity that UP funded—whether or not now used—is reserved for potential freight growth.
- Passenger agencies therefore must fund all incremental capacity to accommodate Higher Speed passenger operations, as reflected in a study of capacity requirements and a resulting capacity plan.
- Because new capacity consumes the least expensive capacity opportunities and usually makes the next increment of capacity more expensive, the capacity plan may include additional agency investment at the outset that will leave UP cost-neutral when it needs to invest in additional freight capacity.
- Infrastructure requirements will be determined by UP or a UP-designated and qualified third party.
- UP will not agree to host any type of train preemption technology into grade crossing designs, even if it applies to passenger trains only. No trains can be delayed by vehicle detection technology.

<u>Maintenance</u>

- Passenger Agencies must agree to maintain the incremental improvements necessary for Higher Speed operation on UP tracks. This includes expenses related to maintenance of safety appliances such as PTC and 4 Quad gates. UP will limit its contribution to maintenance to what would otherwise be necessary for its existing freight operations, generally at FRA Class III or IV.
- Prior to the new service start-up, UP will require execution of a maintenance agreement to allow the public agencies to fund incremental maintenance for the duration of its commitment to operate Higher Speed passenger service.

Compensation

- The passenger operator should be prepared to pay for all costs associated with providing information and studies necessary to develop any Higher Speed Rail proposal, including UP's time and resources.
- To the extent passenger operations use UP assets and property, they must provide UP with a reasonable return on Union Pacific's investment.
- UP will seek fair market rates for access. Traditional "incremental cost" formulas are no longer acceptable
- If UP's tax liabilities (income, franchise, sales and use, property, or any other tax) increase as a result of UP's participation in a passenger project, UP expects to be made whole. This will likely require tax indemnification from the public agency or changes to state law.

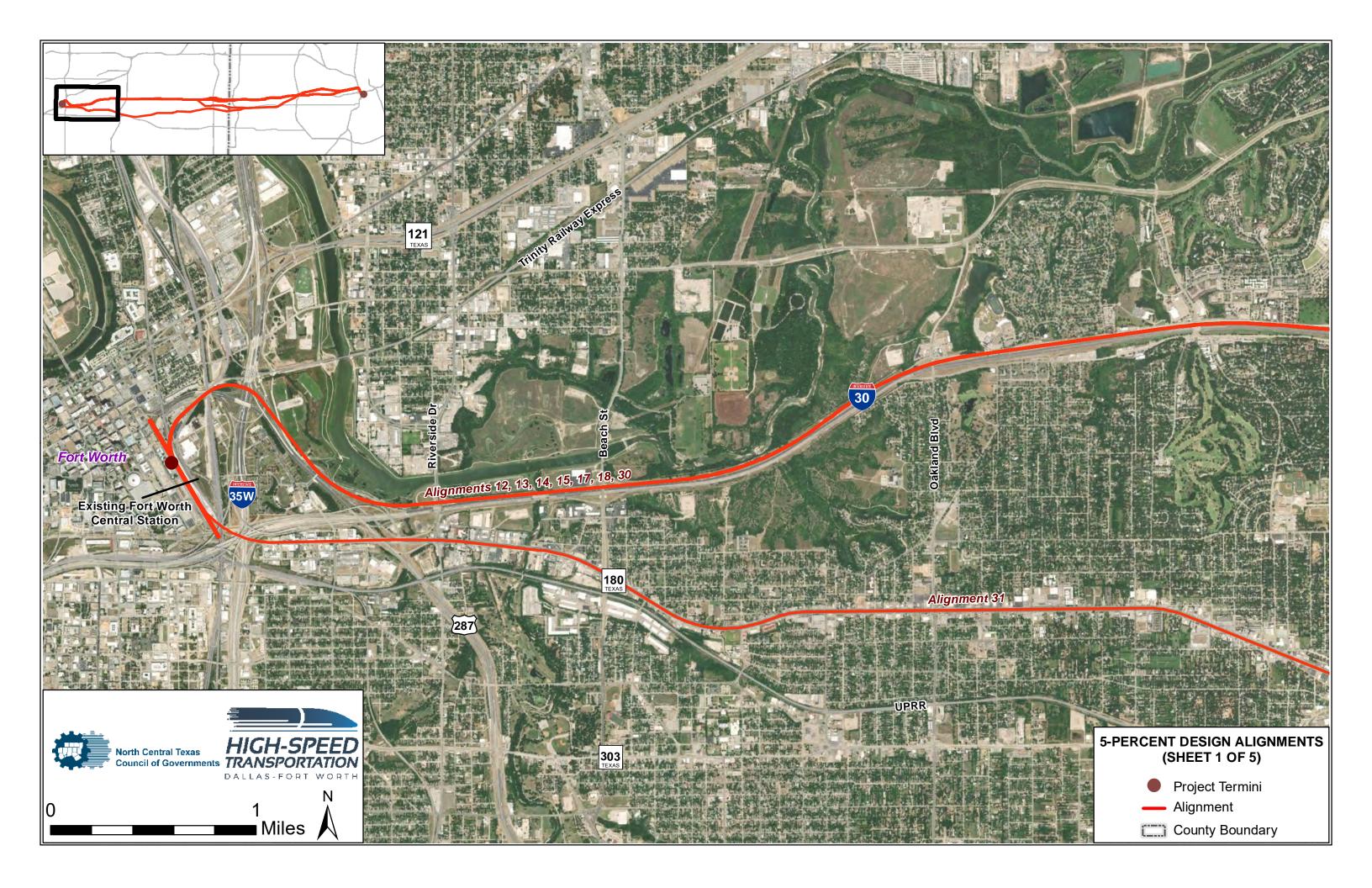
Union Pacific High Speed Rail Access Principles

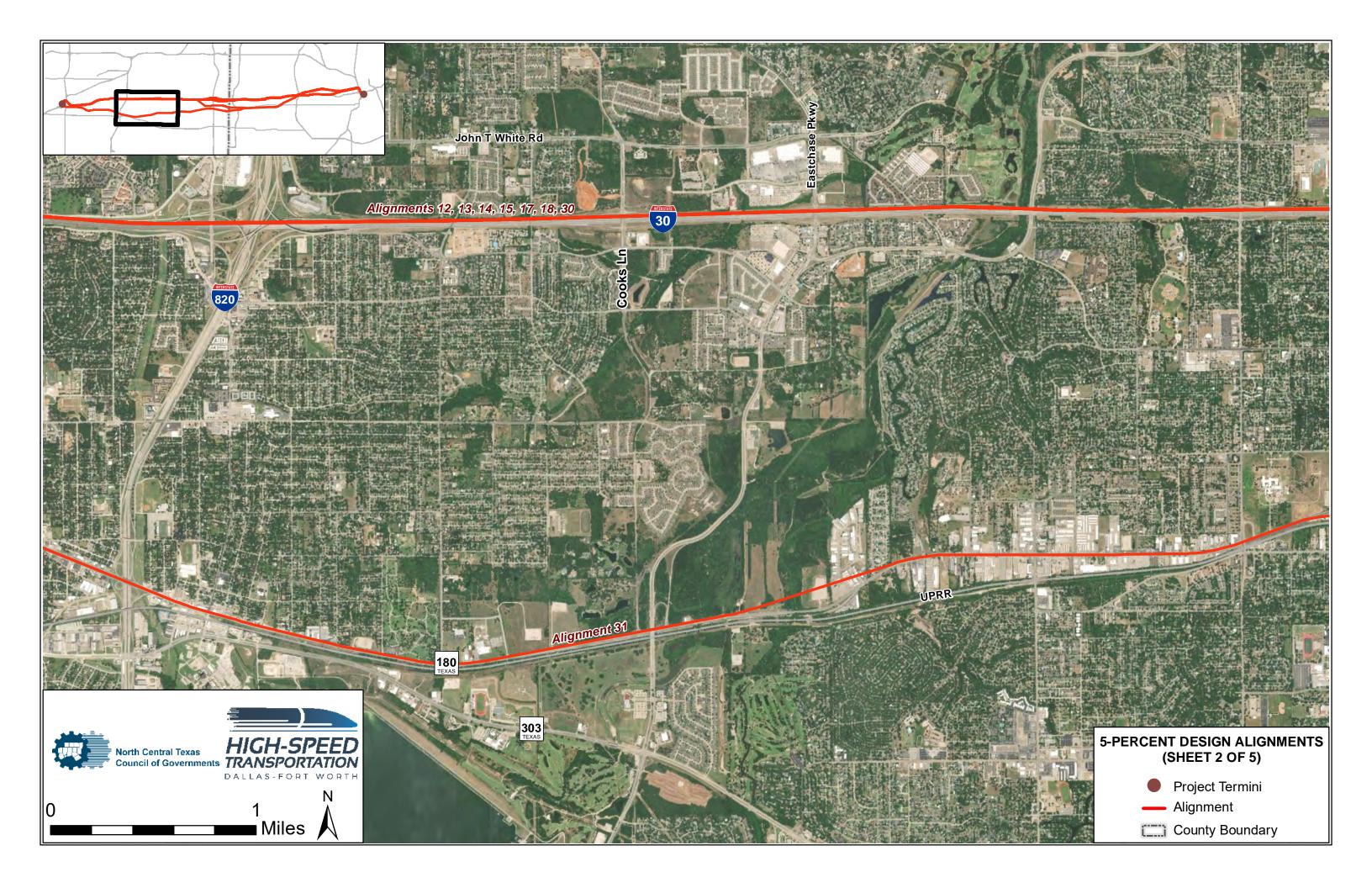
Additional Requirements for High Speed Passenger Trains Operating at Greater Than 110 MPH

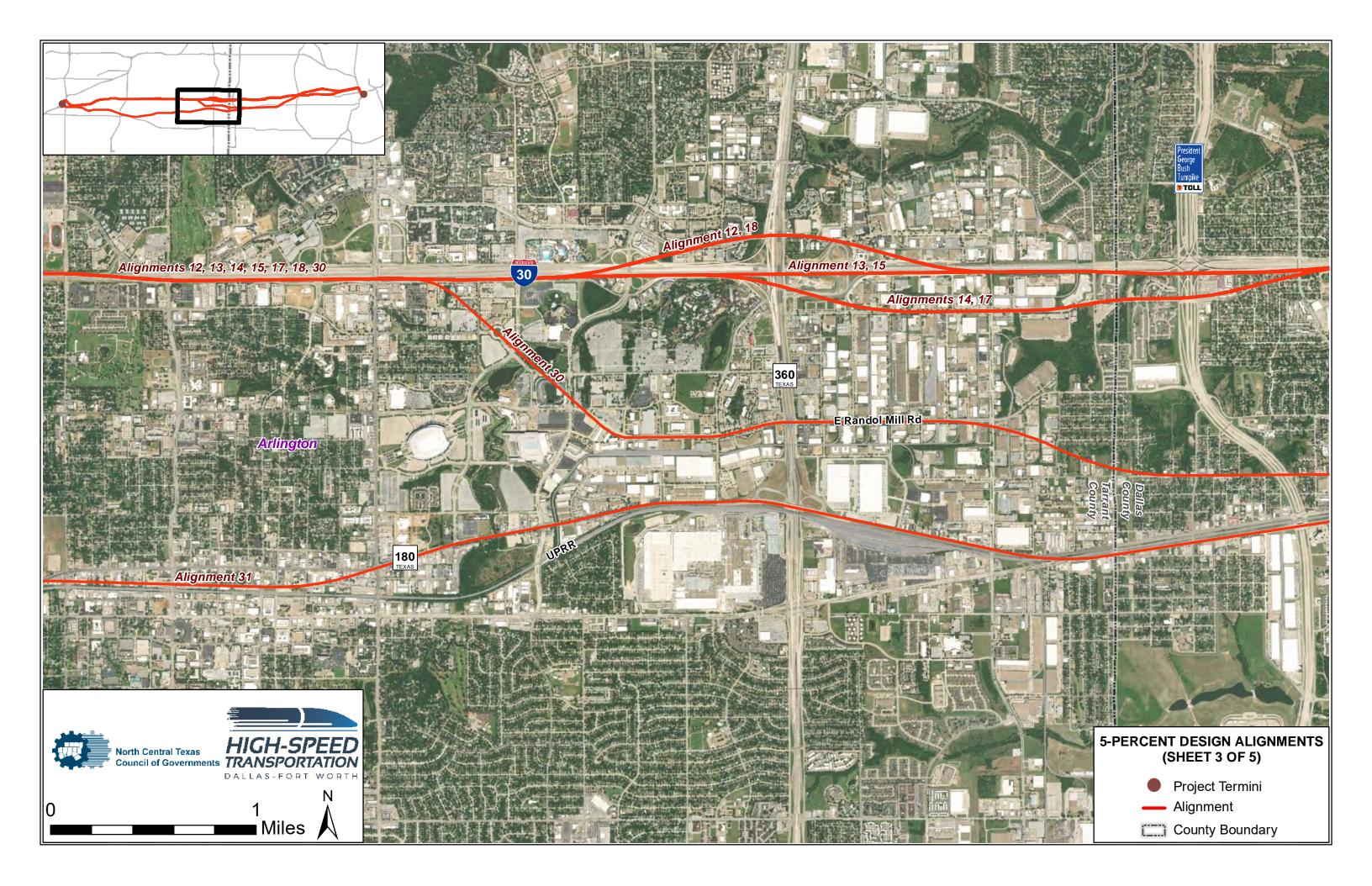
- The following requirements are in additional to all those listed above:
- UP will not allow High Speed trains on its tracks under any circumstances.
- No High Speed Rail (HSR) facilities located on UP's property.
- Minimum 102 feet of clearance between centerline nearest HSR track and adjacent UP ROW -Almost all freight train derailments can be contained within 100 feet of the track centerline and High Speed passenger train derailments have a greater dispersion distance to compensate for.
- If HSR utilizes electrified equipment, must be designed, constructed and maintained to prevent any interference with any UP owned or operated facilities or equipment.
- At locations where HSR and UP parallel each other, any at-grade vehicular road crossings that are closed or grade separated by HSR must be modified accordingly on UP, at expense of other than UP.

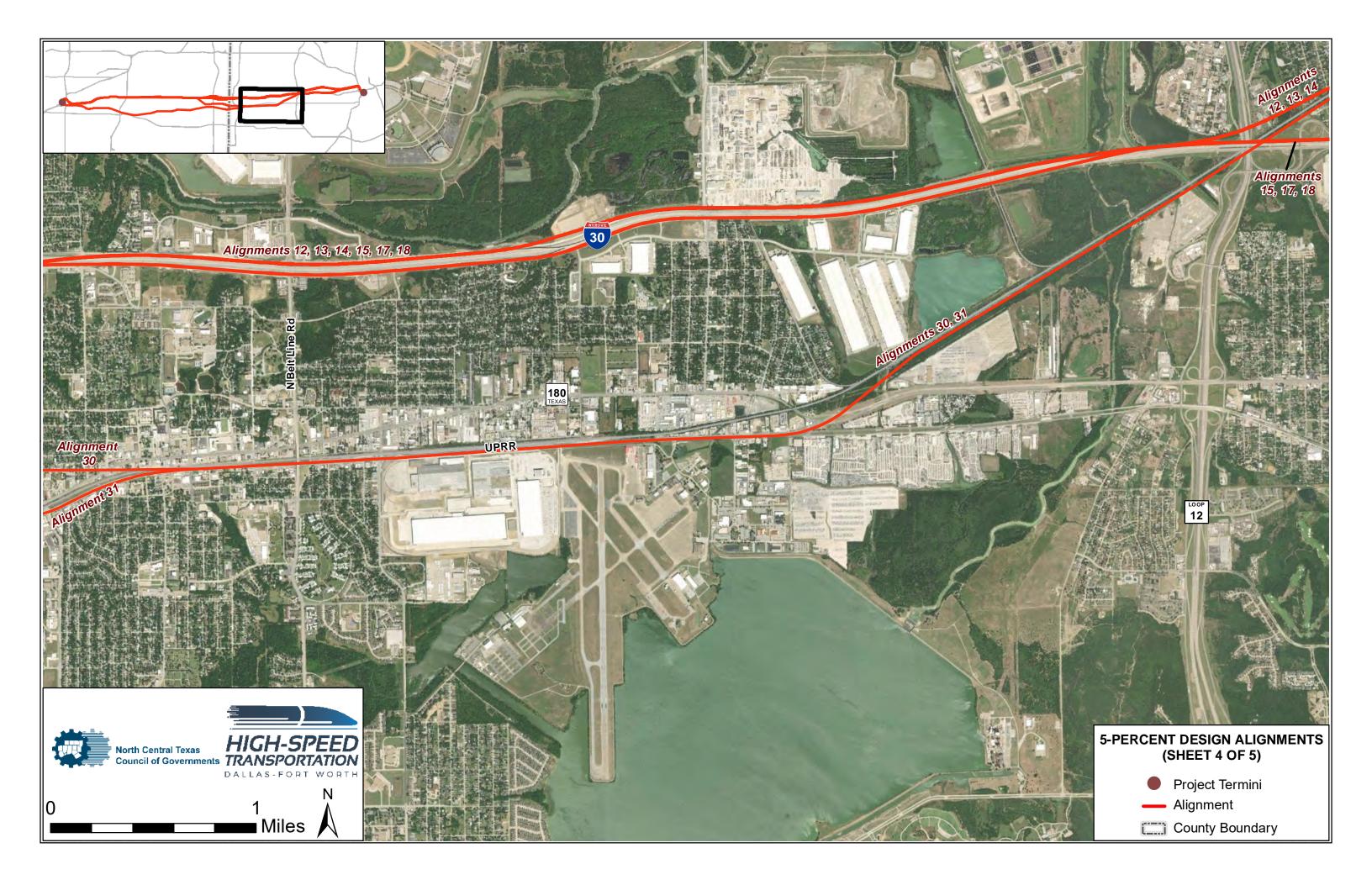


Appendix C 5 Percent Design Alignment Maps





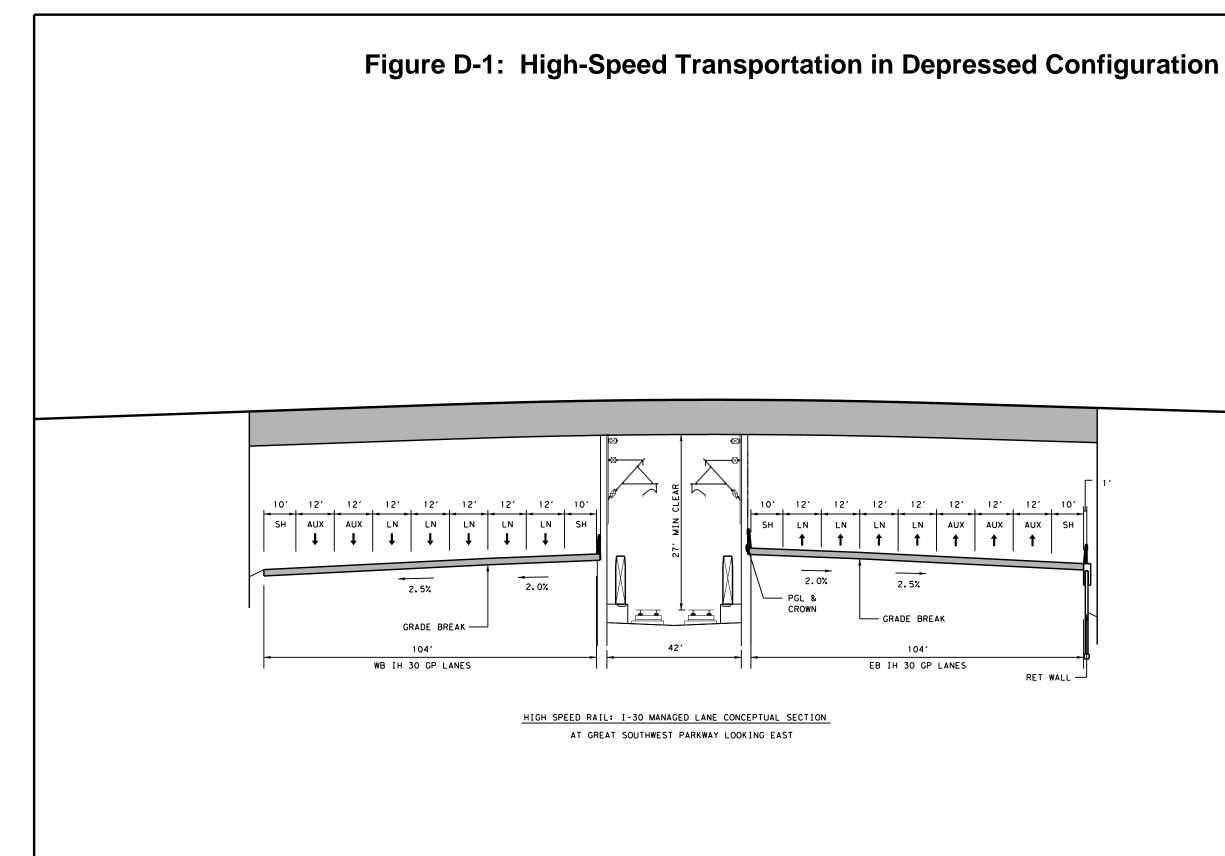








Appendix D I-30 Managed Lane Typical Sections



NOTE:

I-30 TYPICAL SECTION AND GREAT SOUTHWEST PARKWAY PROFILE BASED ON DESIGN SCHEMATIC: I-30 FROM COOPER STREET TO SH 161, DATED AUGUST 7, 2015.

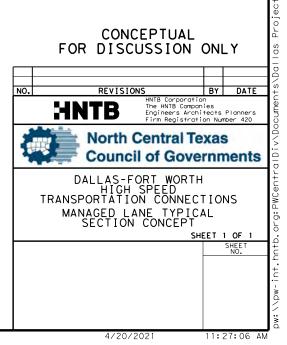
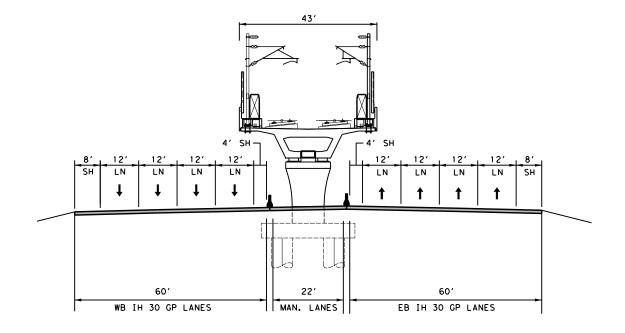


Figure D-2: High-Speed Transportation in Aerial Configuration



HIGH SPEED RAIL: I-30 MANAGED LANE CONCEPTUAL SECTION WEST OF HAMPTON ROAD LOOKING EAST

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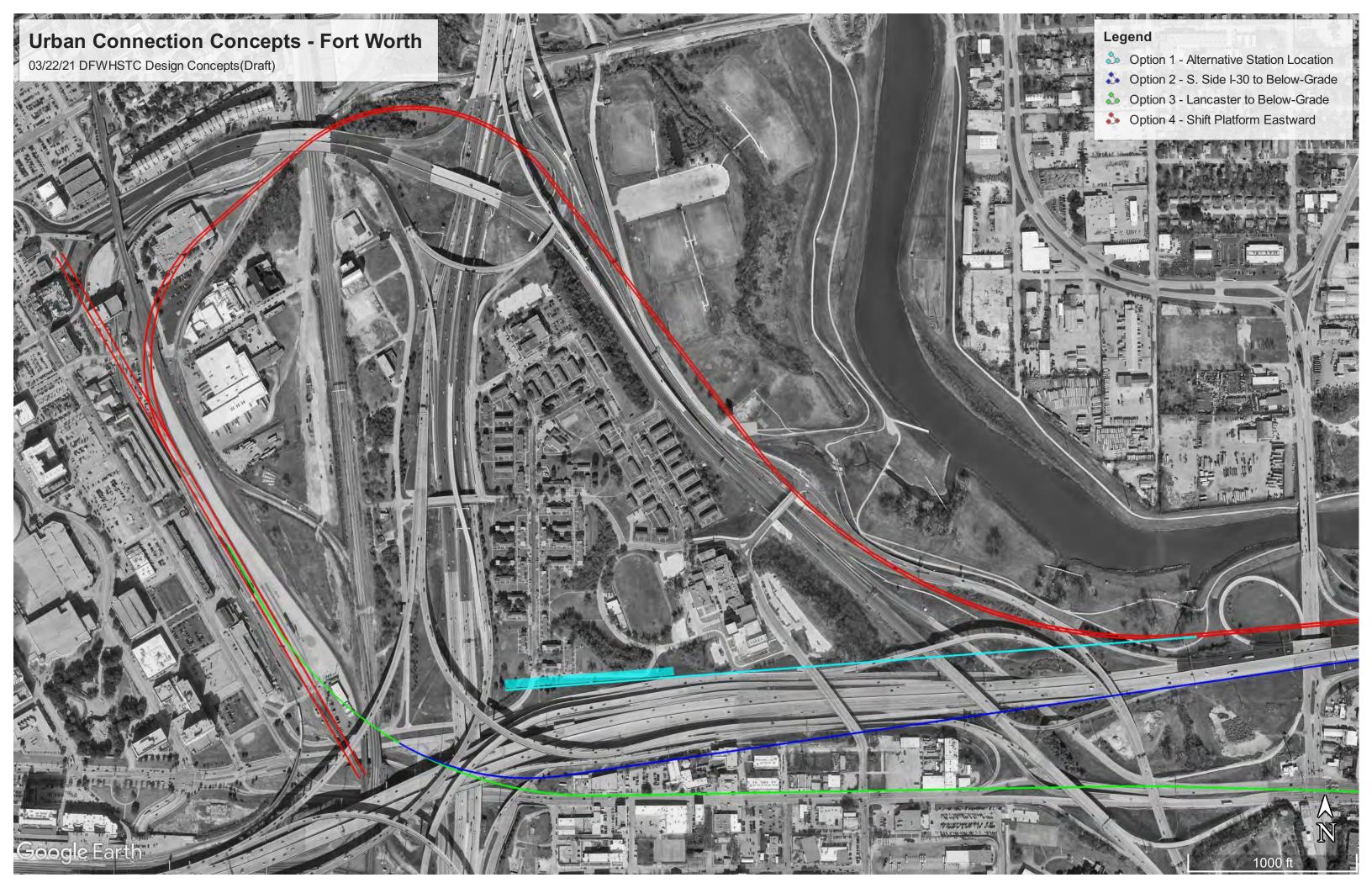
I-30 TYPICAL SECTION BASED ON MEASUREMENTS FROM GOOGLE EARTH.

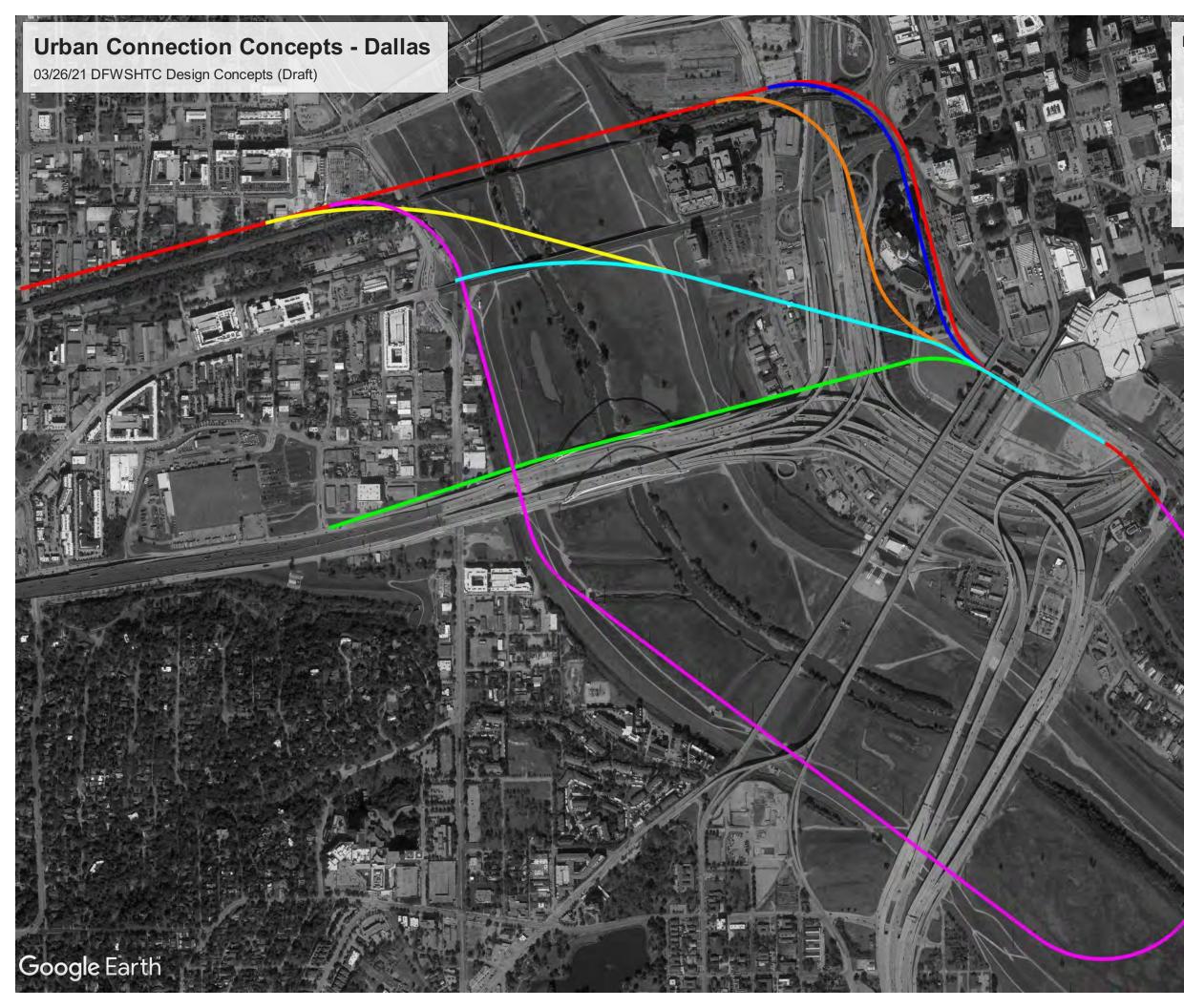


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Appendix E Urban Center Connections





Legend

- Option 1 RR Corridor
- Solution 2 Between RR Corridor & Reunion Tower

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3000 ft

- Option 3 West of Reunion Tower
- Solution 4 Diagonal from UPRR Corridor
- Solution 5 Diagonal from Commerce Street
- Option 6 I-30 Corridor
- Option 7 Southern Entry

DFWHSTC - Urban Connection Options Pros & Cons

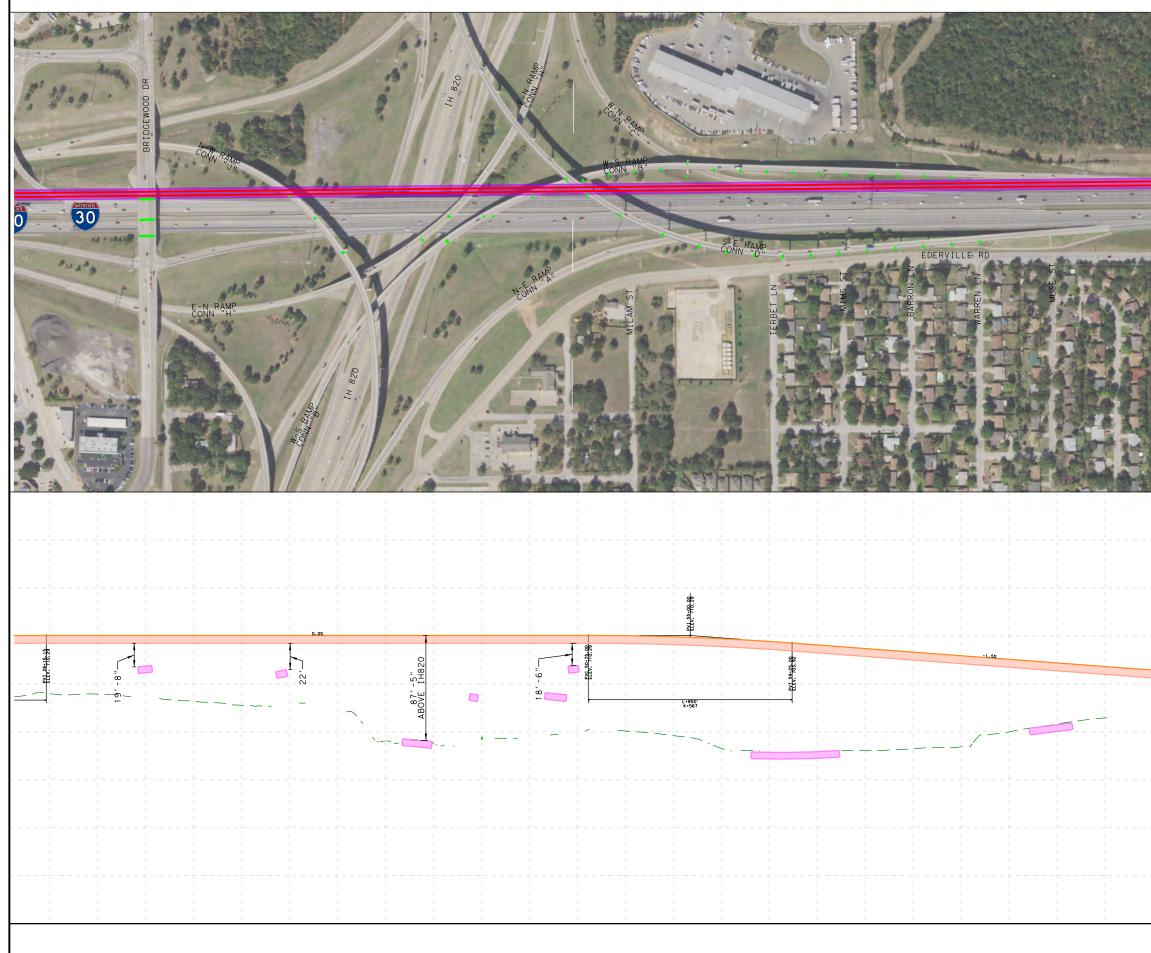
| Urban Center | Option # | Option Name | Pros | Cons |
|--------------|----------|-------------------------------------|--|---|
| Fort Worth | 1 | Alternative Station Location | Shortened corridor length Opportunity for Transit-Oriented development Convenient transi on to future southern expansion corridor Minimal impacts to exis ng transit (rail and bus) operations during construction | New sta on loca on requires coordina on with multiple parties Eliminates direct transfer to other rail and bus transportation modes |
| Fort Worth | 2 | S. Side I-30 to Below-Grade | Shortened corridor length Below-grade configura on avoids above-grade conflicts with existing highway and railroad infrastructure. | Impacts to proper es south of I-30 Alignment would need to be deep enough to accommodate exiting railroad corridor infrastructure. |
| Fort Worth | 3 | Lancaster to Below-Grade | Shortened corridor length Below-grade configura on avoids above-grade conflicts with existing highway and railroad infrastructure. May minimize impacts by aligning along Lancaster | Alignment would need to be deep enough to accommodate exiting railroad corridor infrastructure. Requires alignment to deviate from I-30 corridor for a longer distance Below-Grade through the I-35E/I-30 interchange |
| Fort Worth | 4 | Shift Platform Eastward | Provides more space for sta on development Provide opportunity for more pla8orms Allows vehicle to con nue head-first to the future southern expansion corridor | Longer corridor Introduces highway and railroad infrastructure impacts northeast of the station |
| Dallas | 1 | RR Corridor | Straight alignment across Trinity River (shorter crossing distance) Parallel exis ng railroad bridge over Trinity River, reducing visual impact Aligns with mul ple conceptual alignments to Fort Worth Perpendicular crossing of I-35 at rela vely narrow location. | Very limited space along exis ng railroad corridor on east side of Trinity River Use or railroad right of way requires authorization Limited rail corridor capacity atop the "Triple Underpass" over Commerce Street Tighter curves result and slower travel speed |
| Dallas | 2 | Between RR Corridor & Reunion Tower | Straight alignment across Trinity River (shorter crossing distance) Parallel exis ng railroad bridge over Trinity River, reducing visual impact Aligns with mul ple conceptual alignments to Fort Worth Avoids much of the railroad corridor conges on on east side of Trinity River Perpendicular crossing of I-35 at rela vely narrow location. | Access impact to Hya@Regency Hotel Drive along the east side of the Hyatt Regency and Reunion Tower Limited rail corridor capacity atop the "Triple Underpass" over Commerce Street Some impact to Railroad Corridor just north of the "Triple Underpass" Tighter curves result and slower travel speed |
| Dallas | 3 | West of Reunion Tower | Straight alignment across Trinity River (shorter crossing distance) Parallel exis ng railroad bridge over Trinity River, reducing visual impact Aligns with mul ple conceptual alignments to Fort Worth Avoids much of the railroad corridor conges on on east side of Trinity River Avoids impact to Hya@Regency Hotel Drive Avoid impacts to the "Triple Underpass" | Crosses I-35 at a diagonal along a rela vely wider section of the highway Tighter curves result in slower travel speed |
| Dallas | 4 | Diagonal from UPRR Corridor | Aligns with mul ple conceptual alignments to Fort Worth Trinity River Avoid conflicts with railroad corridor on the east side of Trinity River Avoids impact to Hya@Regency Hotel Drive Avoid impacts to the "Triple Underpass" Most direct route with li@e curvature. | Diagonal crossing of the railroad corridor on the west side of Trinity River Long crossing over Trinity River could impact Trinity River development Crosses the Commerce Street bridge alignment Crosses I-35 at a diagonal along a rela vely wider section of the highway Bisects planned Harold Simmons Park |

DFWHSTC - Urban Connection Options Pros & Cons

| Urban Center | Option # | Option Name | Pros | Cons |
|--------------|----------|-------------------------------|---|--|
| Dallas | 5 | Diagonal from Commerce Street | Avoid conflicts with railroad corridor on the east side of Trinity River Avoids impact to Hya@Regency Hotel Drive Avoid impacts to the "Triple Underpass" Most direct route with li@e curvature. | Long crossing over Trinity River could impact Trinity River development Crosses the Commerce Street bridge alignment Crosses I-35 at a diagonal along a rela vely wider section of the highway Does not align with a current conceptual alignment concept to Fort Worth Bisects planned Harold Simmons Park |
| Dallas | 6 | I-30 Corridor | Straight alignment across Trinity River (shorter crossing distance) Parallel exis ng I-30 bridge over Trinity River, reducing visual impact | Does not align with a current conceptual alignment concept to Fort Worth Crosses I-35 at a very wide sec on of the highway Located directly adjacent to the Margaret McDermott signature bridge |
| Dallas | 7 | Southern Entry | Avoids impacts to poten al developments along the east side of the Trinity River Avoids impacts to exis ng railroad corridors Avoids impact to exis ng parking garage located west of the Convention Center Avoids conflicts to Conven on Center parking lot that is to be used for dense urban development Avoids crossing of I-35 on the east side of the Trinity River | Long extension to the corridor by rou ng to the south of the Dallas station Crosses over Commerce Street, I-30, Houston Street, Jefferson Street and I-30 bridges along the Trinity River Enters Dallas sta on in the opposite direc on than currently expected Major levee/Sec on 404 impacts Tighter curves result and slower travel speed Poten al visual impact |



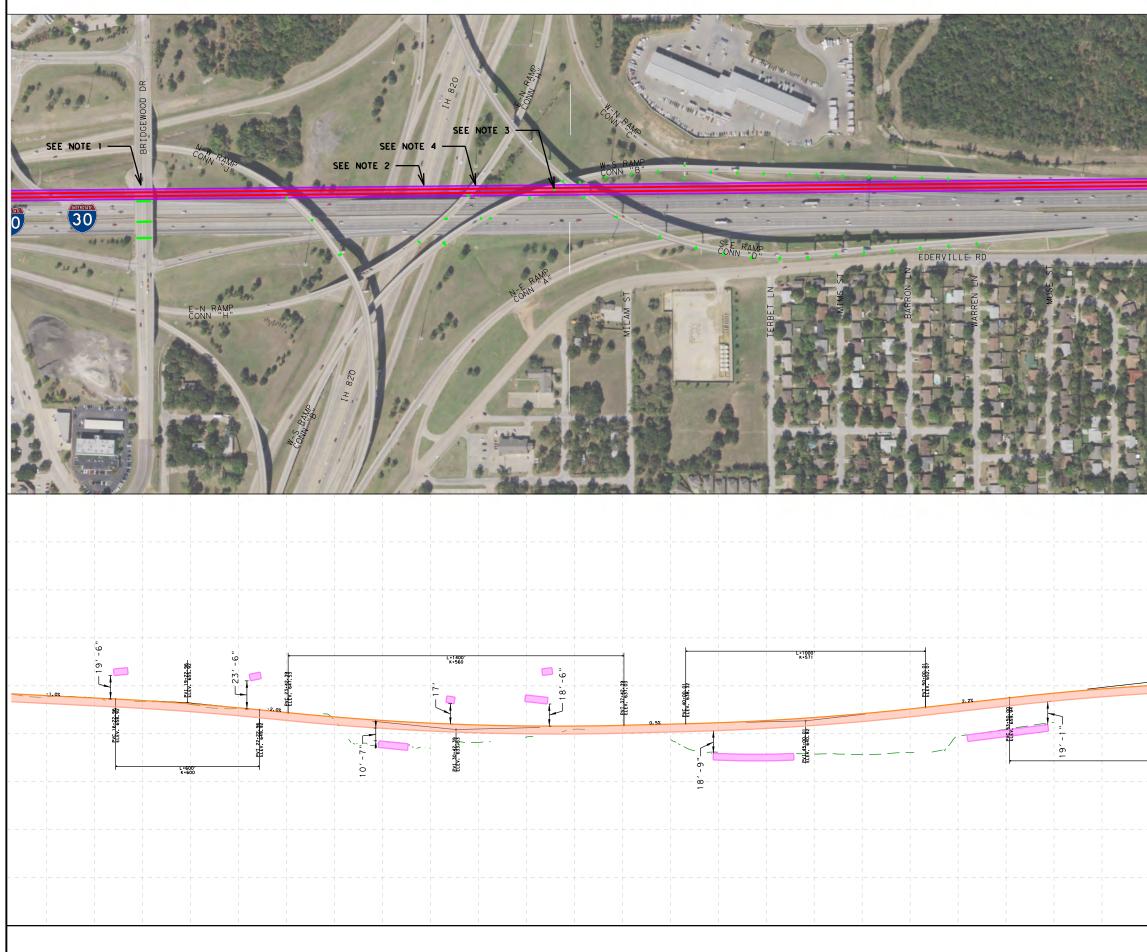
Appendix F I-30 Interchange Conflicts



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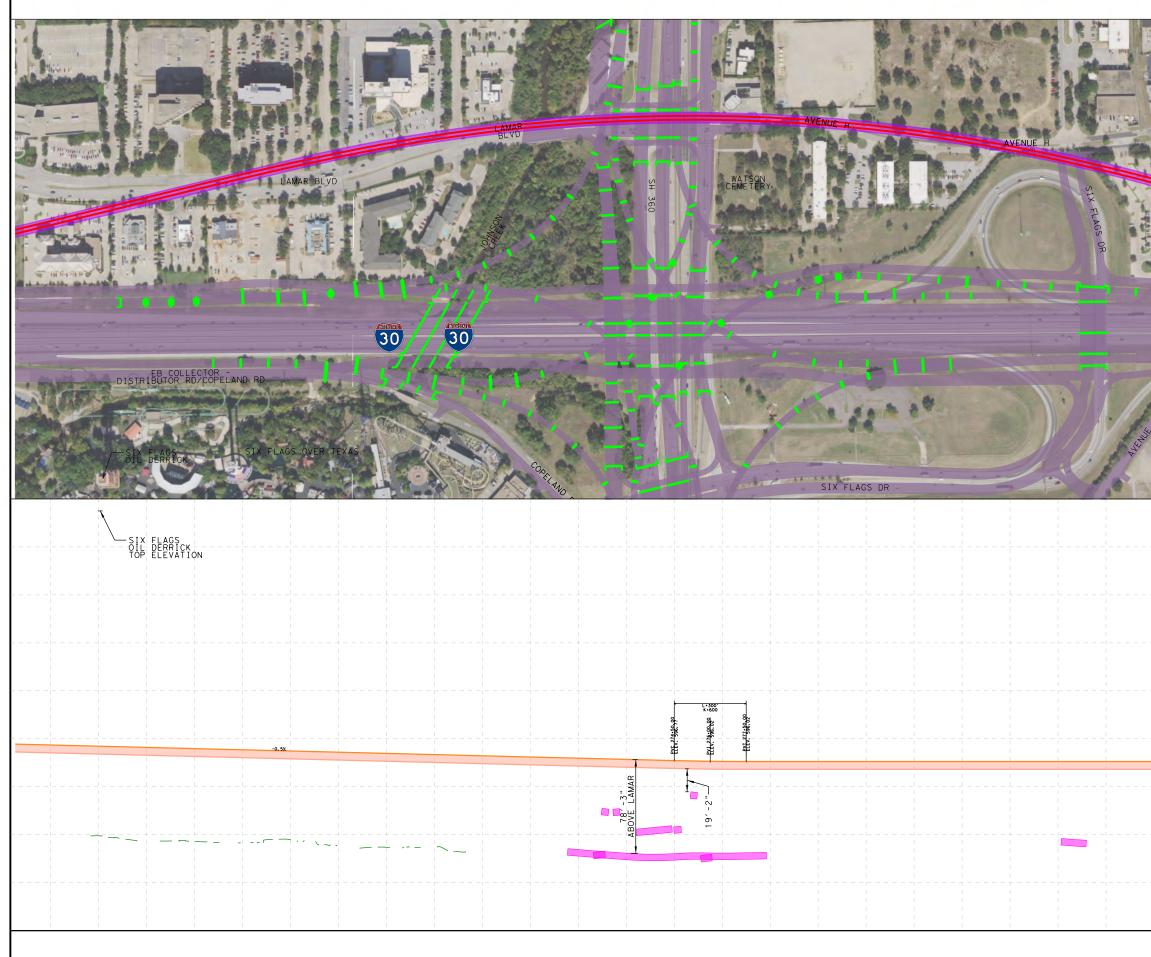
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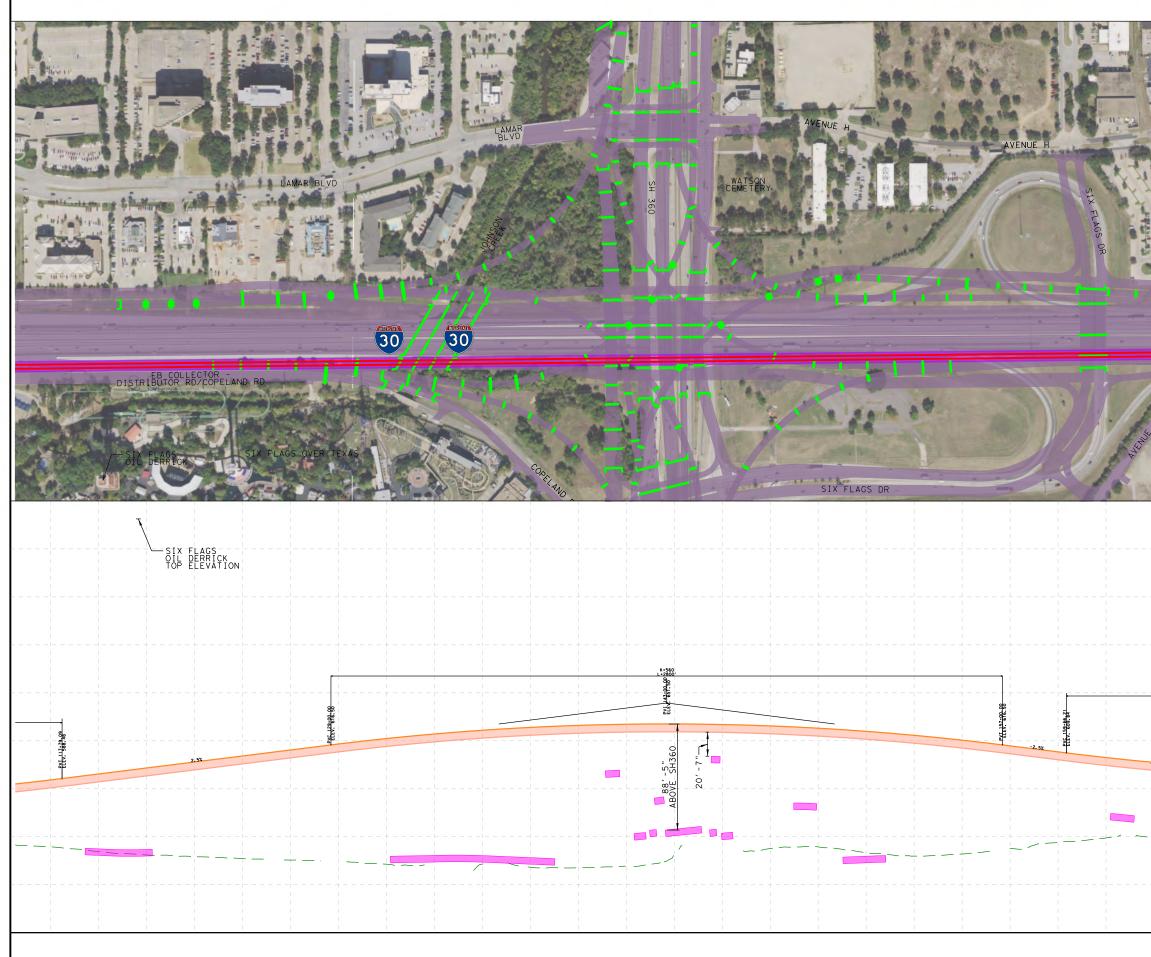


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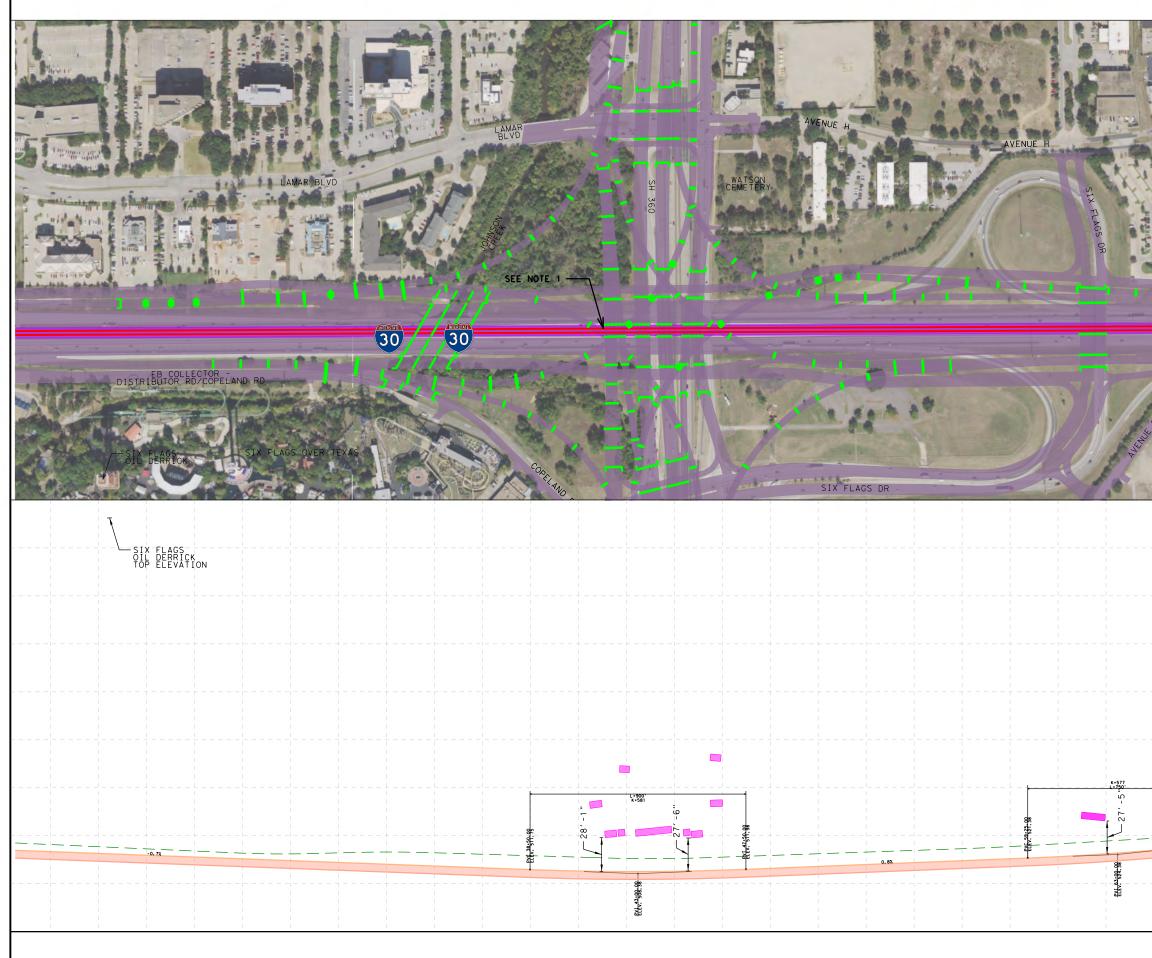
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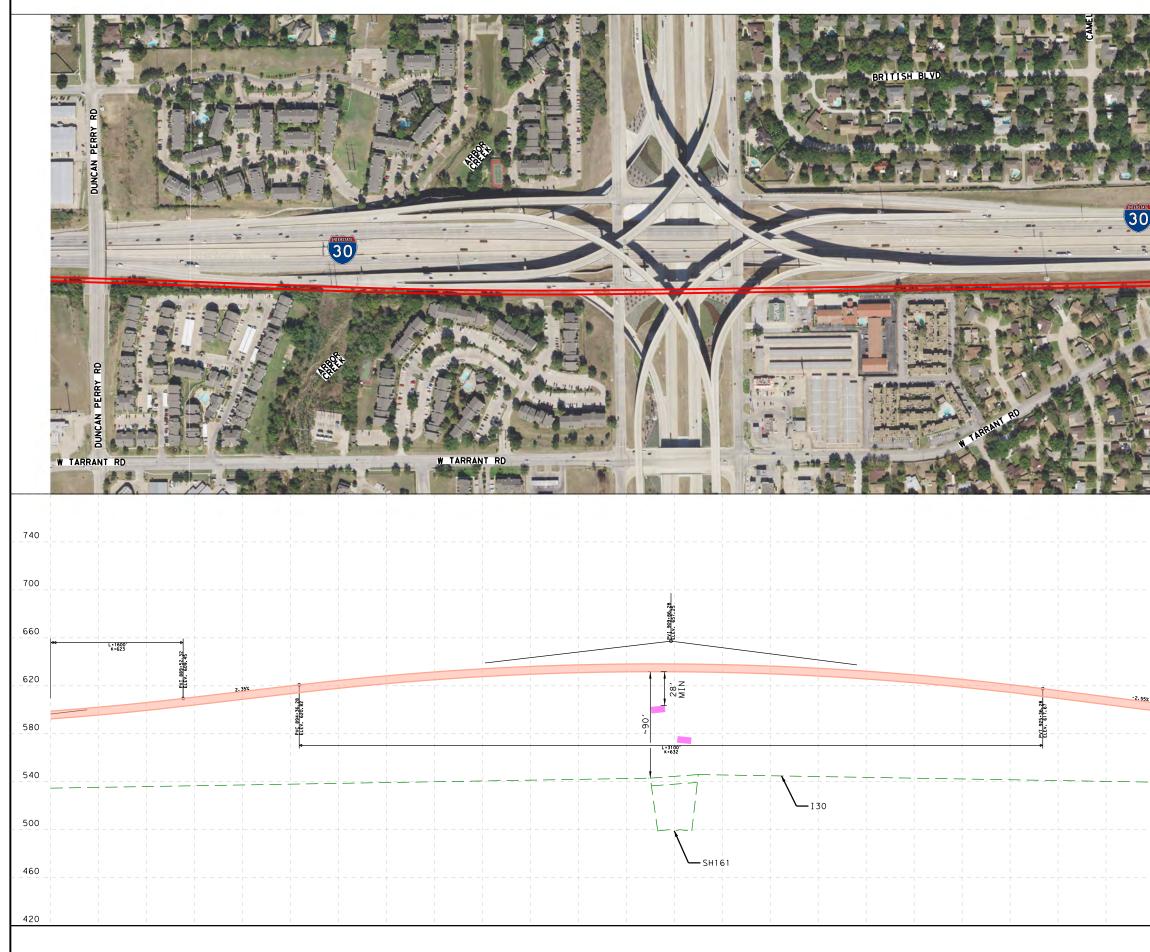
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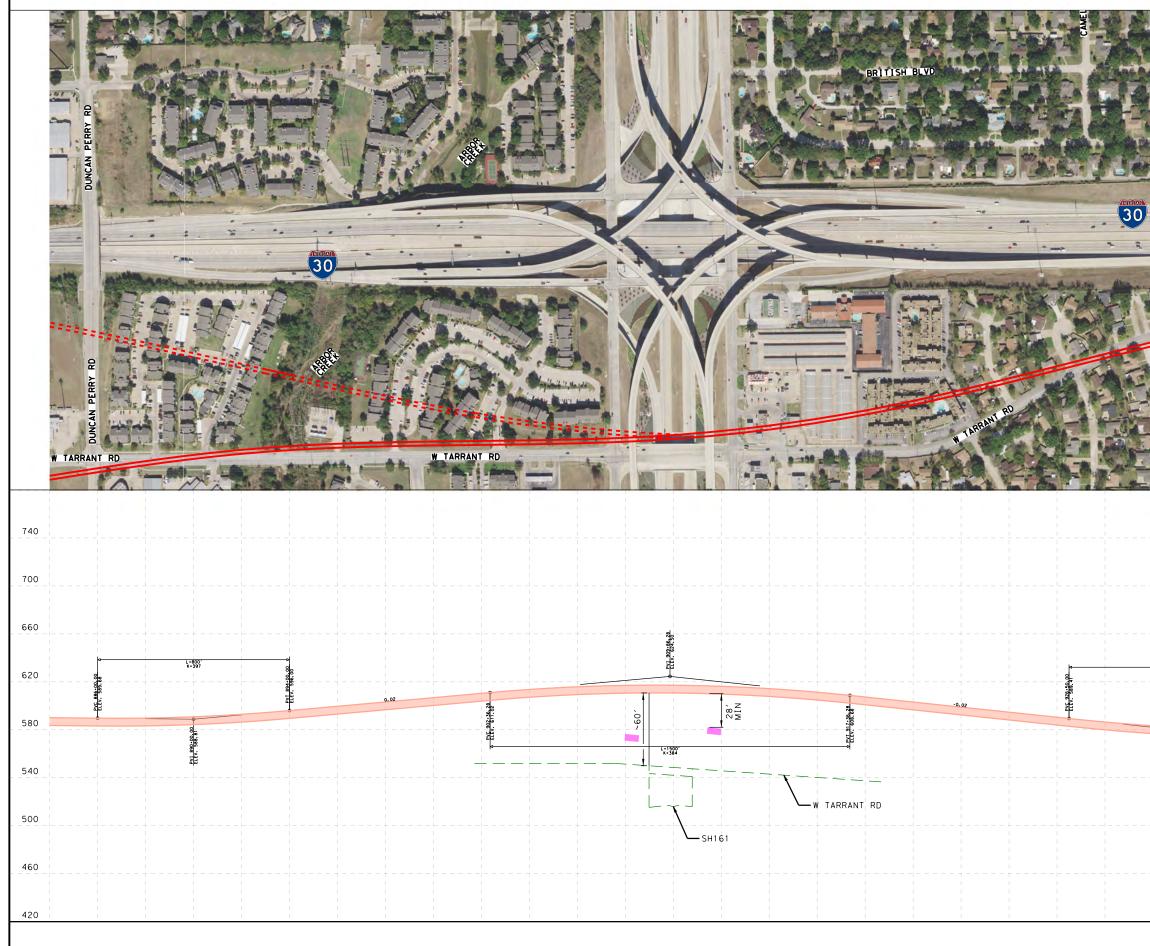
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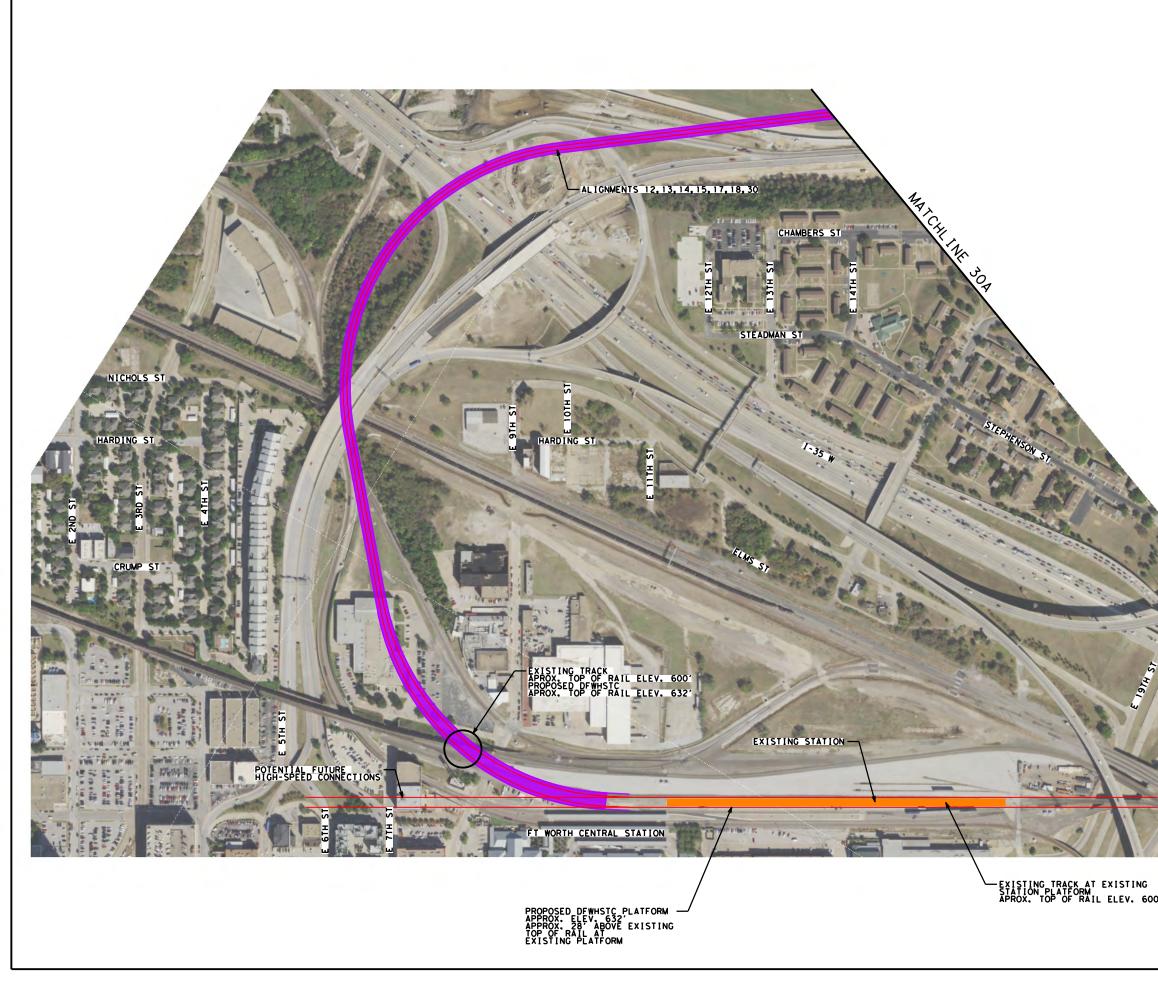
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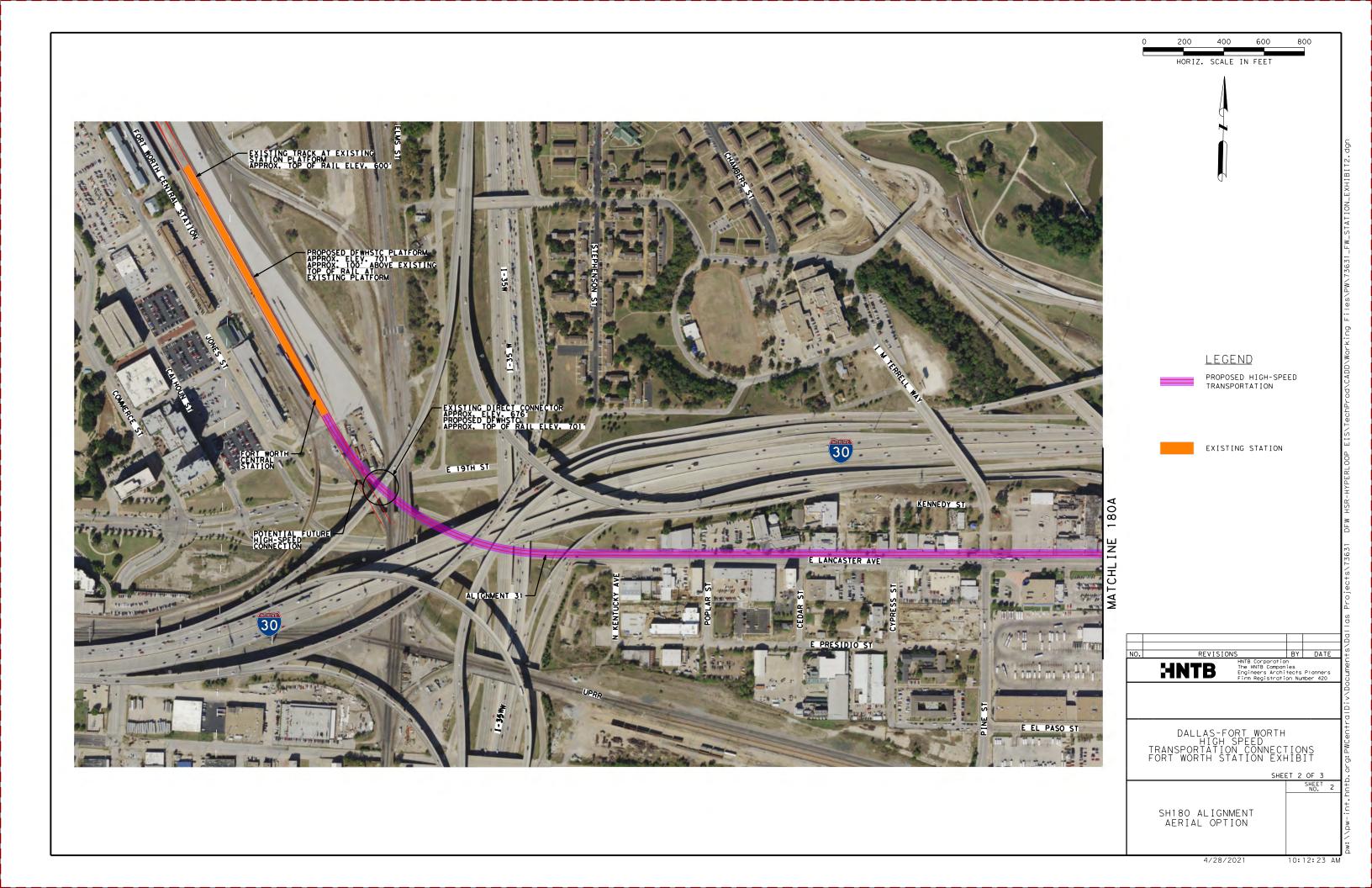
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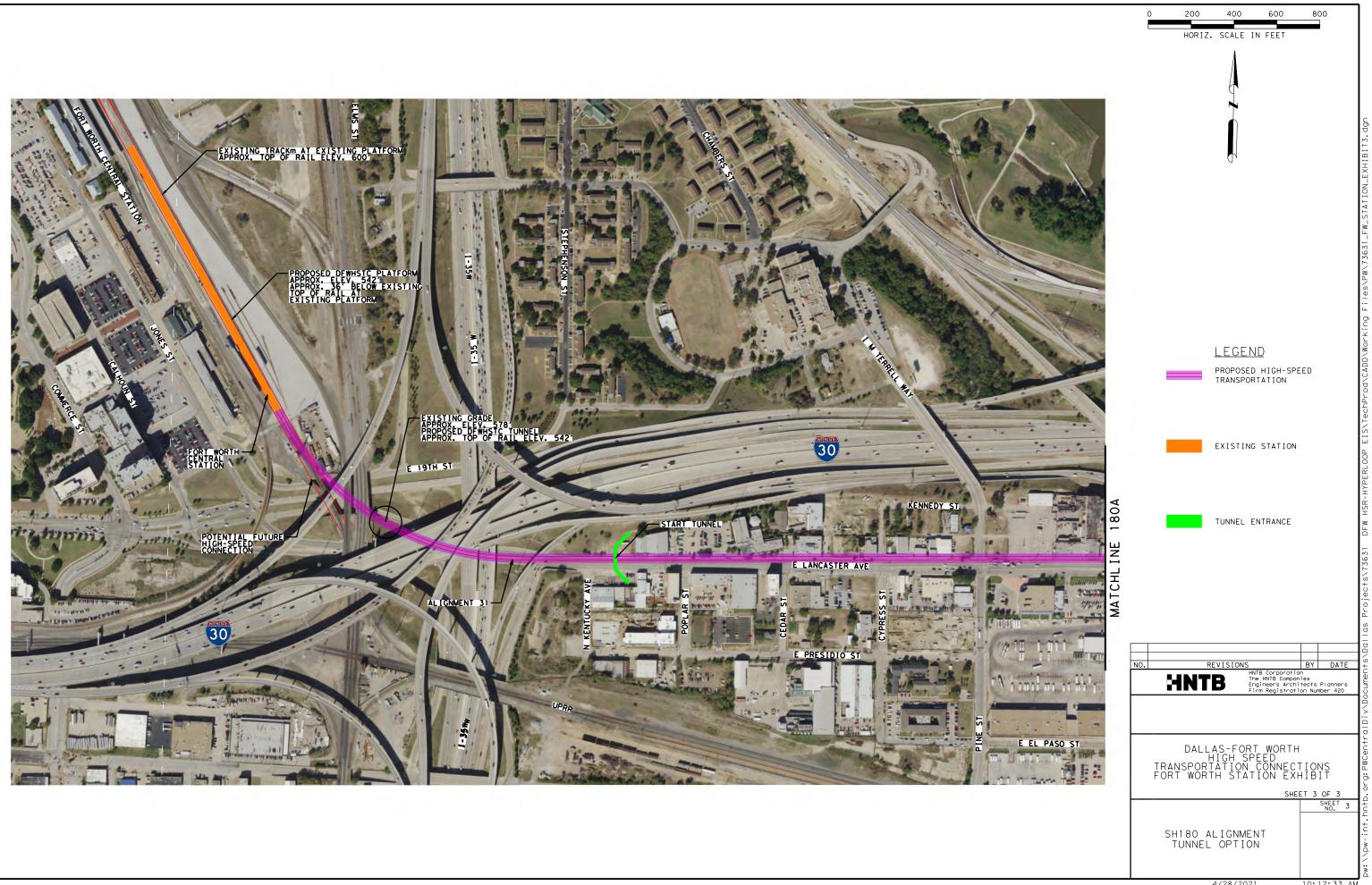


Appendix G Fort Worth Central Station



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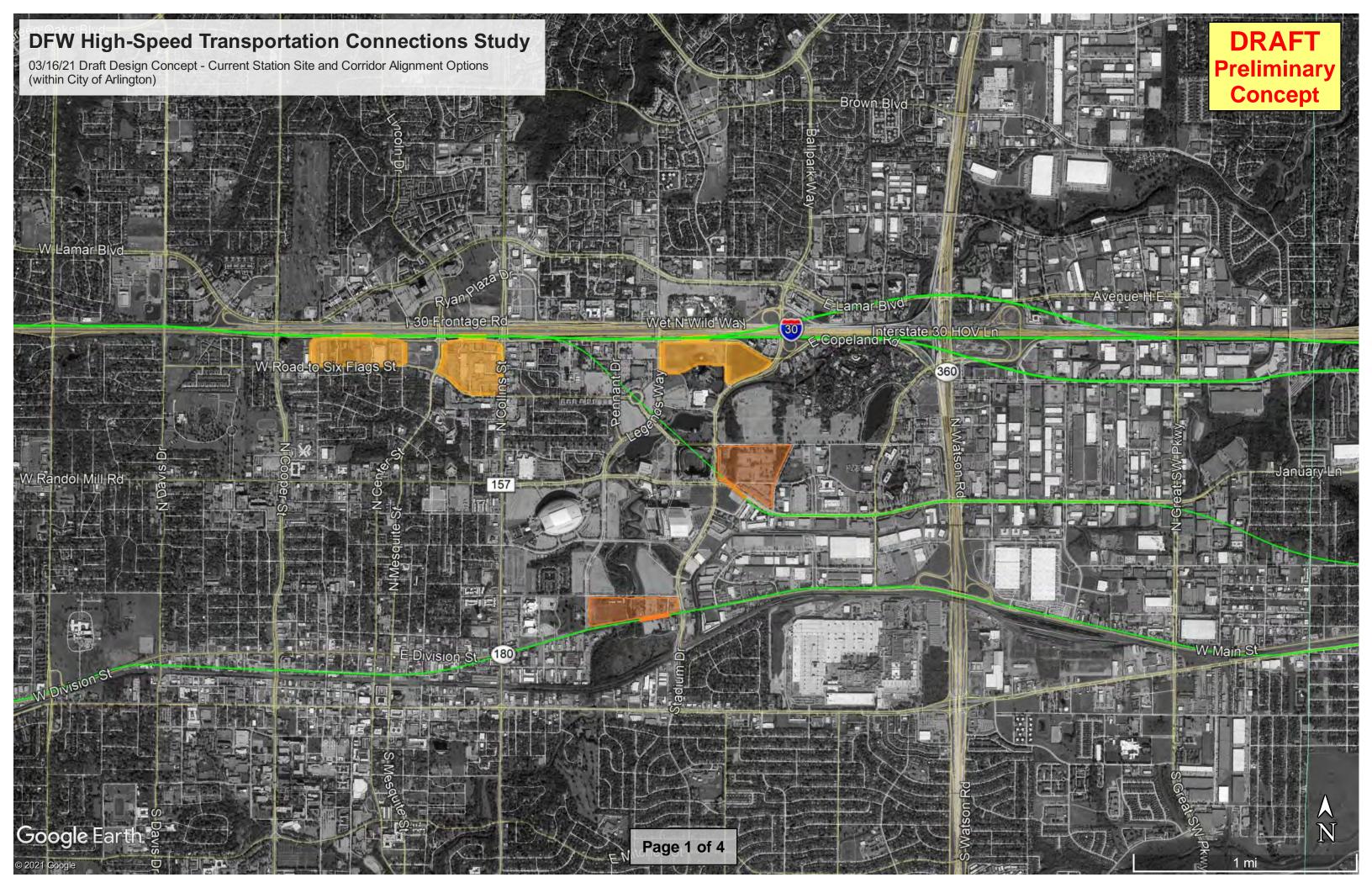


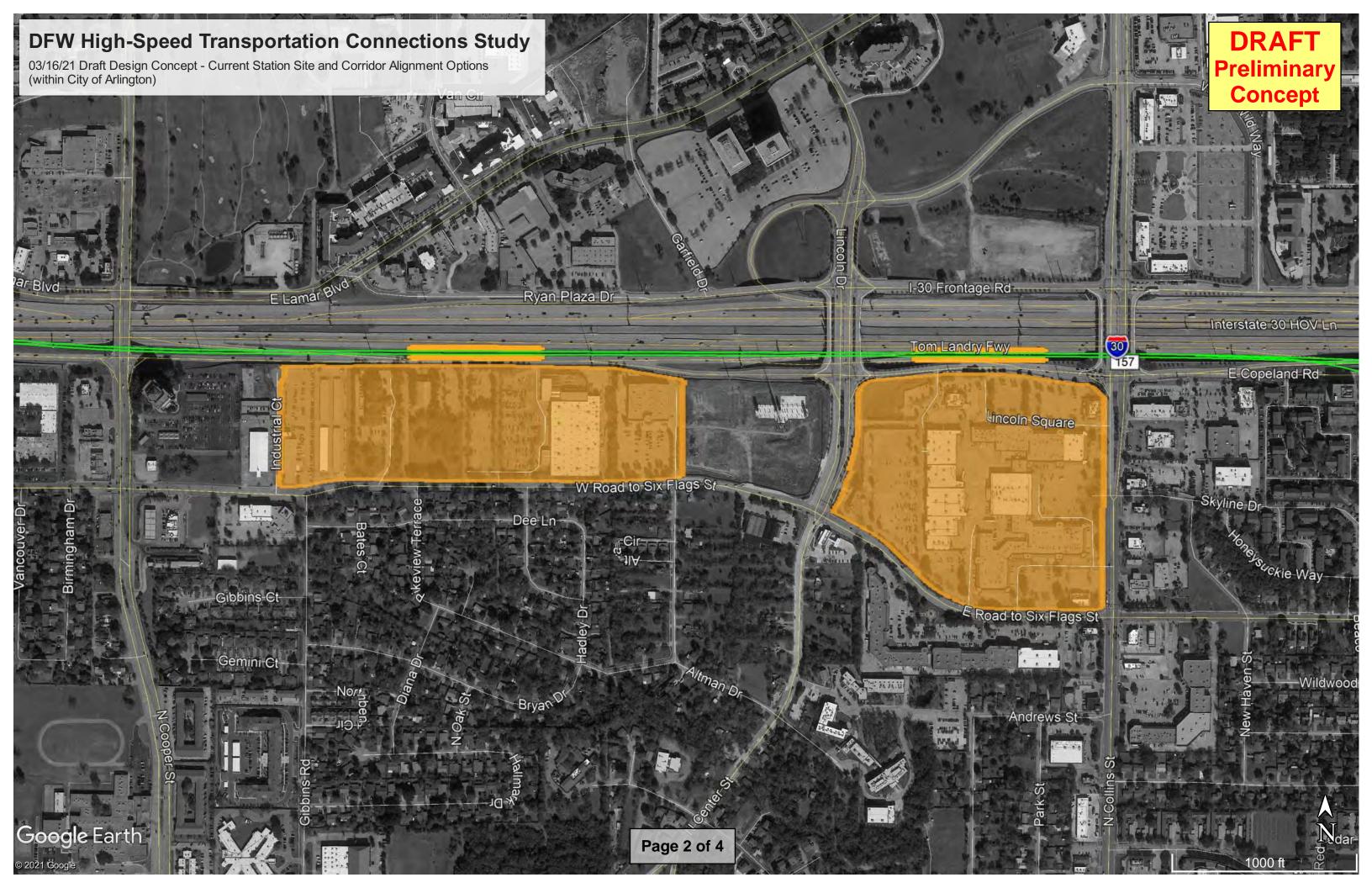


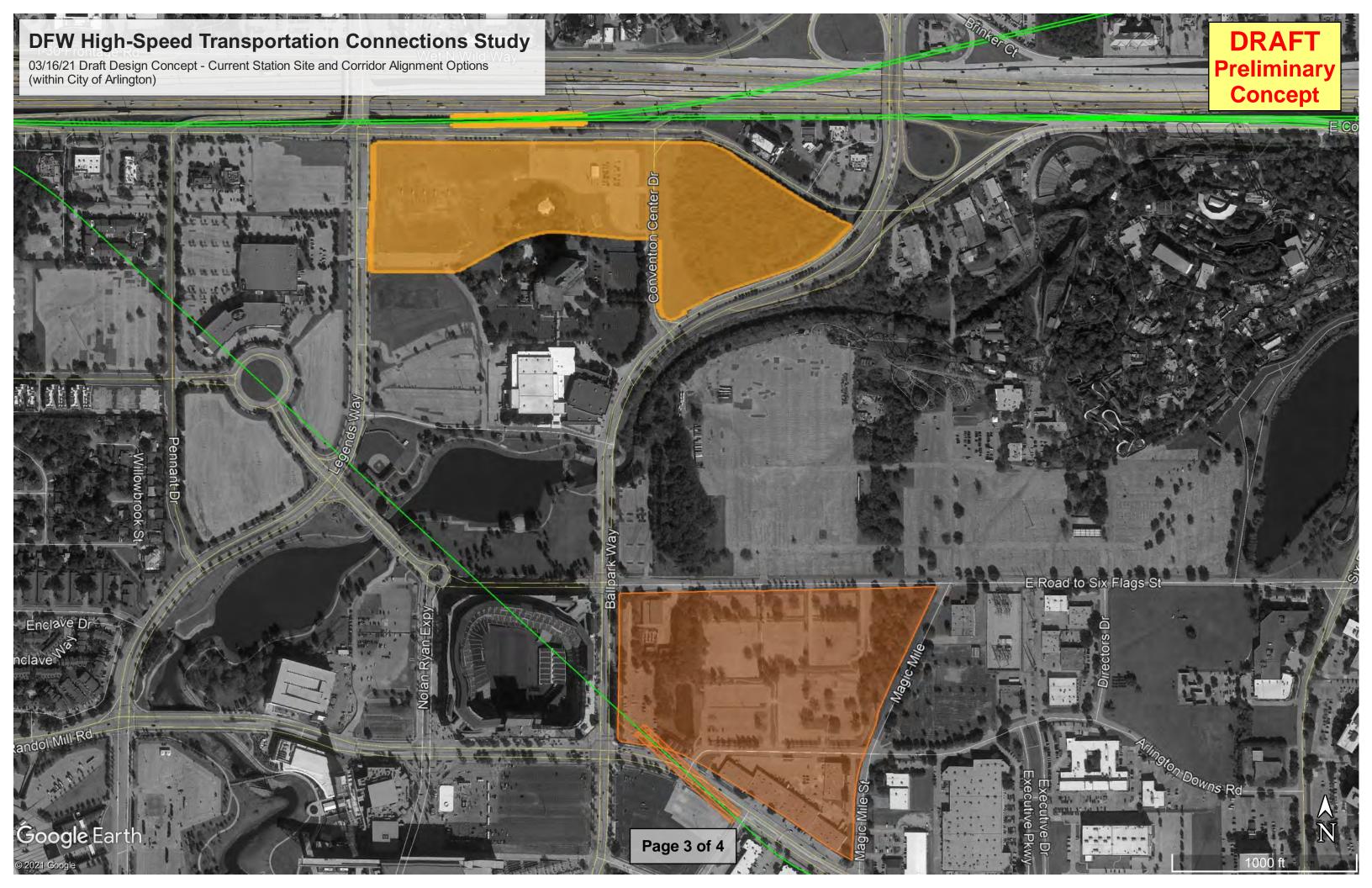
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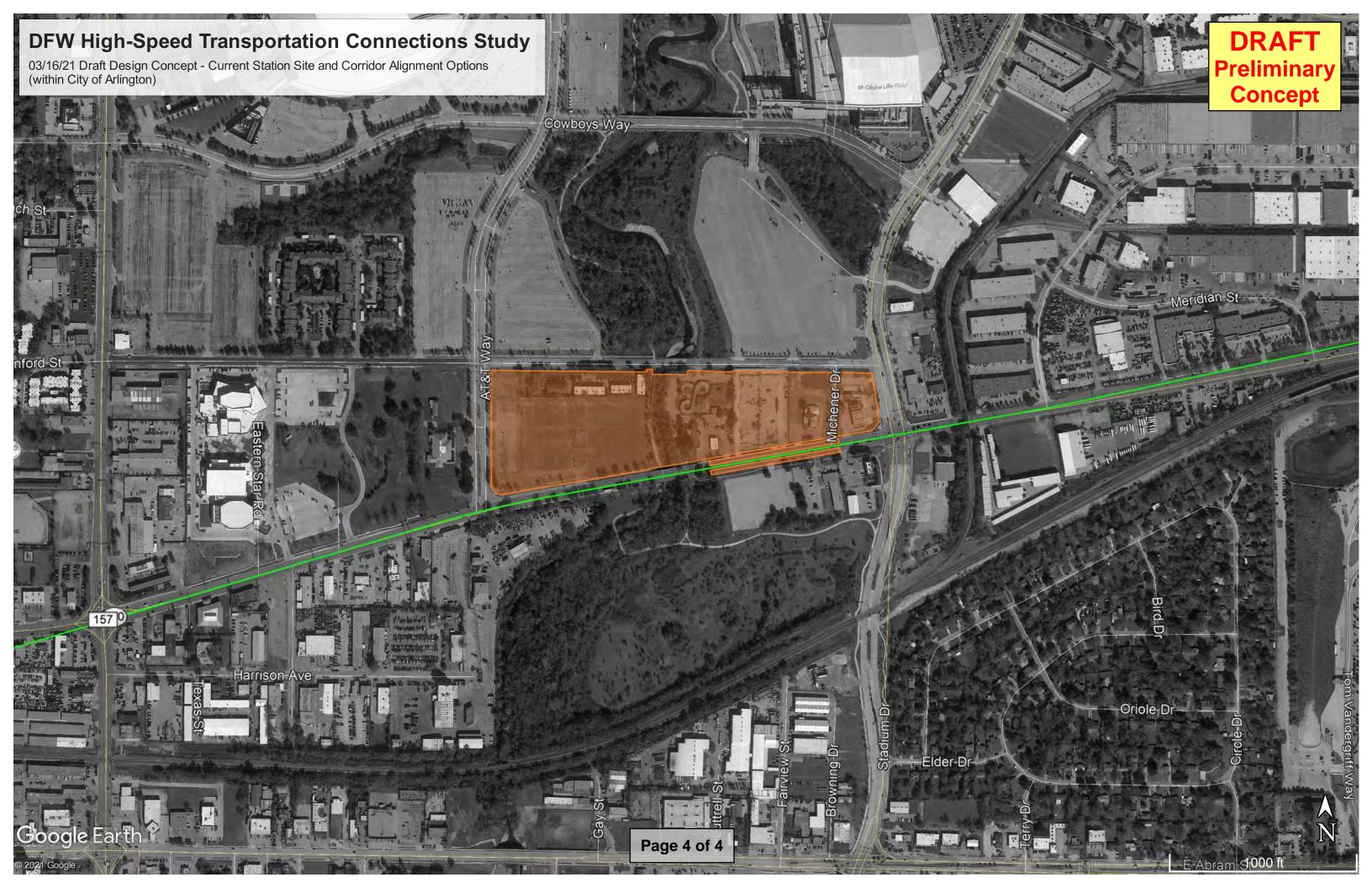


Appendix H Preliminary Station Locations in Arlington



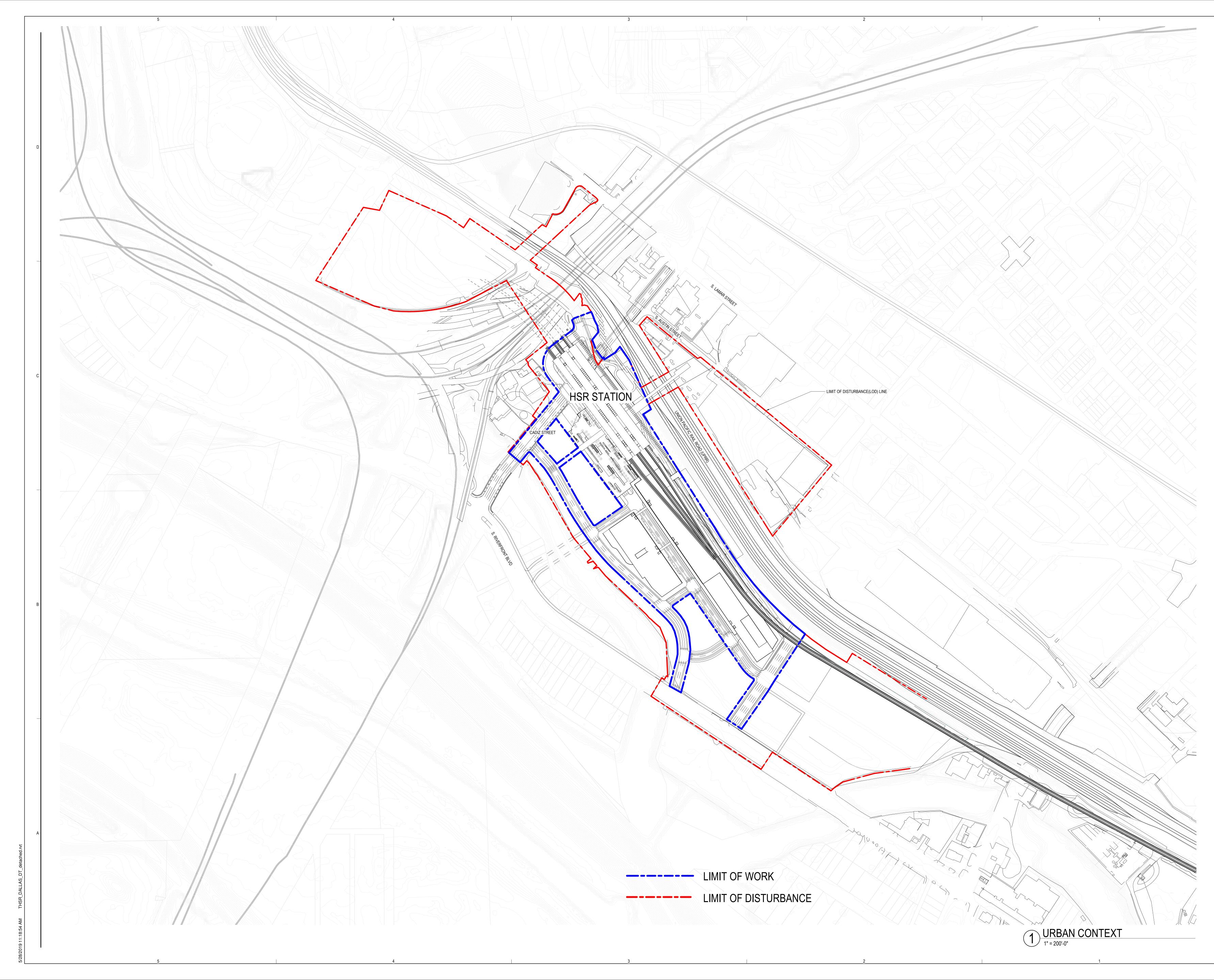


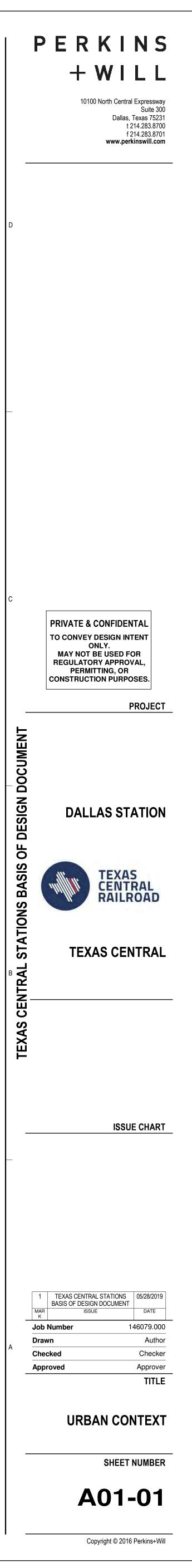


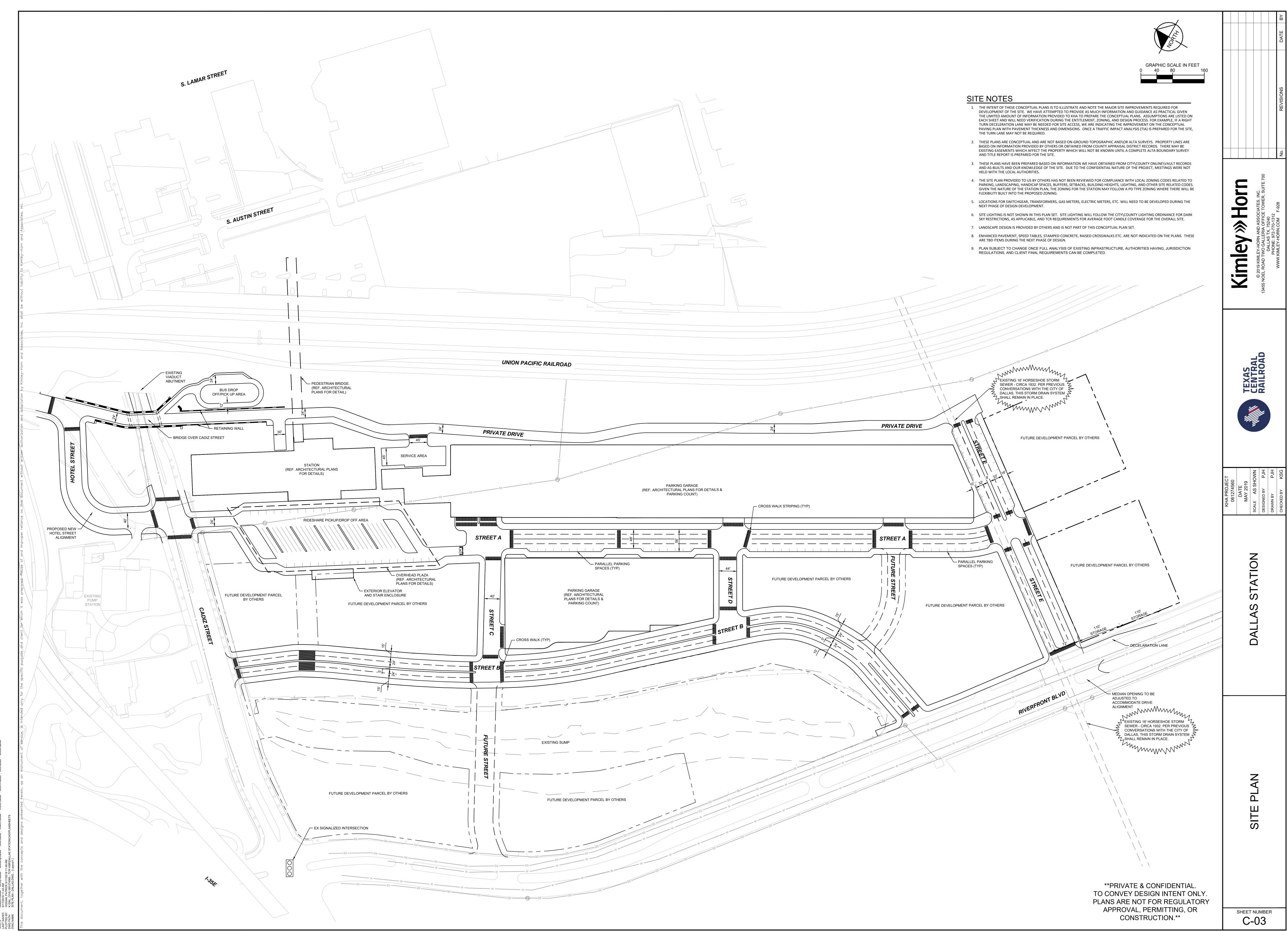


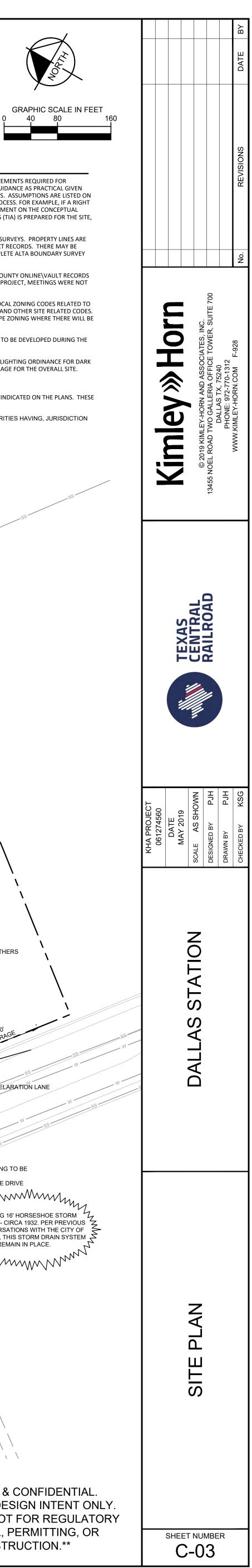


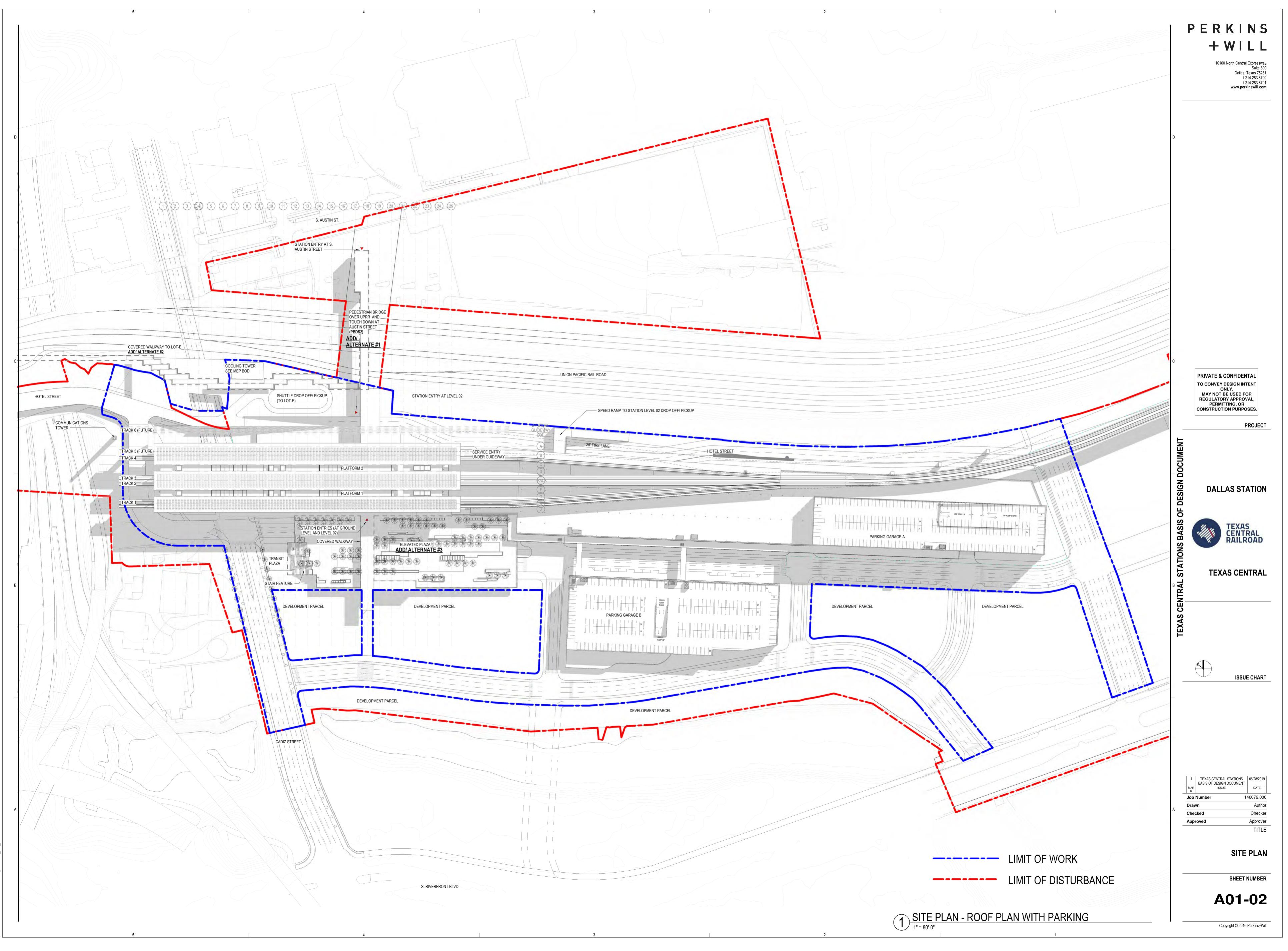
Appendix I Texas Central Railroad High-Speed Rail Station Area Concept in Dallas



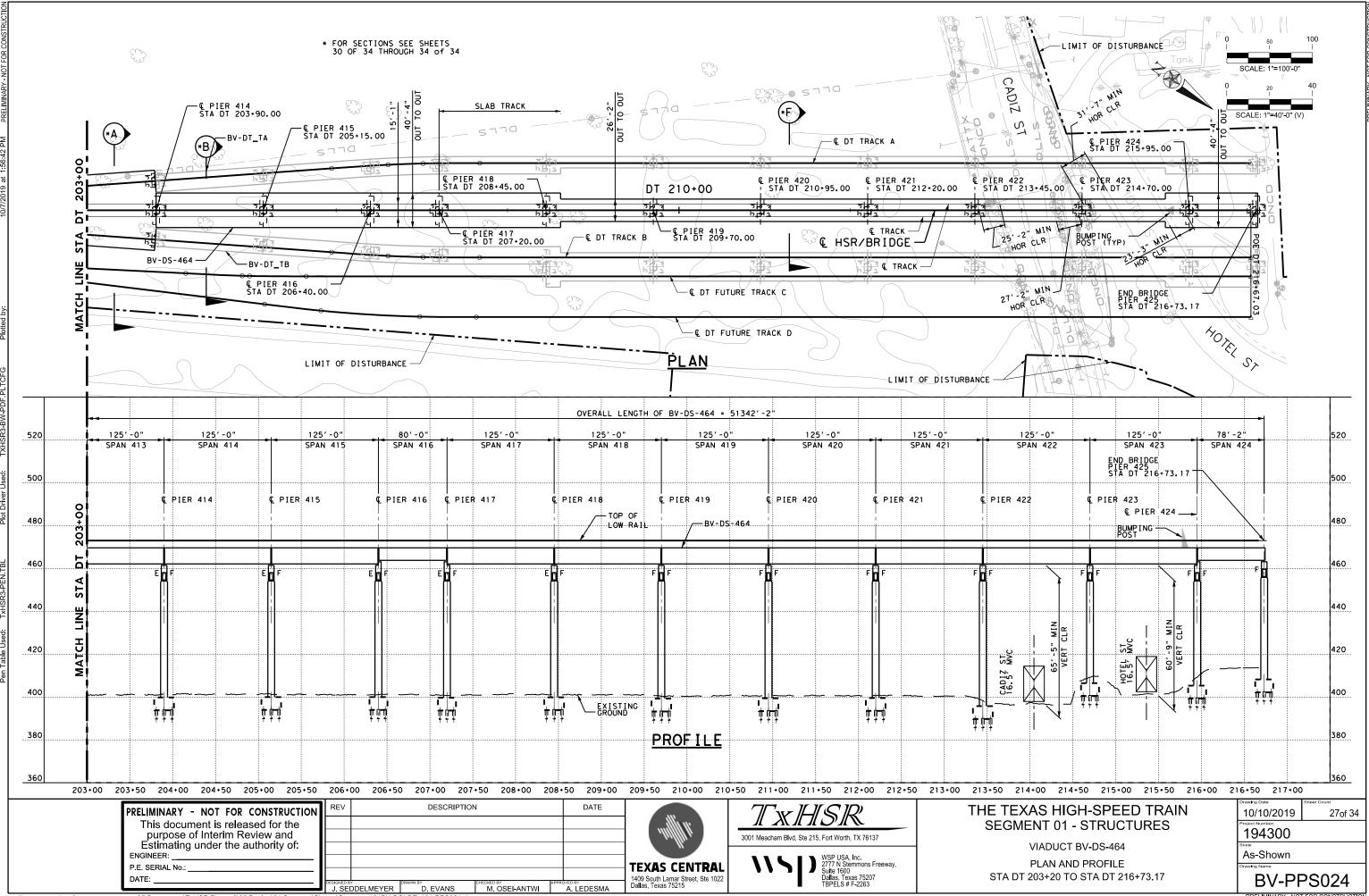








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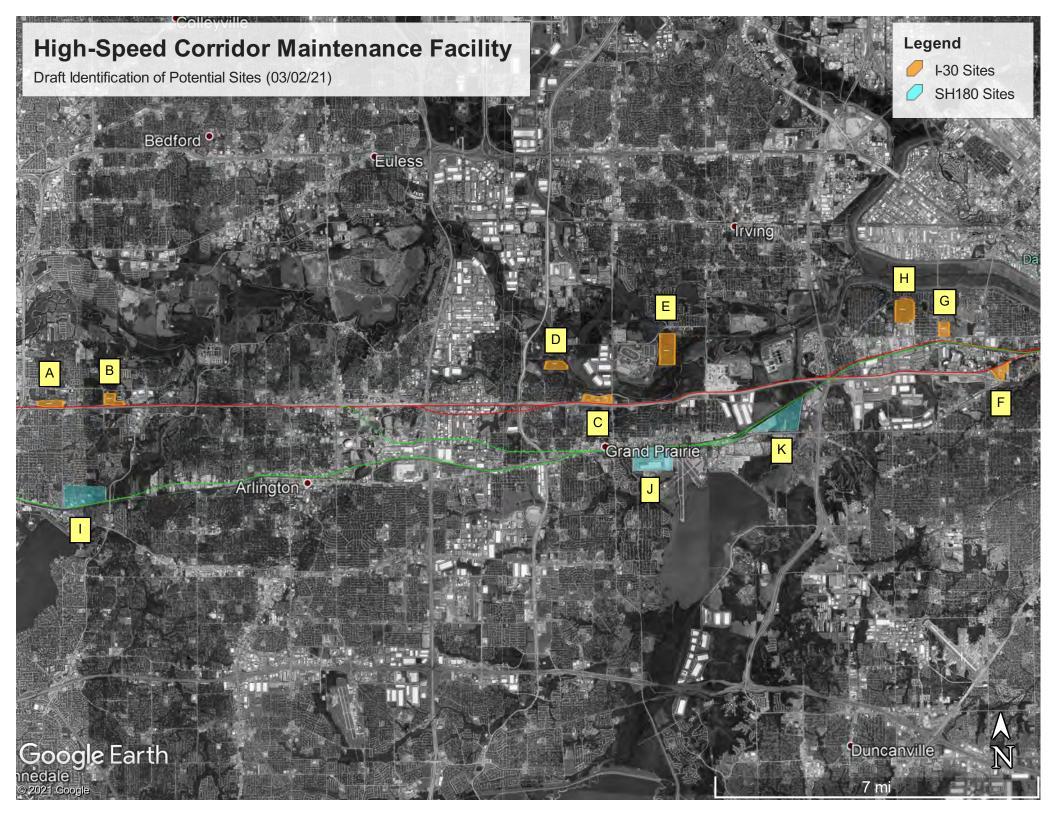


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Appendix J Potential Maintenance Facility Locations





Appendix K Summary Design Criteria

Design Criteria Summary Table

The following table provides a summary version of design criteria outlined within the 2020 *Fort Worth to Laredo High-Speed Transportation Study* (highlighted in yellow) supplemented by information provided by high-speed transportation technology providers participating in the *Dallas to Fort Worth High-Speed Transportation Connections Study* Technology Forum (highlighted in blue).

| | High-Speed Rail | Maglev | Hyperloop |
|--|---|---|---|
| | 186-205 mph ¹ | 220 ² - 311 mph ³ | Up to 670 mph⁴ |
| Operating Speed | 220 mph ^F | 300 – 350 mph ^D | 621 mph ^A 760 mph max (theoretical) ^C |
| Horizontal Curve Radius (Radius at approx. operational | Min Top Speed: 17,100 ft ⁵ | Desired: 10 mi (52,800 ft) Min Top Speed: 5 mi (26,400 ft) ⁶ | At 600 mph 1.6 miles (8,448 ft) according to VHO Studies assume similar to HSR (no greater than .028 gravitational force) ⁷ |
| speed) | | 1,640 ft minimum ^D TBD ft at max speed ^D | 57,000 ft at 621 mph ^B 1.36 km at 100 m/s (4,460 ft at 223 mph) ^G |
| Horizontal Clearances | Approx. 12 ft from catenary pole to 25 ft depending on available right-of-way ⁸ | 23-36 ft can vary depending on available right-of-way ⁹ | Approx. 13 ft according to preliminary design drawings |
| | | 16 ft when passing D | |
| Technology Specific Vertical | For HSR crossing over 14.5 ft (private roads) to 18.5 ft (for interstates) ¹⁰ For HSR crossing under a min. 21 ft – 2 in ¹¹ | Min. under-clearance 18 ft ¹² Min. 20 ft for areas with pedestrians ¹³ | Similar to HSR and Maglev |
| Clearances* | | 22.6 ft for freight ^D | |
| | Absolute Max - 7 7/8 in ¹⁴ | 10 degrees ¹⁵ | Assumed 12 degrees (7 in, similar to California HSR) ^{16 17} |
| Maximum Super elevation (angle of cant) | | 10 degrees ^D | 19 degrees (9.5 degree track tilt + 9.5 degree vehicle suspension tilt) ^A 12 degrees ^C |
| Maximum Grade (Main Line) | Max - 1.8 % < 1.5 miles Max - 2% < 0.6 miles ¹⁸ Up to 3.5% ¹⁹ | 4% ²⁰ | ≤10% (theoretical) ²¹ |
| (| | 10% possible ^D 1-2% recommended ^D | 10% ^{c, g} |
| Center-to- | Approx. 14ft-9in ²² | 19 ft ²³ | Min. 19.6 ft depending on configuration ²⁴ |
| Center Spacing Guideways | | 16 ft ^D | 3.6M (11'-10") ^A |
| Typical Right- of-Way Widths | Approx. 100 ft ²⁵ | Approx. 72 ft - 100ft ²⁶ | Approx. 40–100 ft (Tube and guideways can have varying configuration) ²⁷ |
| | | 33 ft (approximate) ^D | 50 ft ⁶ |
| | Electric | Electric | Electric |
| Energy Type | | Electric ^D | |
| Grade Separation | Yes / Closed System | Yes / Closed System | Yes / Closed System |

| | High-Speed Rail | Maglev | Hyperloop |
|--|---------------------------------|---|---|
| | | Yes, when elevated. Can be configured at-grade on railroad infrastructure. ^D | |
| Capital Cost/Mile (in \$ Millions; adjusted to 2019 dollars) | Approx. \$64 - 75 ²⁸ | Approx. \$265 ^{29 30} Planning level Information found regarding superconducting maglev projects include Baltimore- Washington and Chuo Shinkansen, both projects include significant amount of tunnelling and right of way costs due to their locations. Therefore, capital costs could vary greatly for this technology. | Approx. \$50 - \$75 ^{31 32} Up to \$120 ³³ Estimates vary |
| | | \$33.87M (elevated) ^D | \$55M/mile (28M euro/km) ^A \$40 - \$65M/mi ^C \$45M/mi ^H |

¹ FRA. Dallas to Houston High-Speed Rail Draft Environmental Impact Study, Final Draft Conceptual Engineering Report-FDCEv7, 15 September 2017, p27. Accessed February 2020:

² FRA. *Baltimore-Washington Superconducting Maglev Project Final Alternatives Report Nov 2018*, p84. Accessed, February 2020:

⁴ Virgin Hyperloop One. *How It Works*. Accessed February 2020: https://hyperloop-one.com/facts-frequently-asked-questions

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⁷ Northeast Ohio Areawide Coordinating Agency. Draft Final Great Lakes Hyperloop Feasibility Study, December 2019. Accessed February 2020:

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⁸ FRA. Dallas to Houston High-Speed Rail Draft Environmental Impact Study, Final Draft Conceptual Engineering Report-FDCEv7, 15 September 2017, p34. Accessed February 2020:

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- ¹² FRA. Baltimore-Washington Superconducting Maglev Project Final Alternatives Report Nov 2018, p84. Accessed, February 2020:
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¹⁶ Northeast Ohio Areawide Coordinating Agency. *Draft Final Great Lakes Hyperloop Feasibility Study*, December 2019. Accessed February 2020:

¹⁷ California High-Speed Rail Authority. *Alignment Design Standards for High-Speed Train Operations TM 2.1.2.*, April 2009. Accessed February 2020: https://www.hsr.ca.gov/docs/programs/eir_memos/Proj_Guidelines_TM2_1_2R00.pdf

¹⁸ FRA. Dallas to Houston High-Speed Rail Draft Environmental Impact Study, Final Draft Conceptual Engineering Report-FDCEv7, 15 September 2017, p34. Accessed February 2020:

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¹⁹ California High-Speed Rail Authority. *Alignment Design Standards for High-Speed Train Operations TM 2.1.2.*, April 2009. Accessed February 2020: <u>https://www.hsr.ca.gov/docs/programs/eir_memos/Proj_Guidelines_TM2_1_2R00.pdf</u>

²⁰ FRA. *Baltimore-Washington Superconducting Maglev Project Final Alternatives Report Nov 2018*, p84. Accessed, February 2020:

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²¹ Alderton, M. (2020). *Hyperloop Technology Can Transform Transportation—Within the Decade*. [online] Redshift EN. Available at:

https://www.autodesk.com/redshift/hyperloop-transportation/

²² FRA. Dallas to Houston High-Speed Rail Draft Environmental Impact Study, Final Draft Conceptual Engineering Plans and Details, 15 September 2017, p34. Accessed February 2020:

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²³ FRA. Baltimore-Washington Superconducting Maglev Project Final Alternatives Report Nov 2018, p84. Accessed, February 2020:

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https://www.bwmaglev.info/images/document_library/reports/alternatives_report/SCMAGLEV_Alts_Report_Body-Append-A-B-C_Nov2018.pdf ³ Central Japan Railway Company. *About the Chuo Shinkansen Project*. Accessed February 2020: https://scmaglev.jr-central-global.com/faq/

⁵ FRA. Dallas to Houston High-Speed Rail Draft Environmental Impact Study, Final Draft Conceptual Engineering Report-FDCEv7, 15 September 2017, p34. Accessed February 2020:

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⁶ FRA. Baltimore-Washington Superconducting Maglev Project Final Alternatives Report Nov 2018, p84. Accessed, February 2020:

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¹³ FRA. Baltimore-Washington Superconducting Maglev Project Final Alternatives Report Nov 2018, p84. Accessed, February 2020:

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¹⁵ FRA. Baltimore-Washington Superconducting Maglev Project Final Alternatives Report Nov 2018, p84. Accessed, February 2020:

²⁴ Transpod. *Initial Order of Magnitude Analysis for Transpod Hyperloop System Infrastructure*. July 2017. Accessed February 2020: <u>https://transpod.com/wp-content/uploads/2017/07/TransPod-infrastructure_EN_July-17-update2.pdf</u>

²⁵ Texas Central Railroad. Low Impact Design Facts Sheet, 2018. Accessed February 2020: http://www.texascentral.com/wp-content/uploads/2018/03/TC_Low-impact_design_2018.pdf

²⁶ FRA. Baltimore-Washington Superconducting Maglev Project Final Alternatives Report Nov 2018, p84. Accessed, February 2020:

https://www.bwmaglev.info/images/document_library/reports/alternatives_report/SCMAGLEV_Alts_Report_Body-Append-A-B-C_Nov2018.pdf ²⁷ Transpod. *Initial Order of Magnitude Analysis for Transpod Hyperloop System Infrastructure*. July 2017. Accessed February 2020: <u>https://transpod.com/wp-content/uploads/2017/07/TransPod-infrastructure_EN_July-17-update2.pdf</u>

 ²⁸ FRA. Dallas to Houston High-Speed Rail Draft Environmental Impact Study Executive Summary. December 2017. Accessed February 2020: https://cms8.fra.dot.gov/sites/fra.dot.gov/files/fra_net/17954/1%20Dallas%20to%20Houston%20High%20Speed%20Rail%20DEIS_MAIN%20TEXT%20I.pdf
 ²⁹ FRA. Baltimore-Washington Superconducting Maglev Project FAQ. Accessed February 2020: https://www.bwmaglev.info/index.php/faqs

³⁰ Central Japan Railway Company. About the Chuo Shinkansen Project. Accessed February 2020: https://scmaglev.jr-central-global.com/faq/

³¹ Northeast Ohio Areawide Coordinating Agency. *Draft Final Great Lakes Hyperloop Feasibility Study*, December 2019. Accessed February 2020:

³² Virgin Hyperloop One. *How It Works*. Accessed February 2020: <u>https://hyperloop-one.com/facts-frequently-asked-questions</u>

³³ The Verge. A hyperloop in Missouri? A new study stays it's feasible, but not necessarily affordable, Oct 17,2018. Accessed February 2020: https://www.theverge.com/2018/10/17/17989504/virgin-hyperloop-one-missouri-feasibility-study

*Denotes: Vertical Clearances indicated are technology specific. Should there be a need to cross another railway, road, or utility, vertical clearances would need to comply with the design requirements of the intersecting facility.

Citations for Dallas to Fort Worth High-Speed Transportation Connections Study

^A "The Hyperloop" by Hardt Hyperloop, November 18, 2020

^B "The Hyperloop" by Hardt Hyperloop, November 18, 2020, "Cornering Radii and vehicle cant angle" chart – pg. 23

- ^c Hyperloop TT response to NCTCOG DFWHSTC Technology Forum Phase 1 Questions (December 2020)
- ^D Maglev 2000, Compare and Contrast Table for M2000 and Japanese Offerings (Dec2020 Rev5)

^E Siemens "IDOT_Charger Locomotive_Data Sheet 2021"

- ^F Siemens "Velaro_High Speet_Data Sheet 2021"
- ^G Virgin Hyperloop response to NCTCOG DFWHSTC Technology Forum Phase 1 Questions (December 2020)

^H Zeleros response to NCTCOG DFWHSTC Technology Forum Phase 1 Questions (December 2020)

Technology Review and Operational Characteristics Summary Table

The following table provides a summary version of *technology operational characteristics* outlined within the 2020 *Fort Worth to Laredo High-Speed Transportation Study* (highlighted in yellow) supplemented by information provided by high-speed transportation technology providers participating in the *Dallas to Fort Worth High-Speed Transportation Connections Study* Technology Forum (highlighted in blue).

| | High-Speed Rail | Maglev | Hyperloop |
|------------------------------|--|---|---|
| Operating | 186-205 ³⁴ | 220 ³⁵ - 311 ³⁶ mph | Up to 670 mph ³⁷ |
| Speed | 220 mph ^F | 300 – 350 mph ^D | 621 mph ^A |
| Typical Station Distances | 20 to 100 miles, up to 250 miles ³⁸ | 10 to 100 miles; up to 180 miles ³⁹ | Undetermined; range from 10 to 250 miles up to 500 miles. |
| Distances | | | |
| | 400-1300 passengers depending on trainset configuration ^{40 41} | 400-1300 passengers depending on trainset configuration ⁴² | Estimated 28-40 per pod |
| Vehicle Capacity or | | | 60 per vehicle ^A 20,000 - 40,000 /hour ^A |
| Capacity Per Trainset | 420-500 passengers per 8- car trainset ^E | | 50 per vehicle ^c 4,500 pphpd/tube ^c |
| | | | 28 per pod ^G 16,000 pphpd ^G |
| | | | 4,800 pphpd ^H |
| Headway | Shinkansen System As low as every 3 minutes. Dallas to Houston HSR will run every 30 minutes during peak times and 1 hour in off-peak | Typical 15-20 minutes | Anticipated ever 1-3 minutes |
| | | | 5 minutes or faster ^A 2 minutes ^C 4 seconds ^G 2.5 minutes ^H |
| Typical Fare | Approximately \$0.25 – \$0.40 per mile in Europe and Asia. Intended to compete with short haul air travel | Typical fare for the Shanghai Maglev ranges from \$10 to \$30 | Unknown; anticipated to compete with air travel |
| | | | |
| | Limited ⁴³⁴⁴ | Unknown | Yes |
| Freight Service | | | |
| Other | Acceleration 0.503 m/s ^{2 1} | | Acceleration 0.15 G (longitudinal) ^{A C} 0.20 G (longitudinal) ^G 1.50 m/s ² (0.15 G) ^H 0.10 G (lateral) ^A |

| Other Information | | 0.05 G (lateral) ^C |
|----------------------|---|--|
| | Braking 0.322 mph/s ^{2 1} (0.72 m/s ²) ¹ | Emergency Braking 1.2 G ^A 0.6 G ^C 0.4 G ^H |
| | | Operating Cost \$0.10/ton mile (freight) \$0.112/seat mile (passengers) (2030\$) ^C \$0.11M / year ^H |

³⁴ FRA. Dallas to Houston High-Speed Rail Draft Environmental Impact Study, Final Draft Conceptual Engineering Report-FDCEv7, 15 September 2017, p27. Accessed February 2020:

https://cms8.fra.dot.gov/sites/fra.dot.gov/files/fra_net/17677/31%20Dallas%20to%20Houston%20High%20Speed%20Rail%20DEIS%20Appendix%20F_TCRR% 20FDCE%20v7%20REPORT.pdf

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³⁹ Central Japan Railway Company. About the Chuo Shinkansen Project. Accessed February 2020: https://scmaglev.jr-central-global.com/faq/

⁴⁰ FRA. Dallas to Houston High-Speed Rail Draft Environmental Impact Study, Final Draft Conceptual Engineering Report-FDCEv7, 15 September 2017, p17. Accessed February 2020:

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⁴¹ Central Japan Railway Company. About the Shinkansen, Accessed February 2020: https://global.jr-central.co.jp/en/company/about shinkansen/

⁴² Central Japan Railway Company. About the Chuo Shinkansen Project. Accessed February 2020: https://scmaglev.jr-central-global.com/faq/

⁴³ TGV Mail Service https://www.railjournal.com/freight/last-post-for-french-high-speed-freight-as-postal-tgvs-bow-out/

⁴⁴ Shinkansen food https://www.railjournal.com/freight/last-post-for-french-high-speed-freight-as-postal-tgvs-bow-out/

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^G Virgin Hyperloop response to NCTCOG DFWHSTC Technology Forum Phase 1 Questions (December 2020)

^H Zeleros response to NCTCOG DFWHSTC Technology Forum Phase 1 Questions (December 2020)

¹ Talgo response to NCTCOG DFWHSTC Technology Forum Phase 3 One-On-One Session (January 2021)

STATE OF TEXAS NORTH CENTRAL TEXAS COUNCIL OF GOVERNMENTS

INDEX OF SHEETS

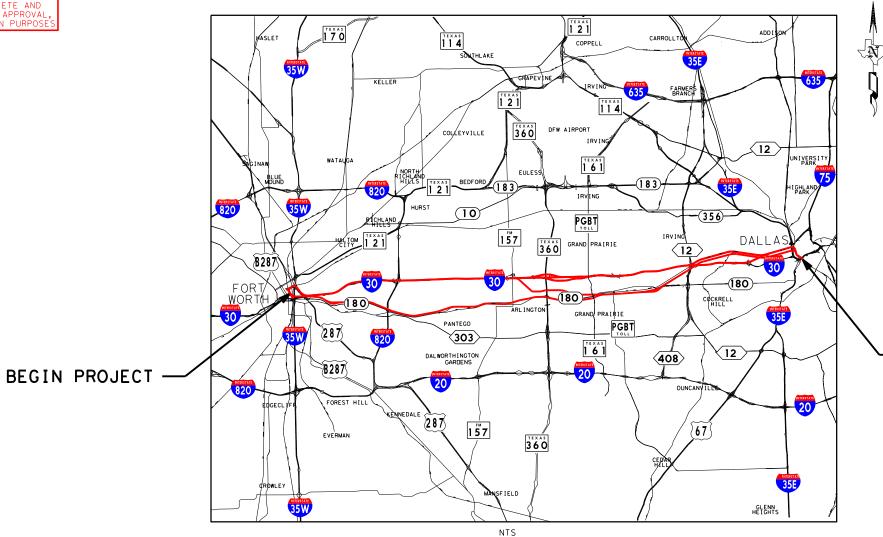
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| 85 | DOWNTOWN FORT WORTH ALTERNATIVES |
| 86 | DOWNTOWN DALLAS ALTERNATIVES |

5% DESIGN SUBMITTAL By: ISRAEL M. W. CROWE P.E.#<u>89251</u> Date: <u>8/16/2021</u> NOT TO BE CONSTRUED AS COMPLETE AND OT TO BE USED FOR REGULATORY APPROVAL RMIT, BIDDING OR CONSTRUCTION PURPOSE

PLANS OF PROPOSED HIGH-SPEED TRANSPORTATION

DALLAS-FORT WORTH HIGH-SPEED TRANSPORTATION CONNECTION DALLAS / TARRANT COUNTY

LIMITS: DOWNTOWN FORT WORTH TO DOWNTOWN DALLAS



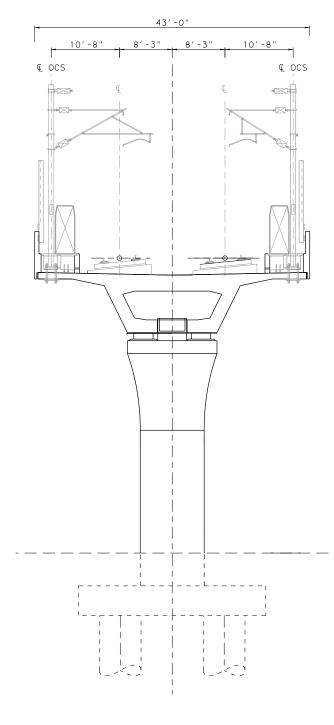


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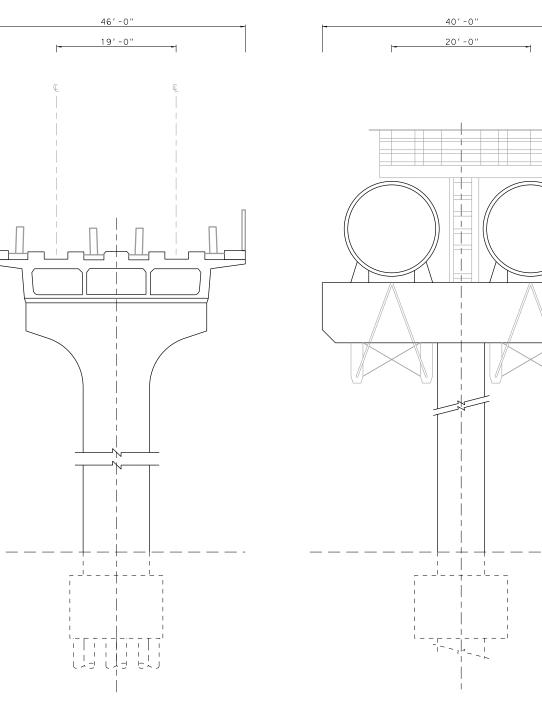
HNTB Corporation The HNTB Companies Engineers Architects Planners Firm Registration Number 420



HIGH-SPEED RAIL

MAGNETIC LEVITATION

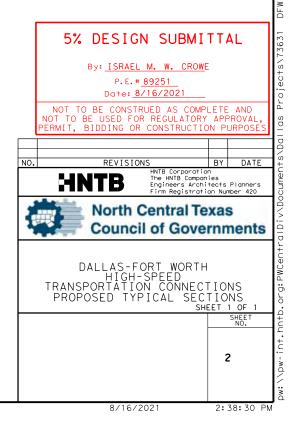
HYPERLOOP

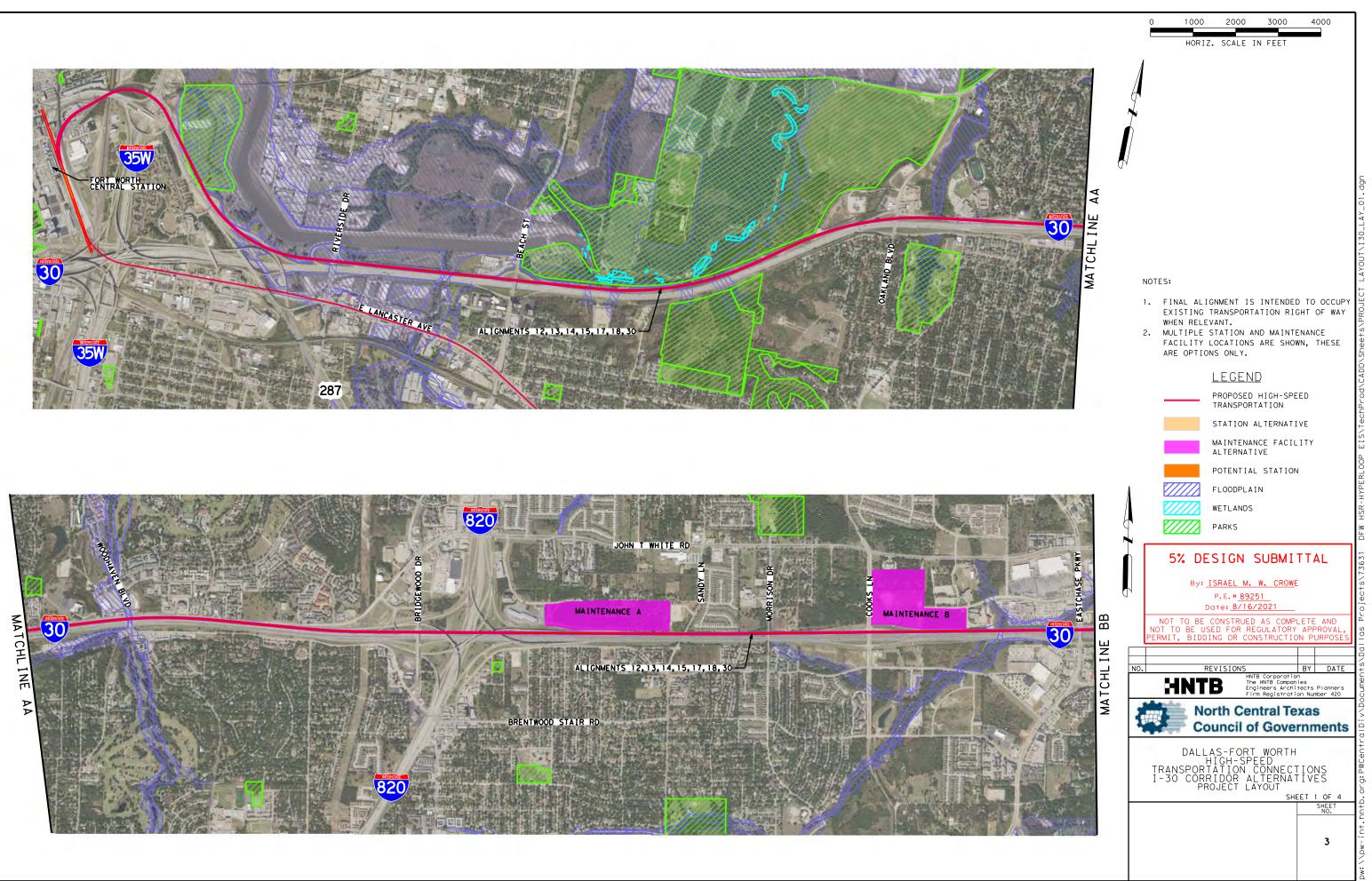


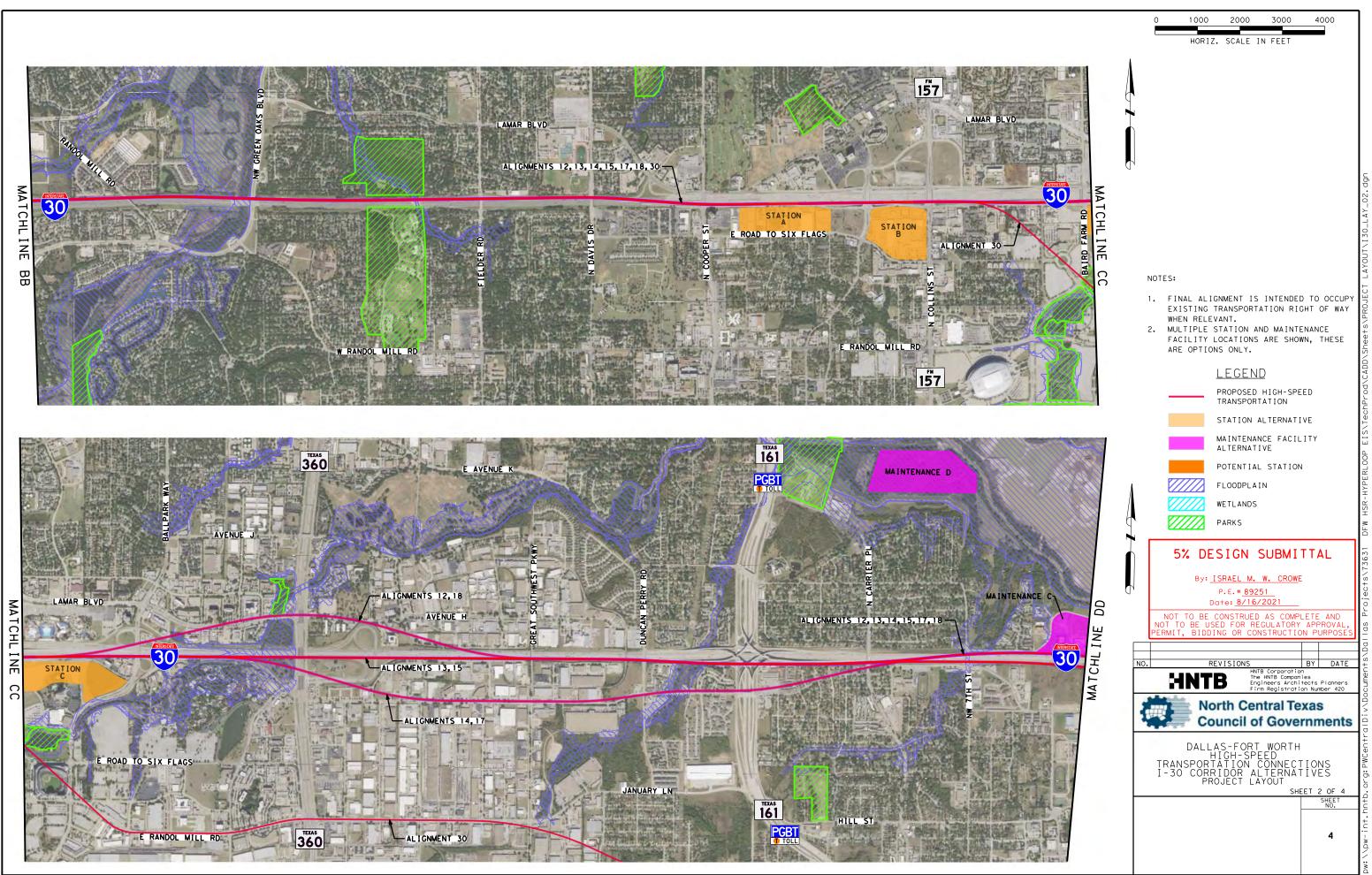


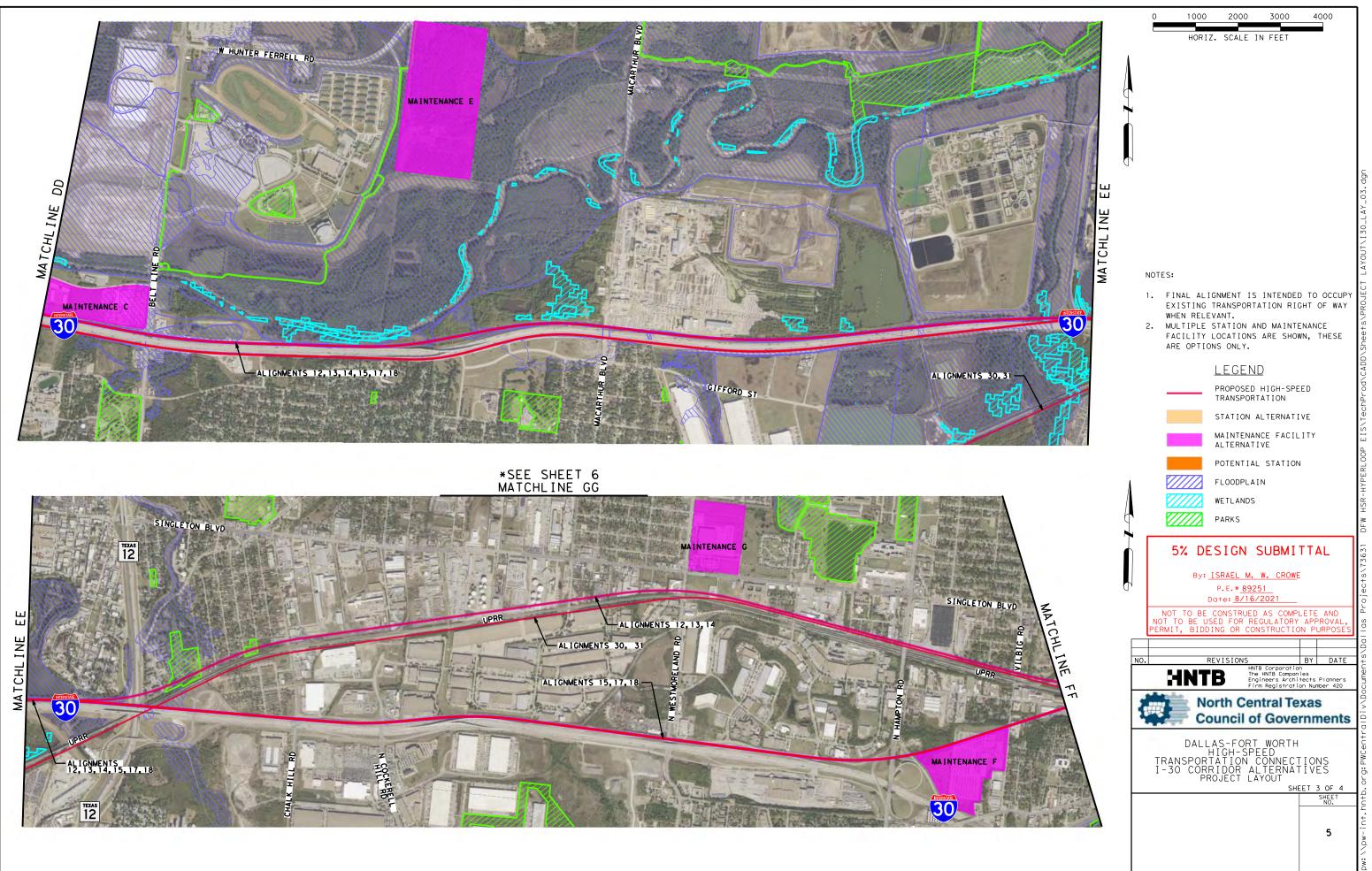
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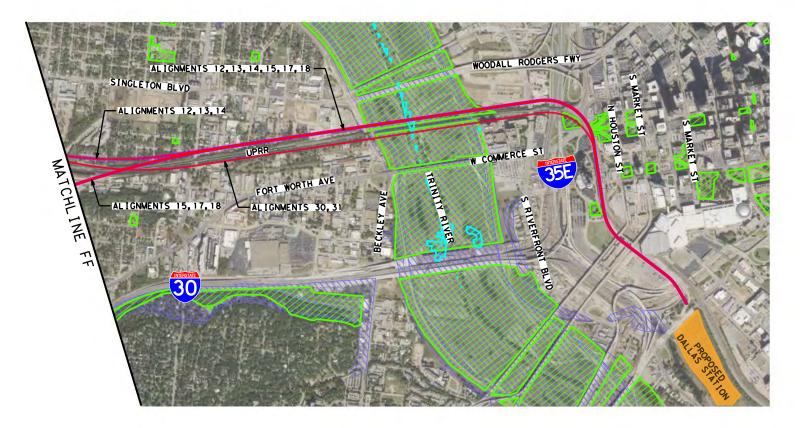
TYPICAL SECTIONS REPRESENT AERIAL, GRADE-SEPARATED CORRIDORS. MORE OPTIONS MAY BE DEVELOPED AFTER FURTHER REVIEW.

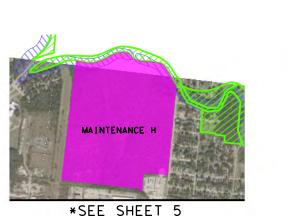












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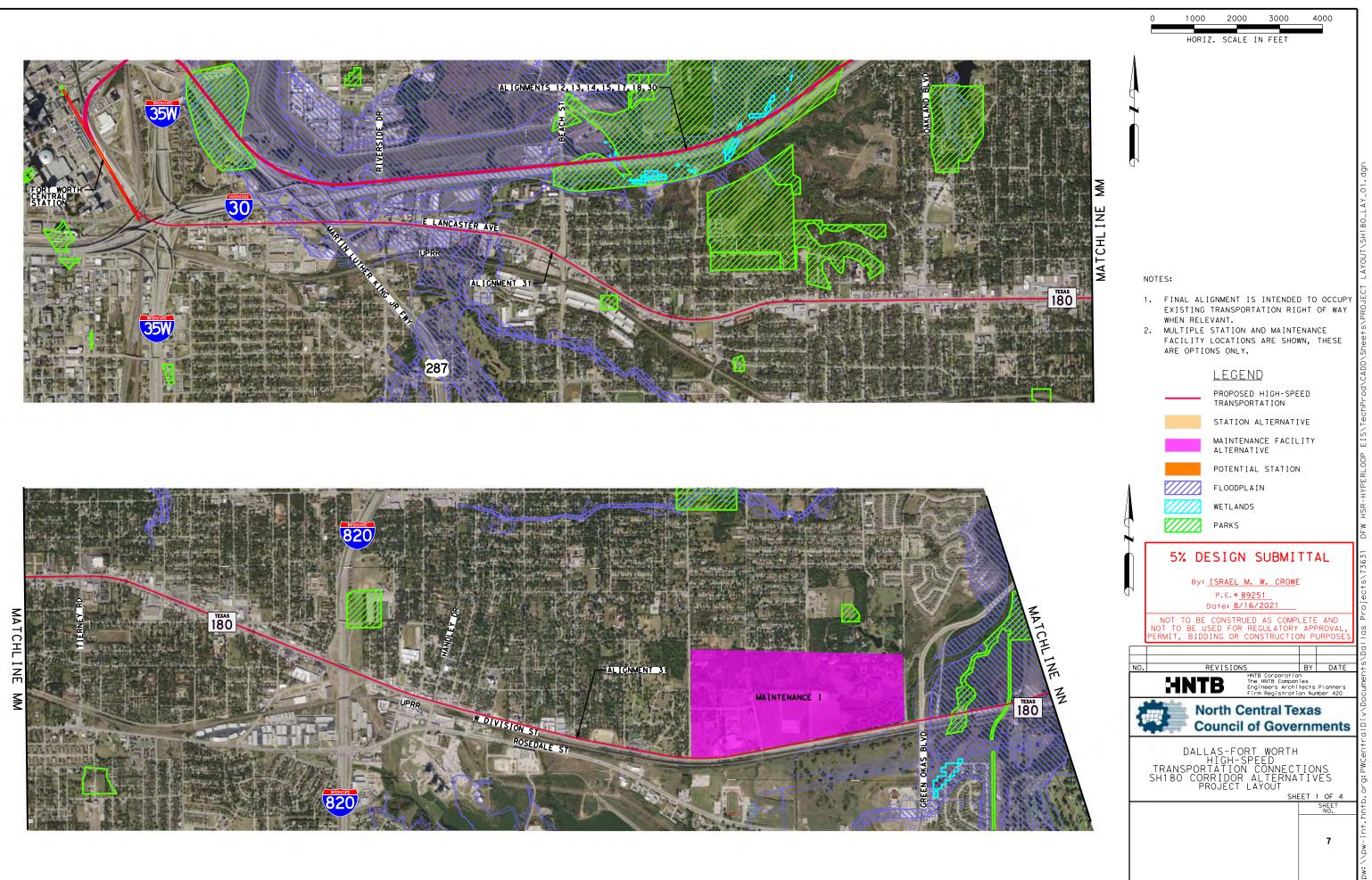
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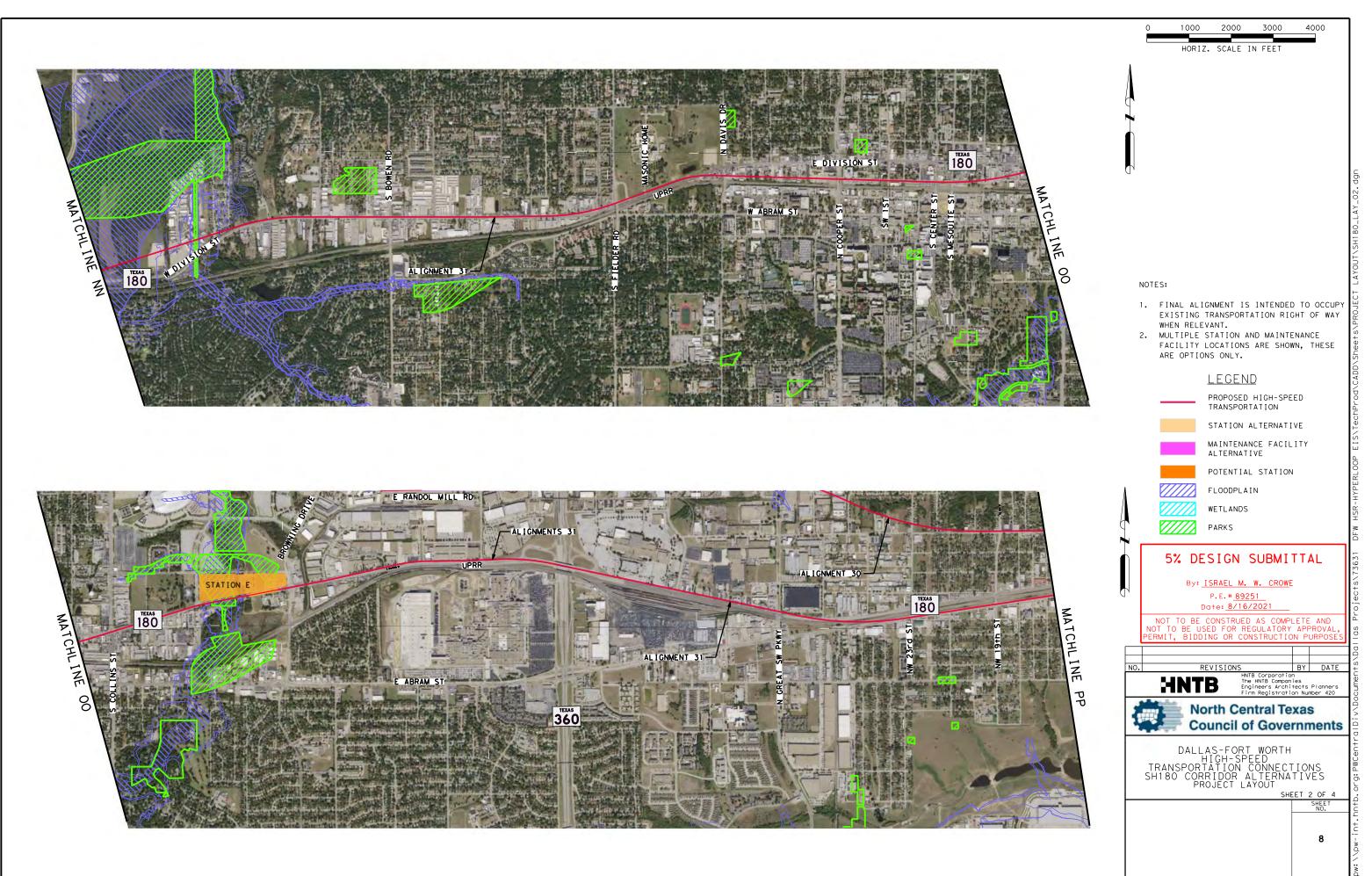
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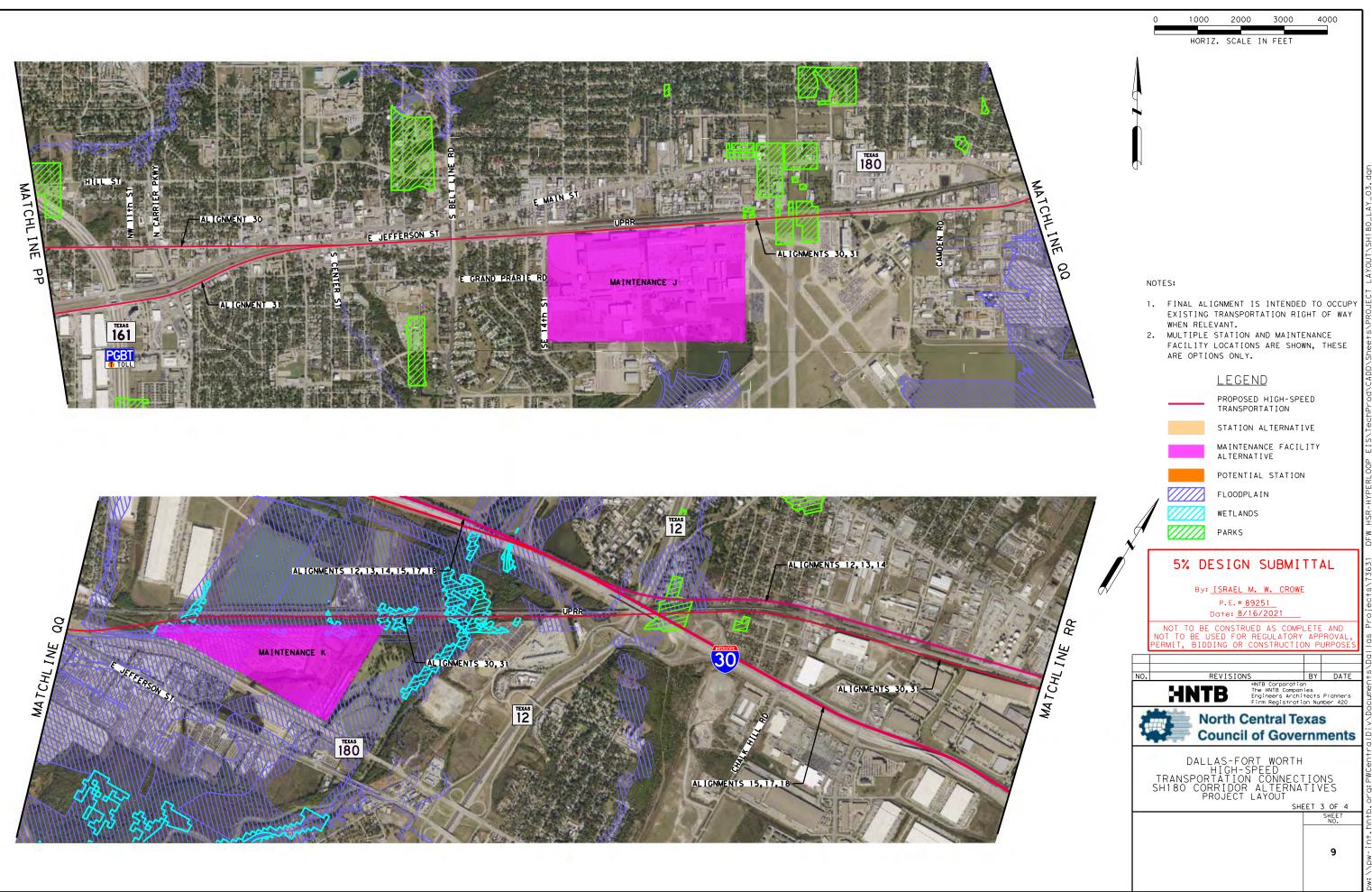
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- 2. MULTIPLE STATION AND MAINTENANCE FACILITY LOCATIONS ARE SHOWN, THESE ARE OPTIONS ONLY.

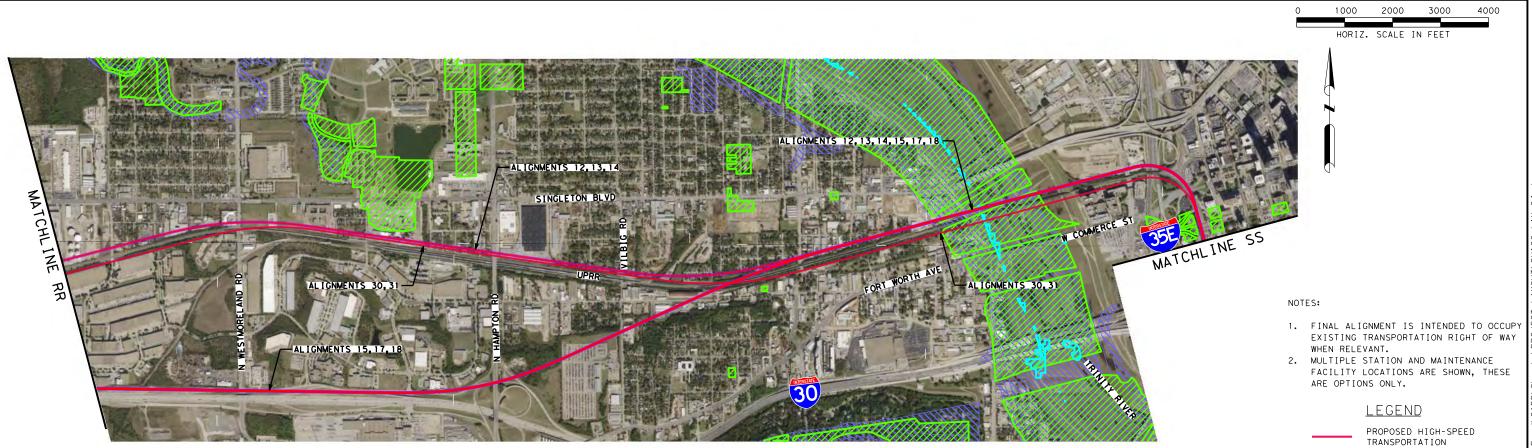














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- MAINTENANCE FACILITY ALTERNATIVE
- POTENTIAL STATION

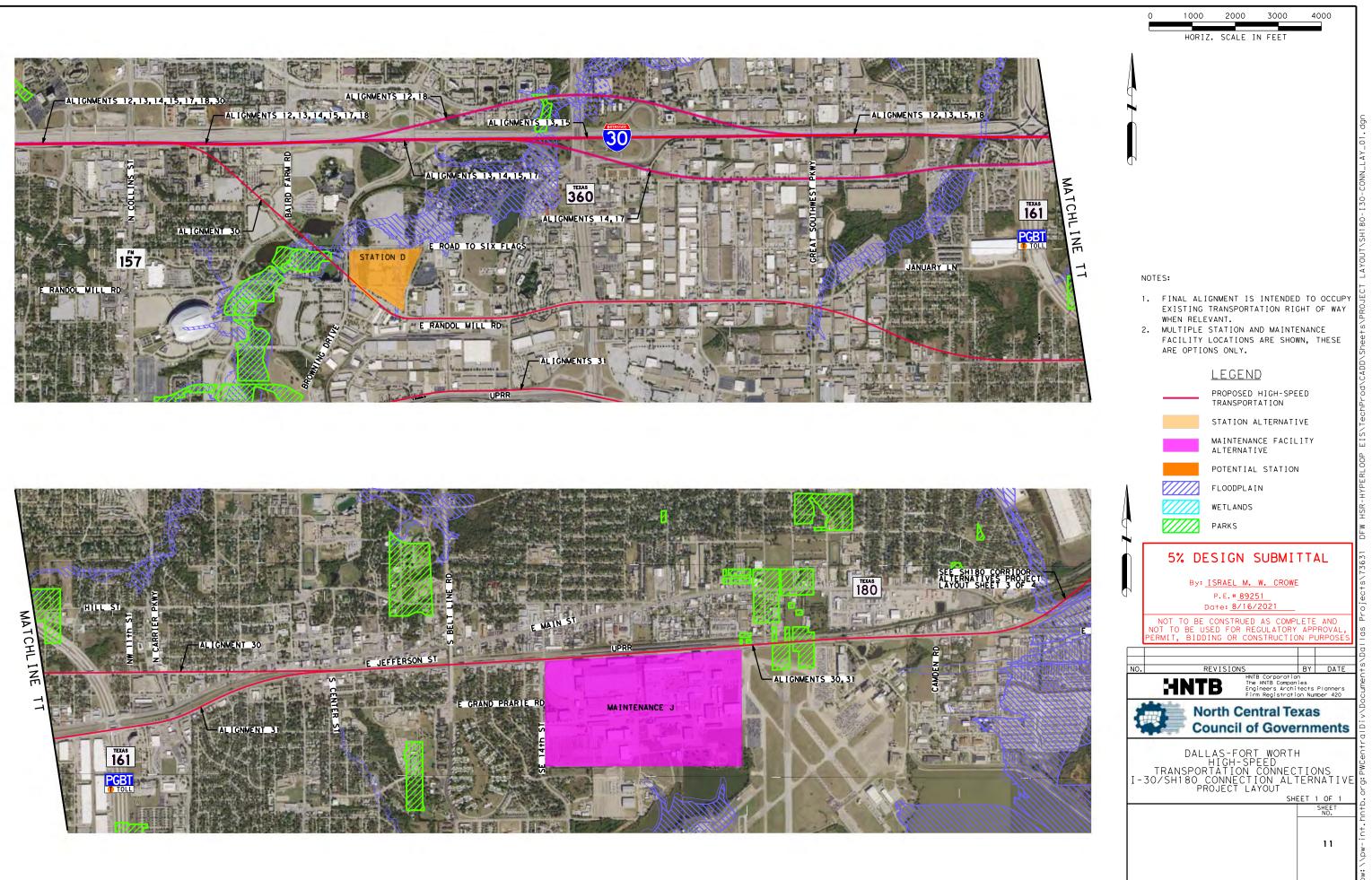


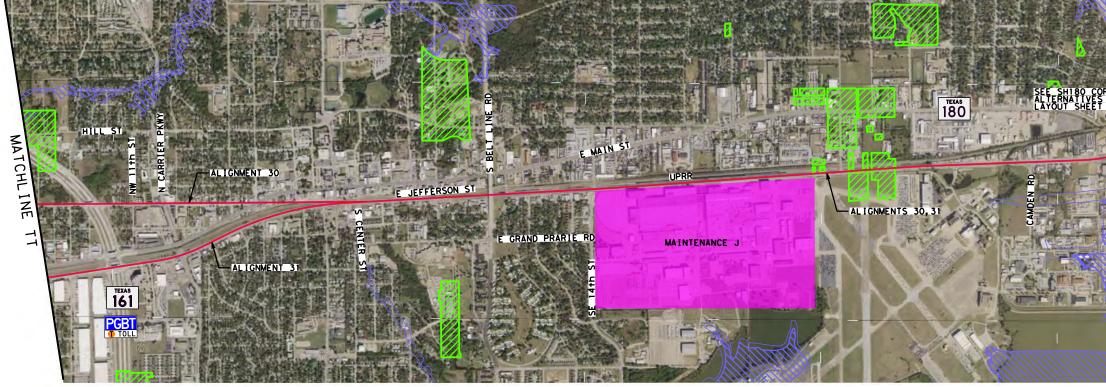
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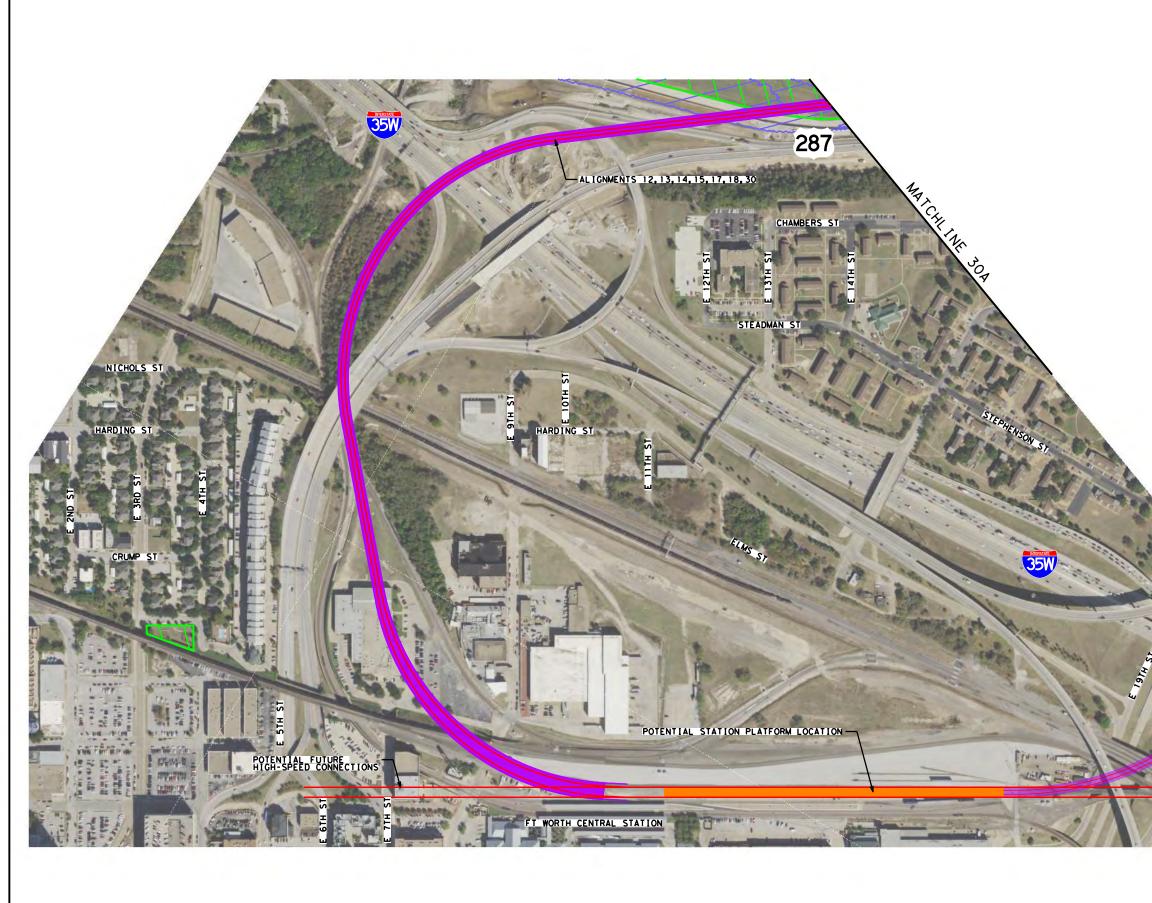
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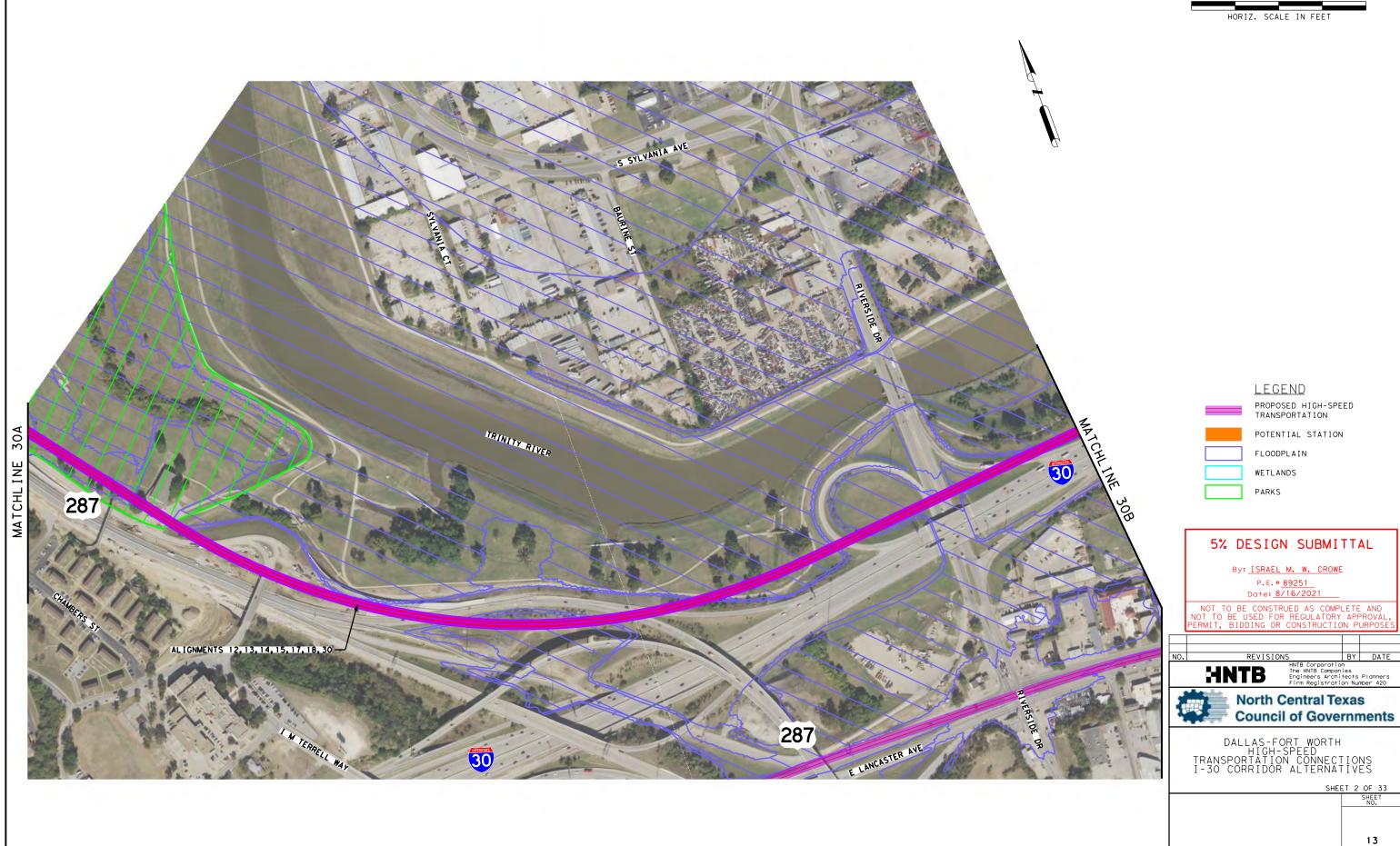




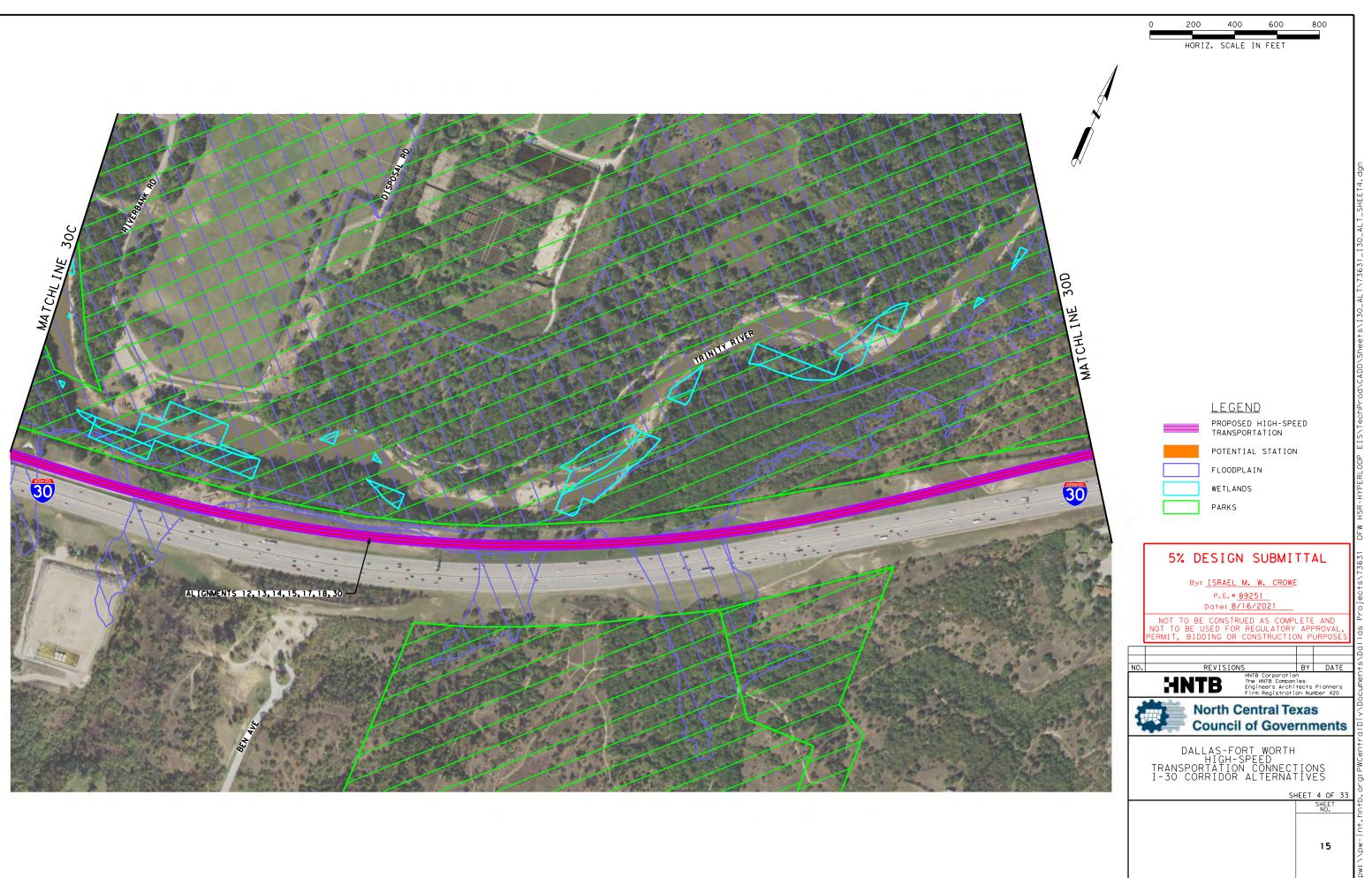


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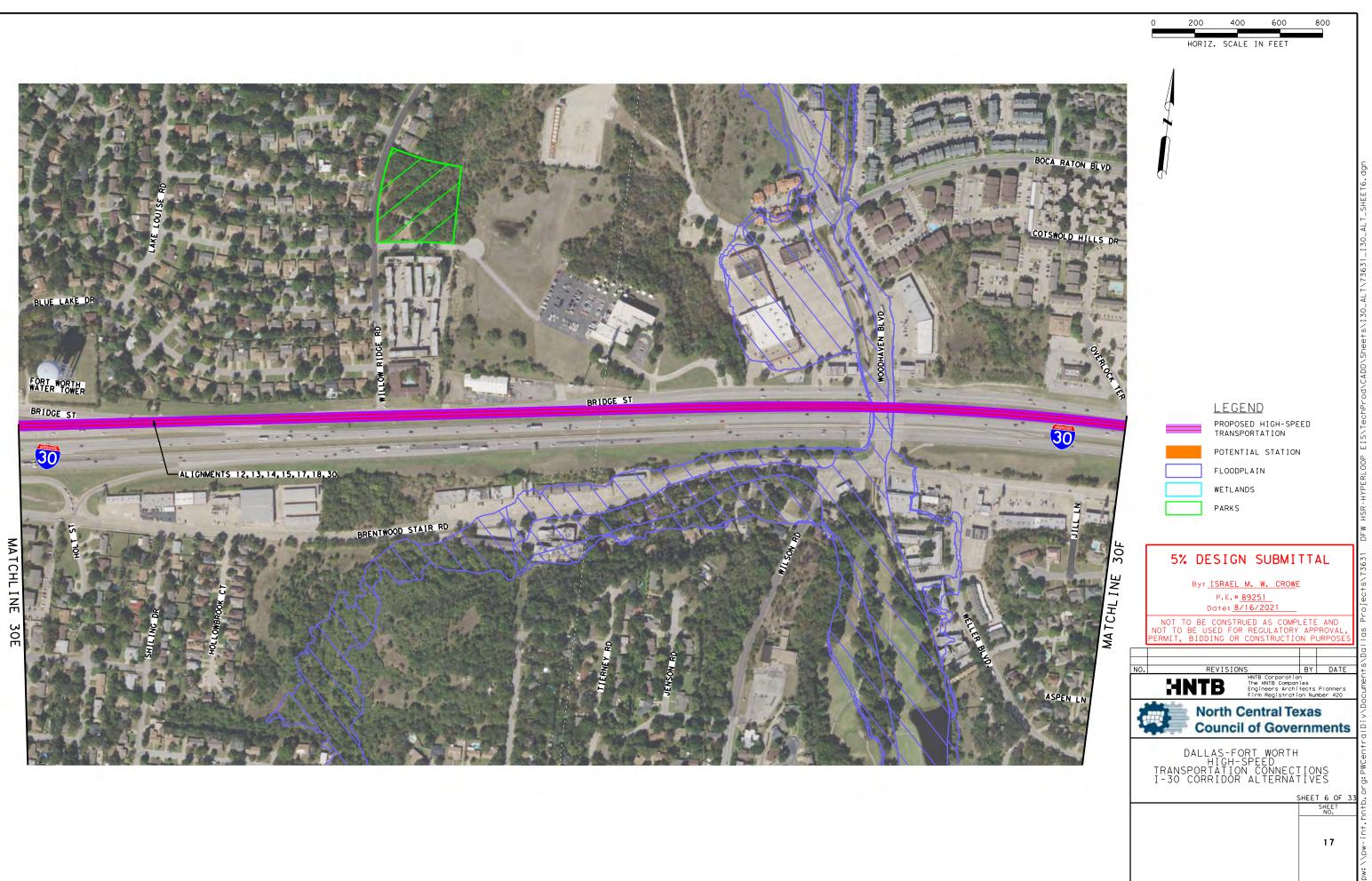
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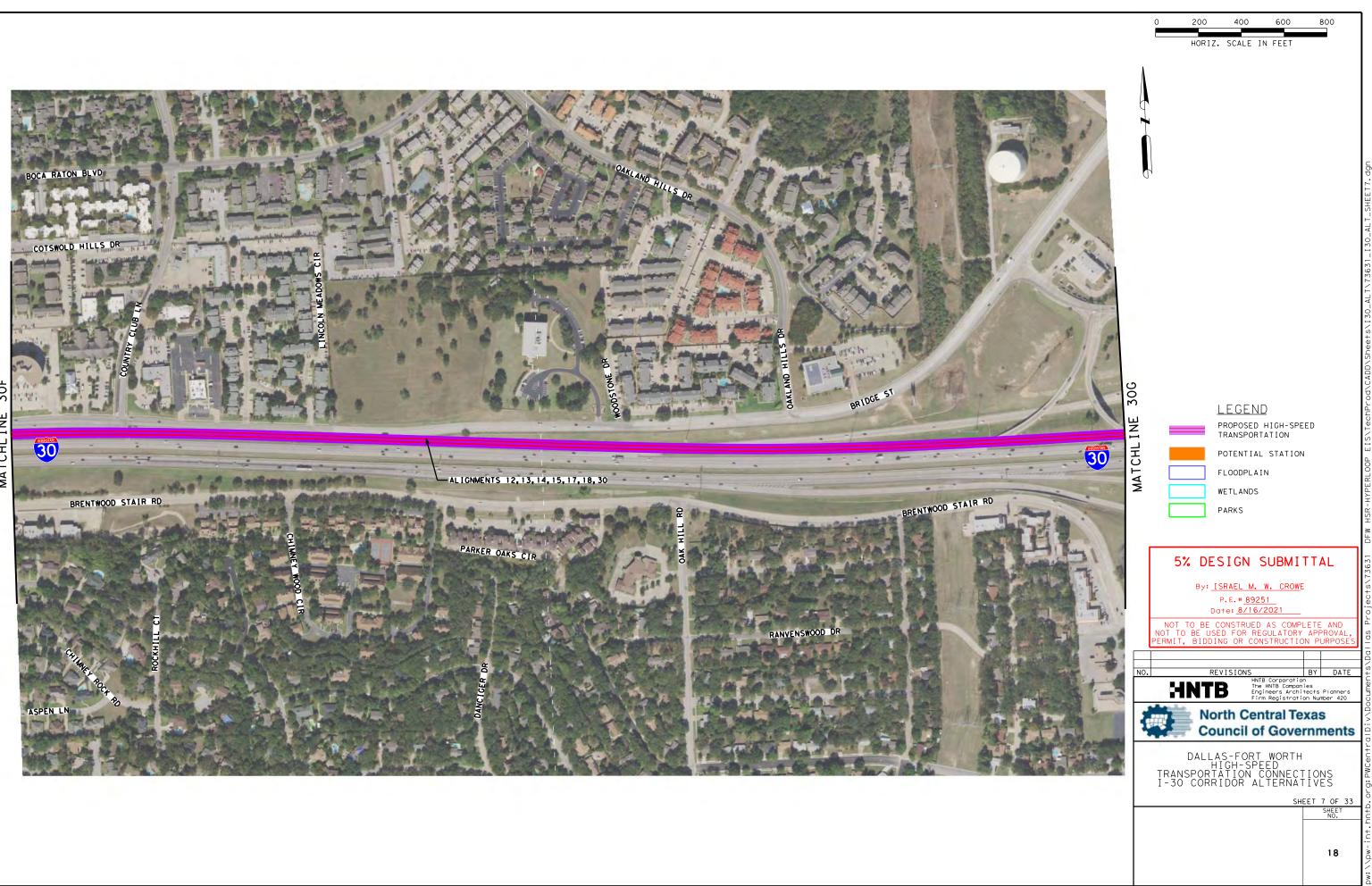




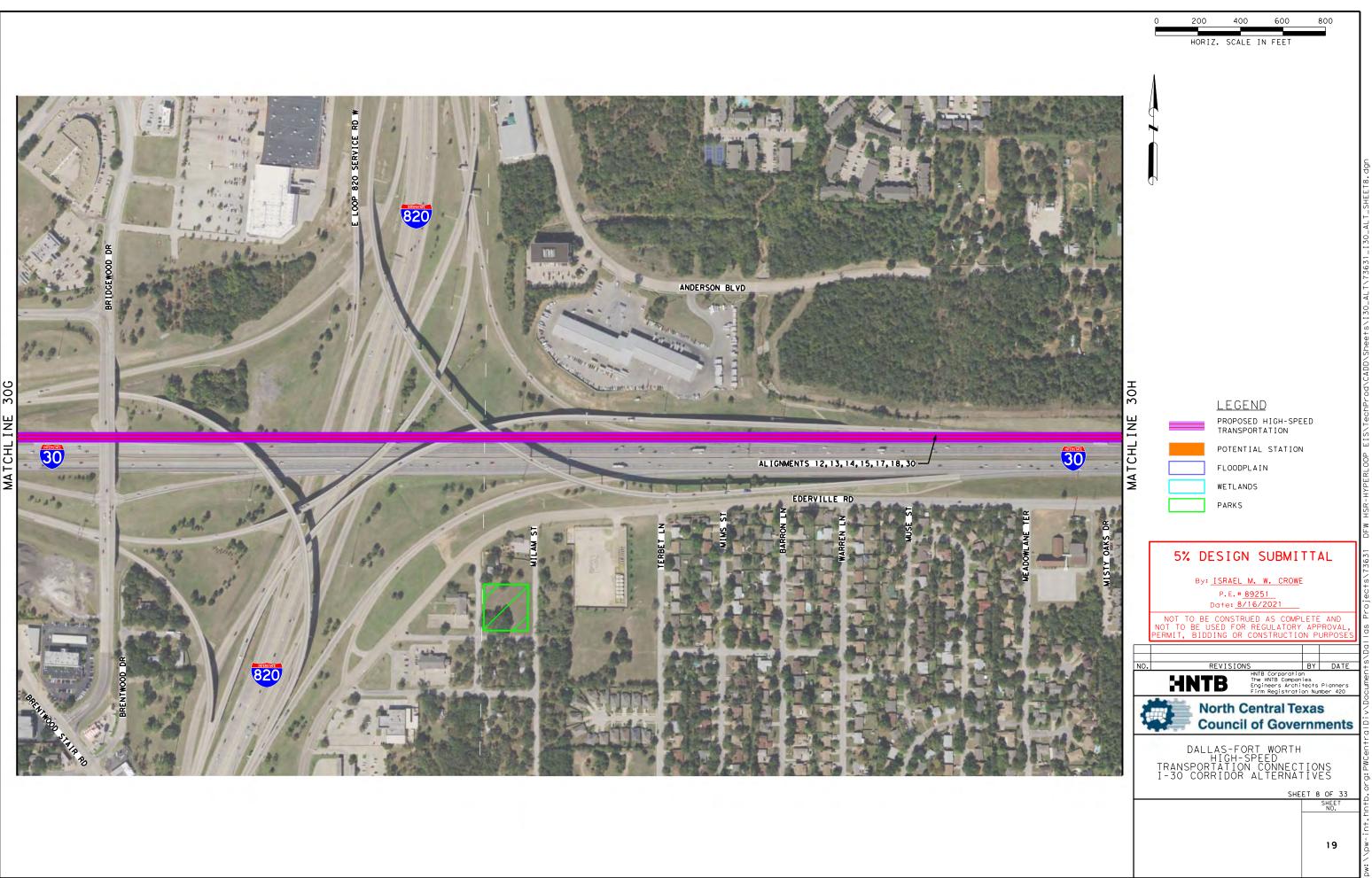


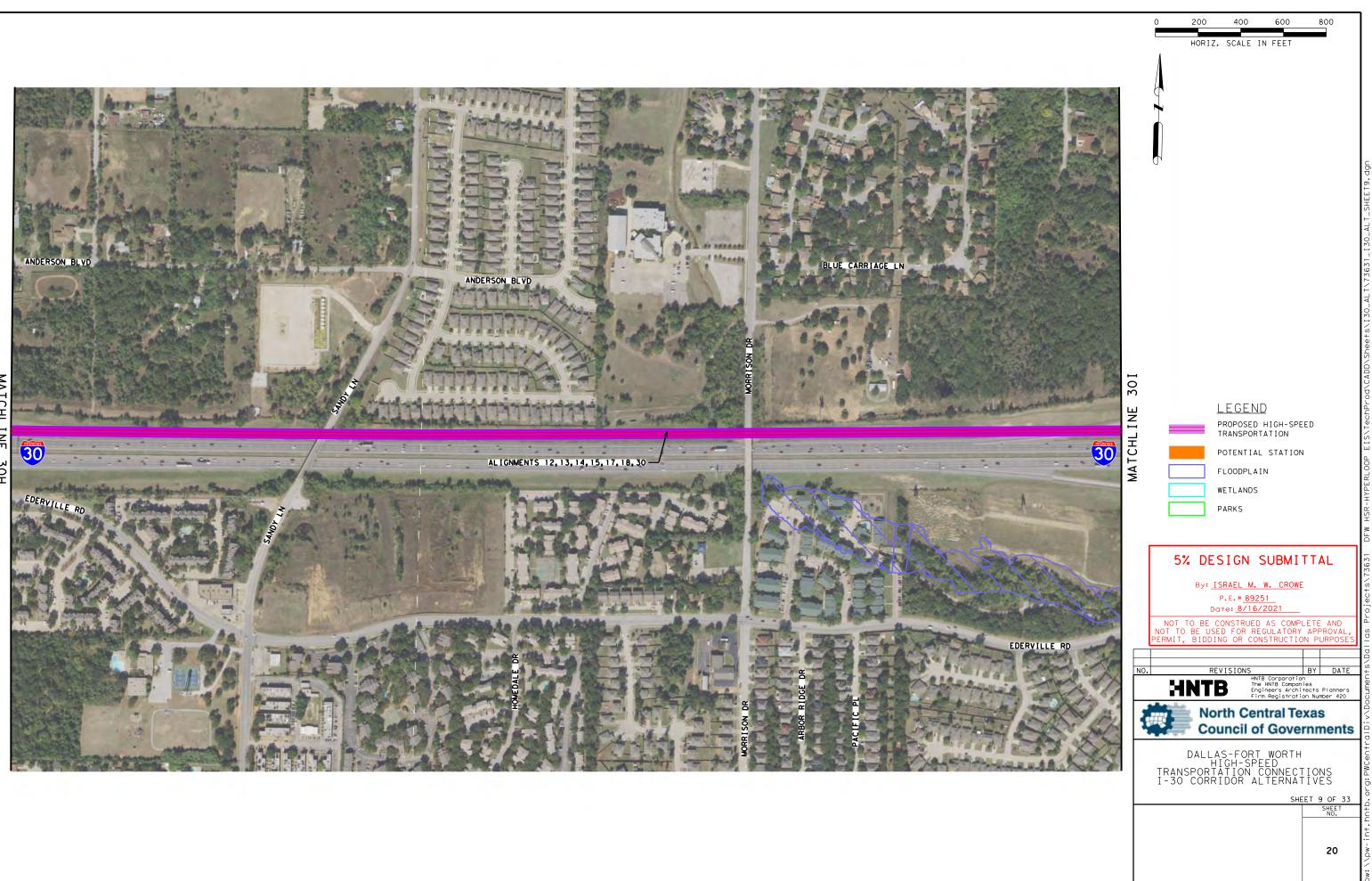


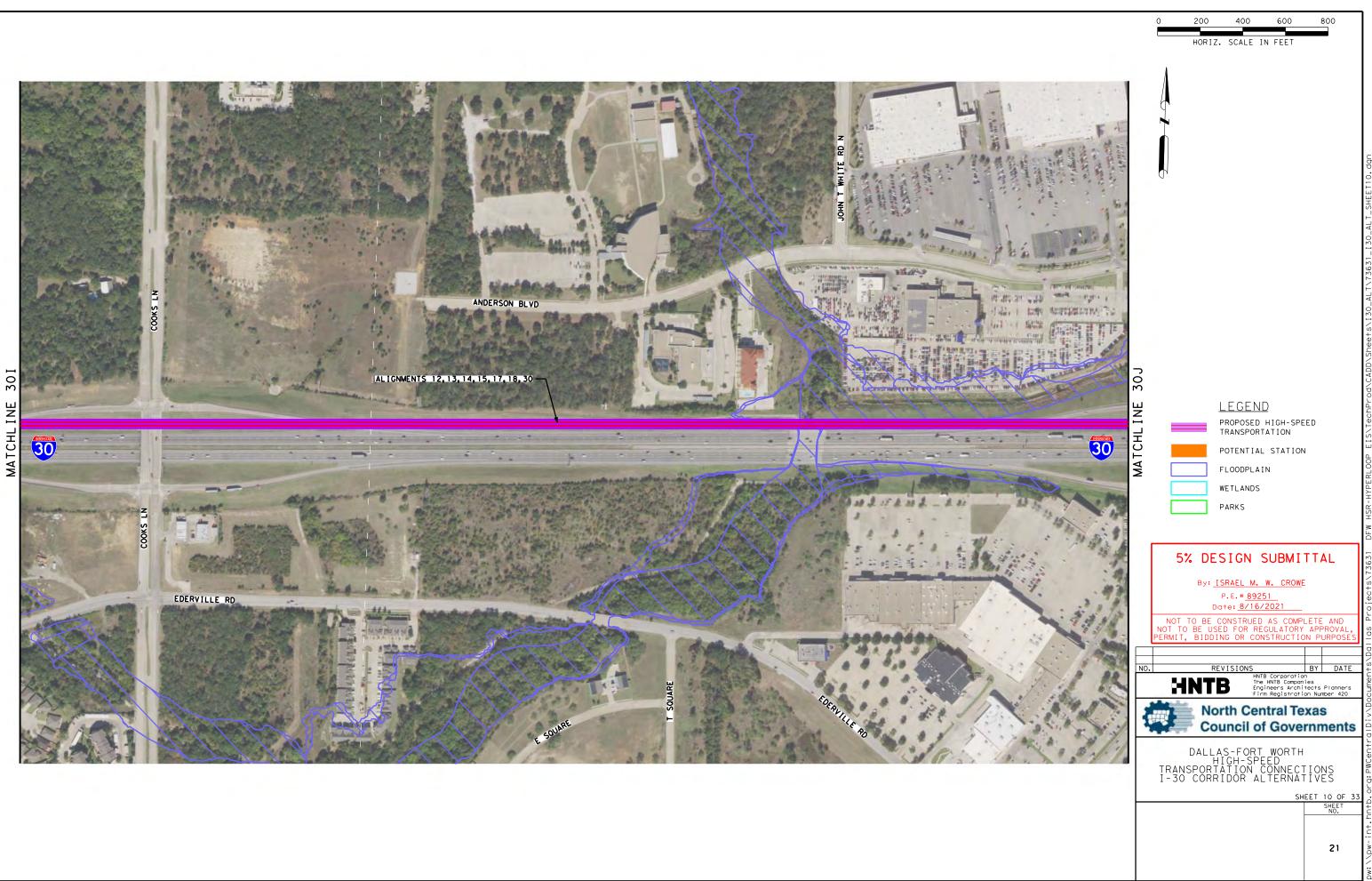


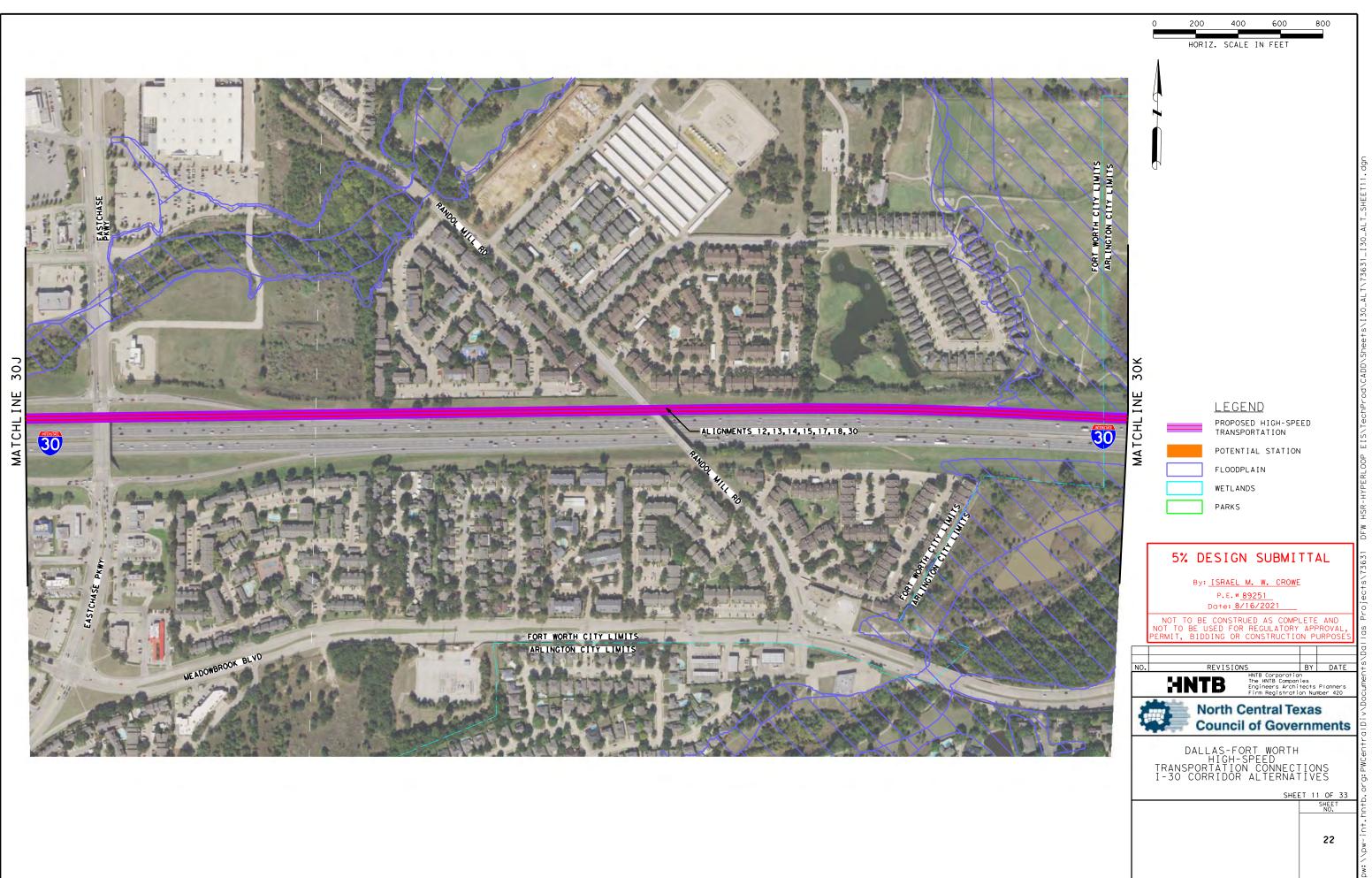


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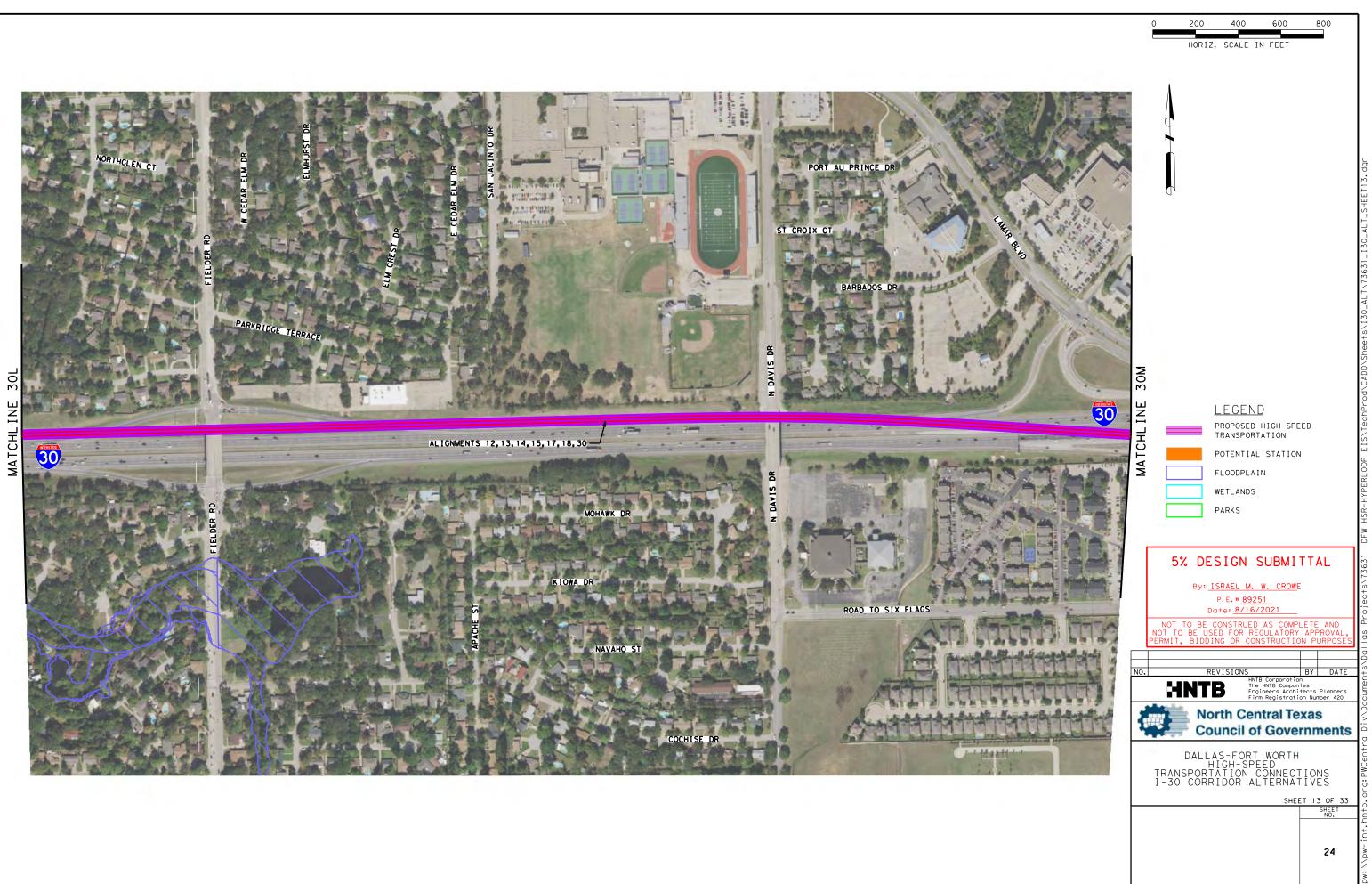


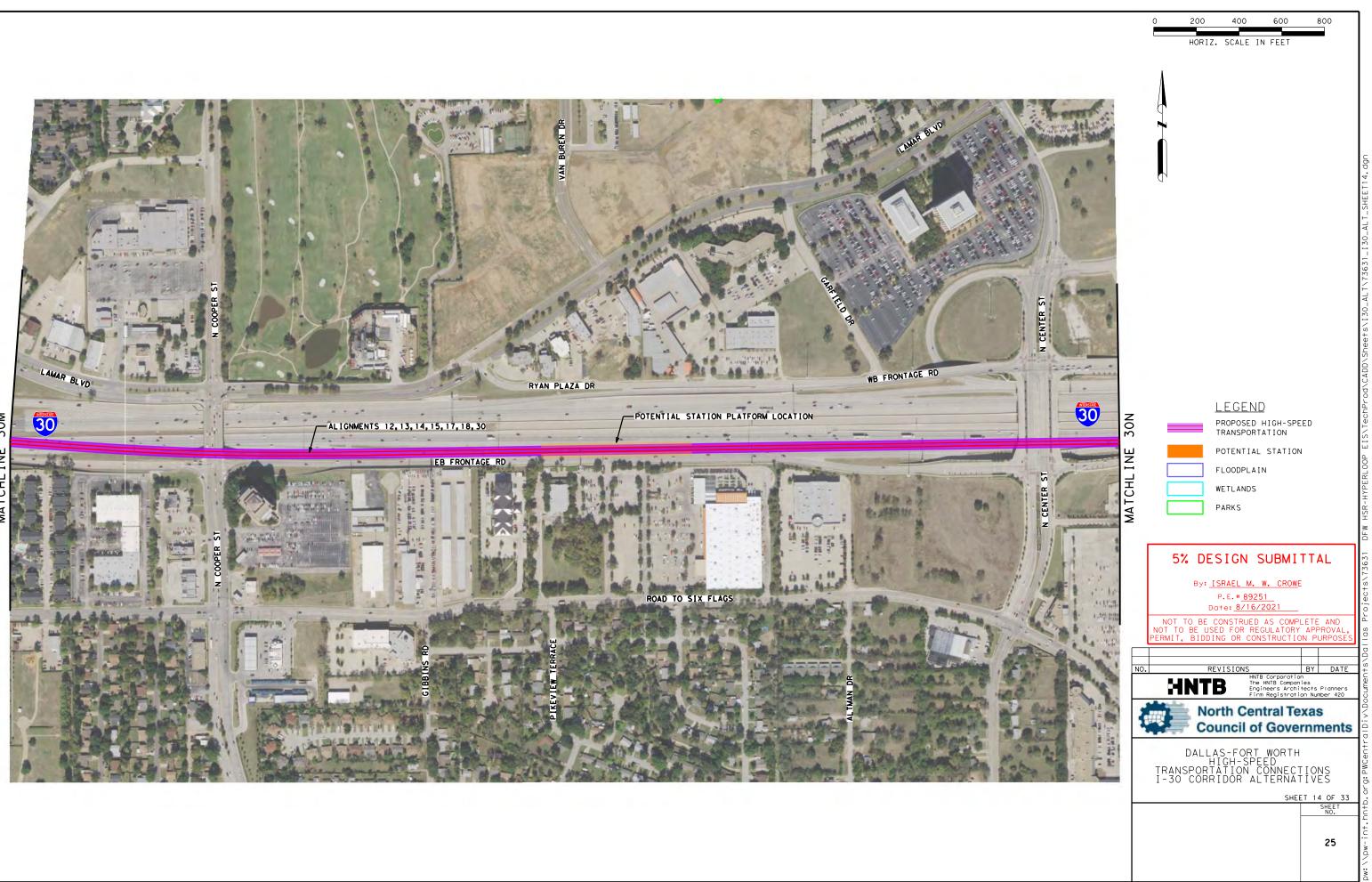


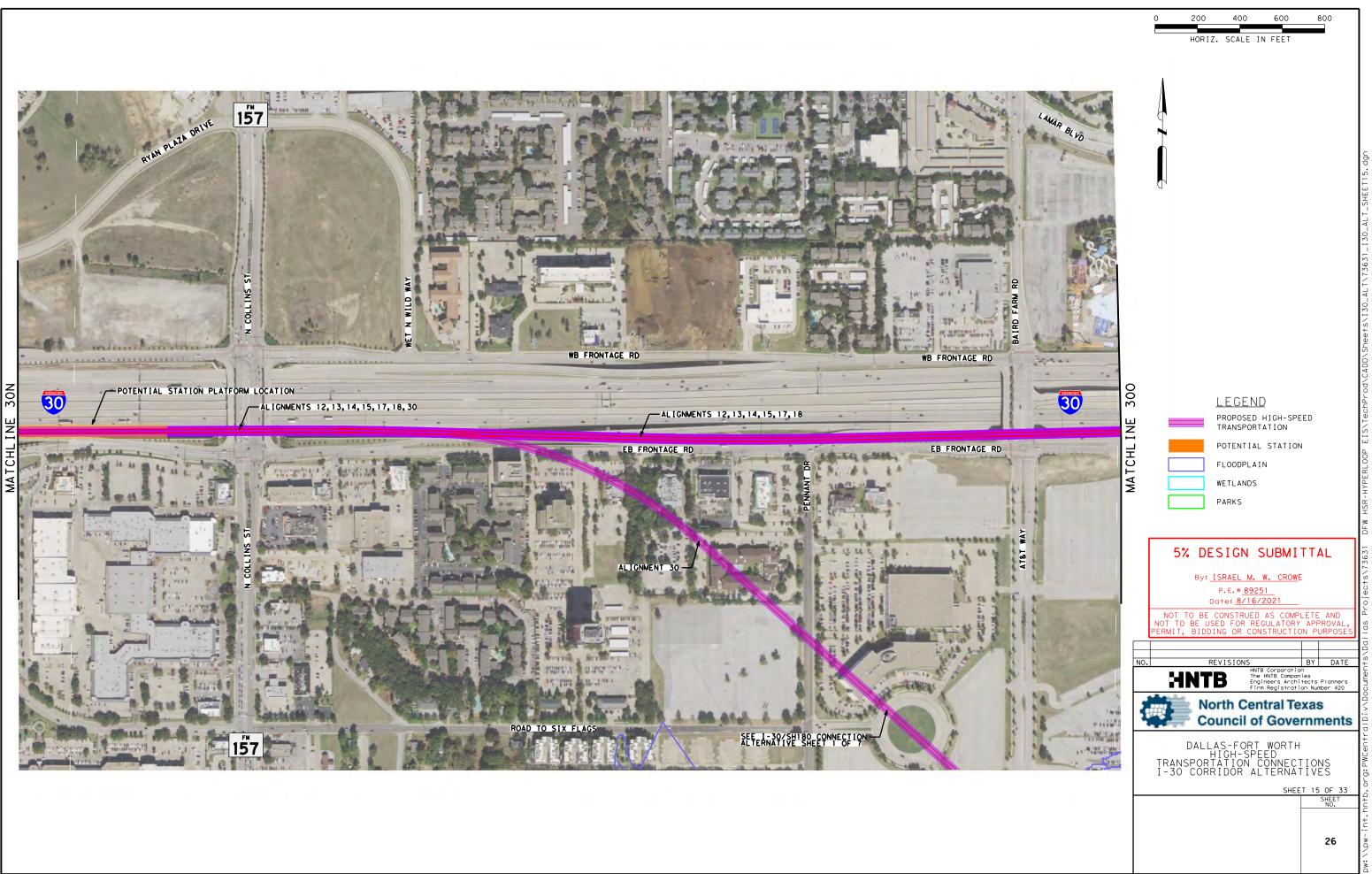


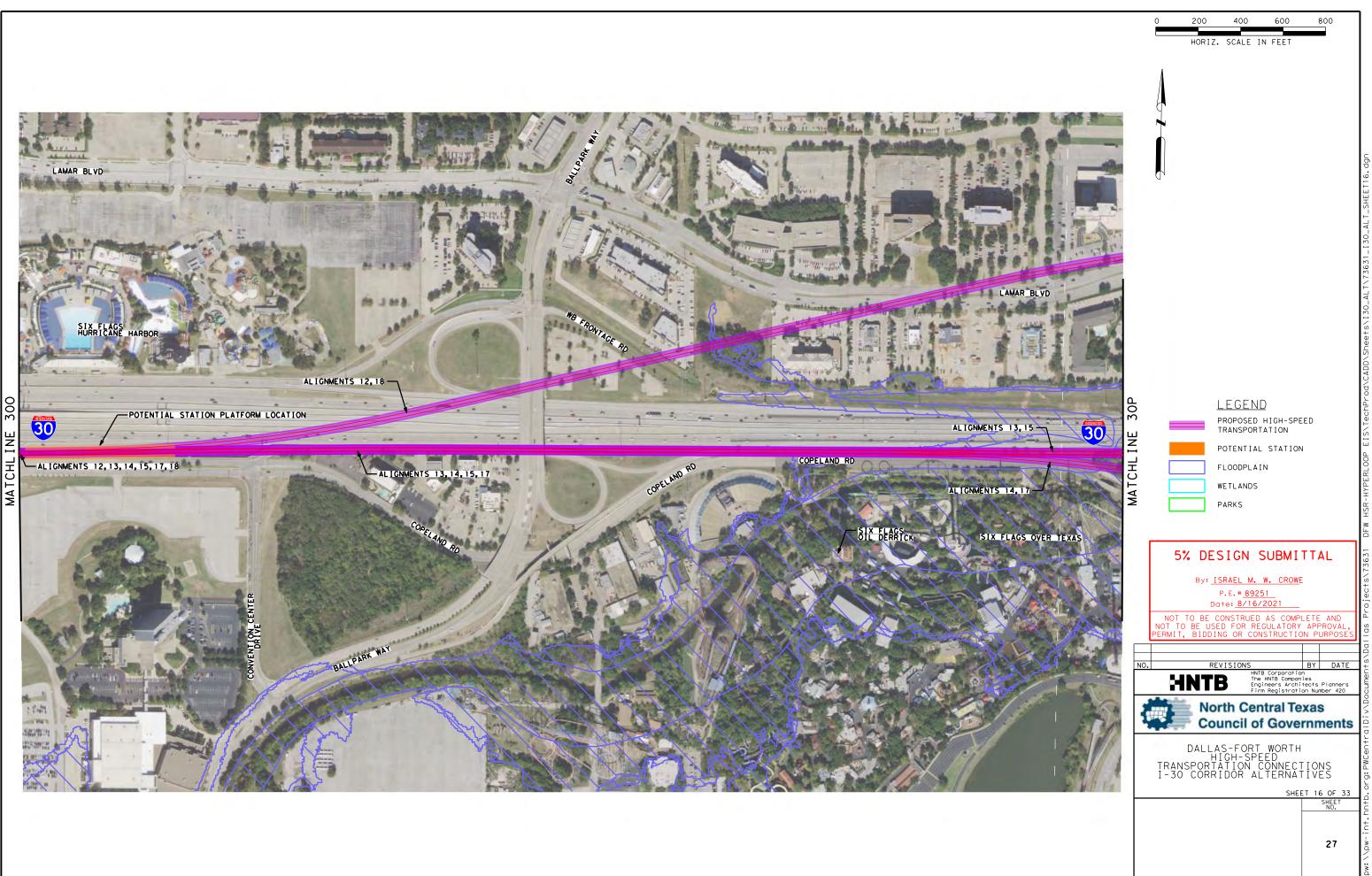


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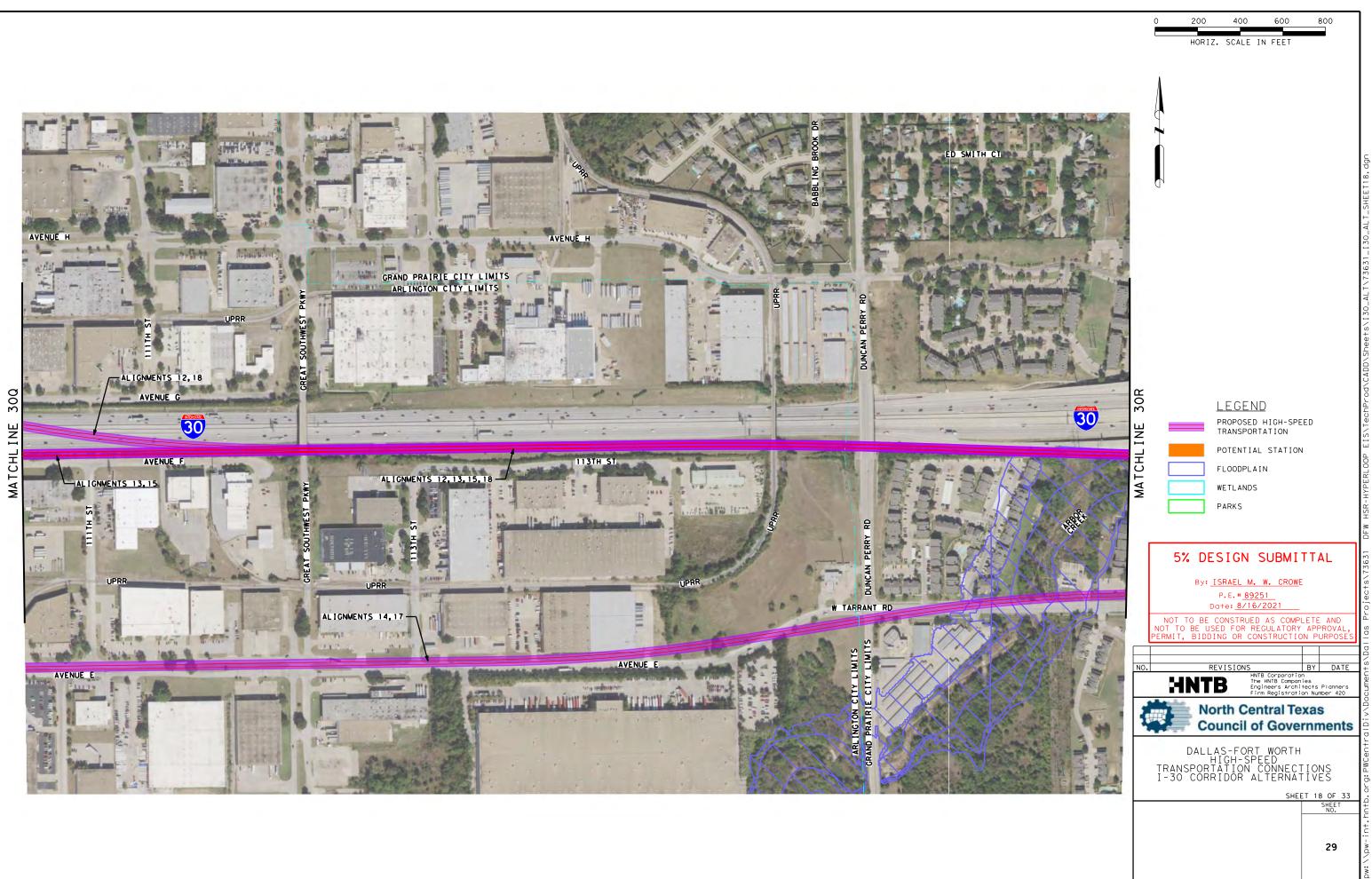


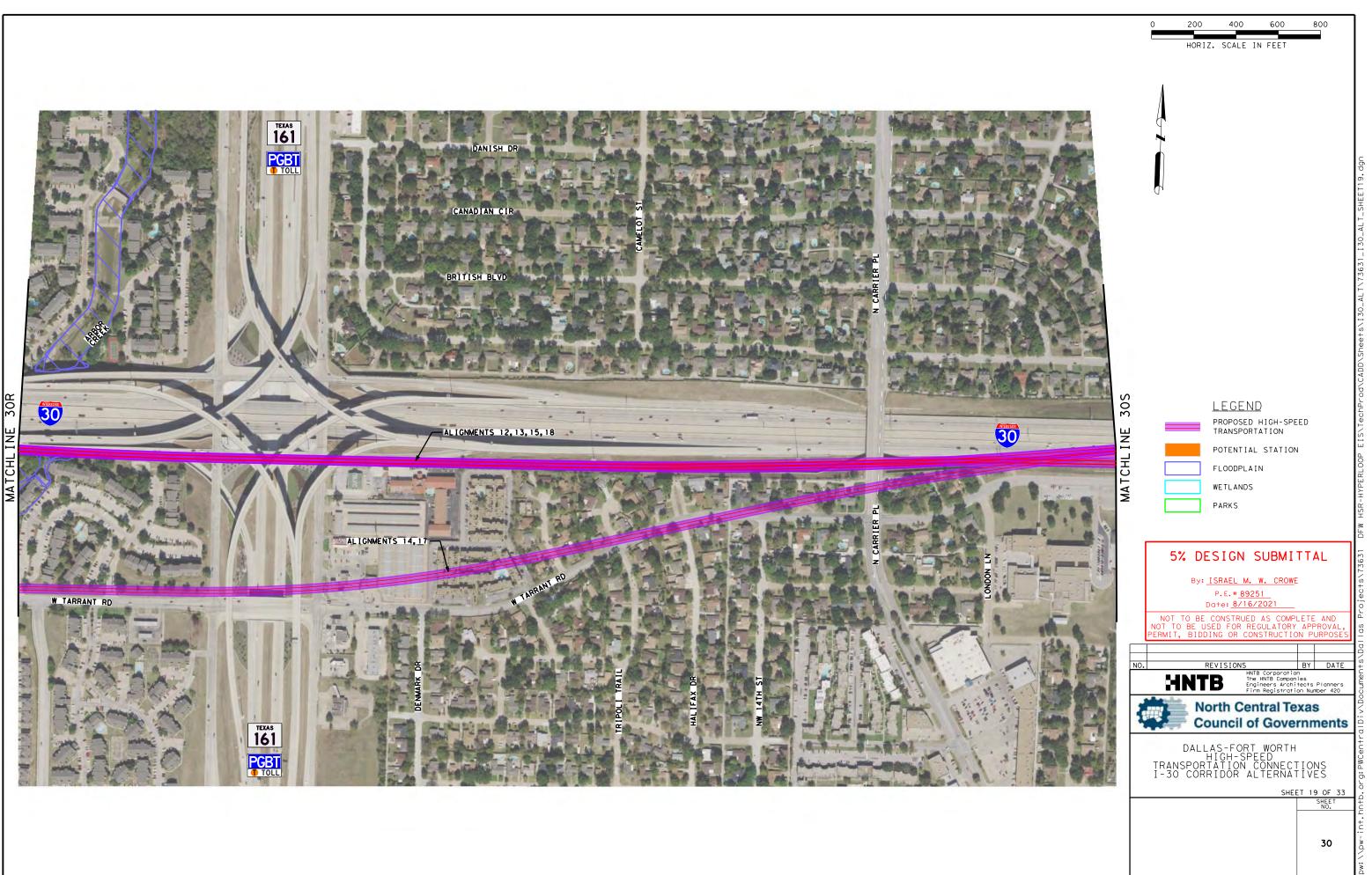


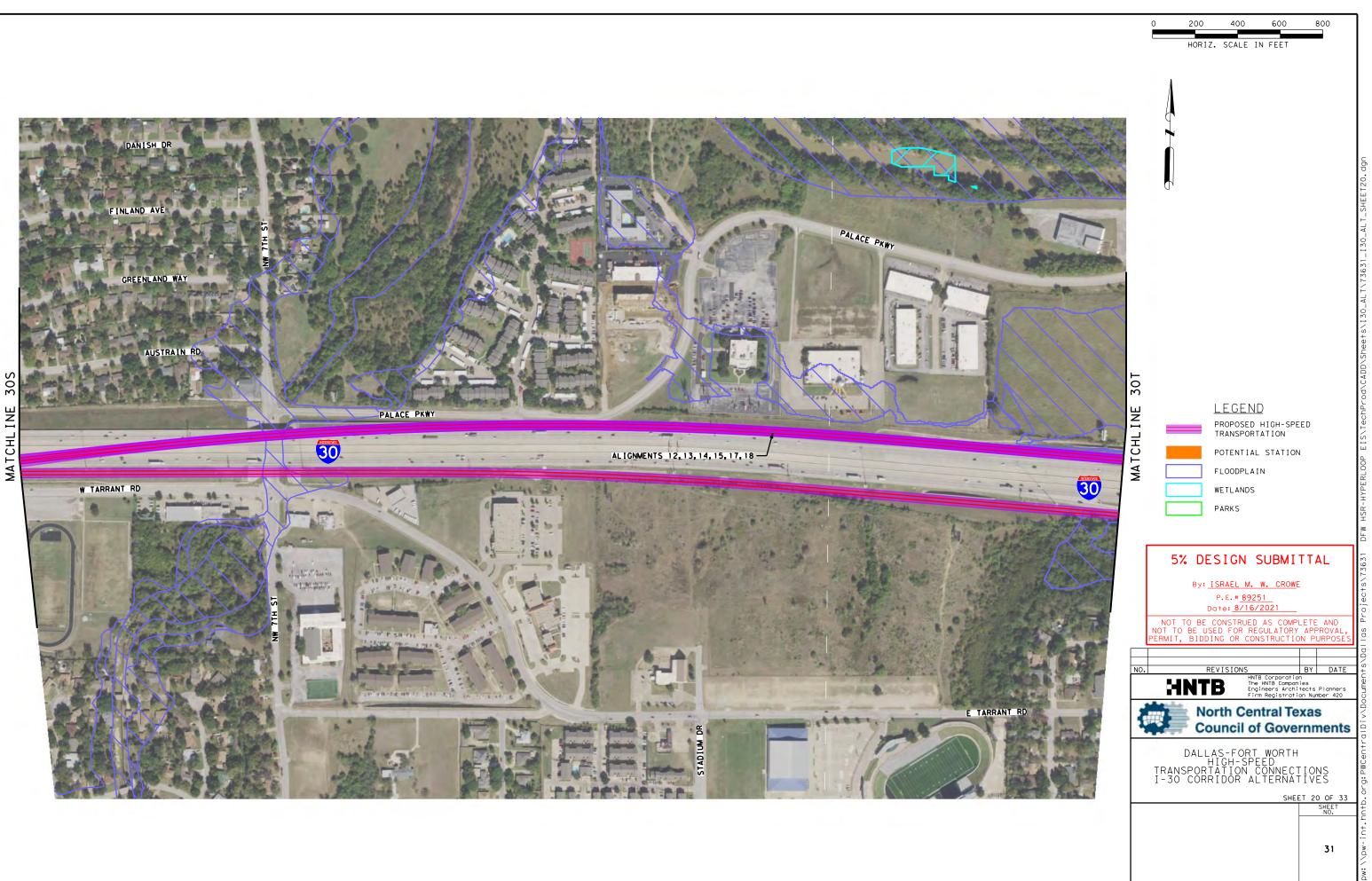


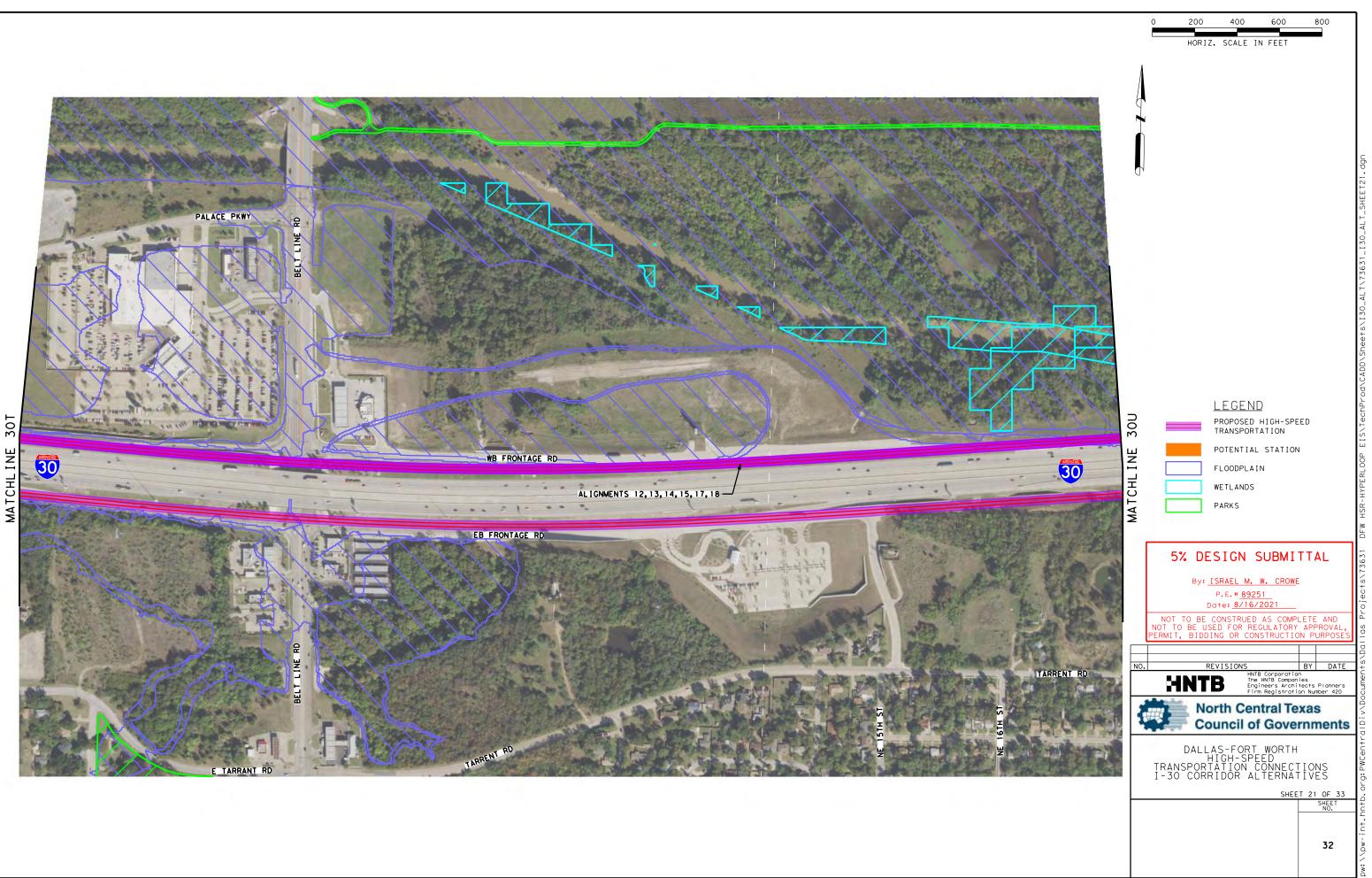


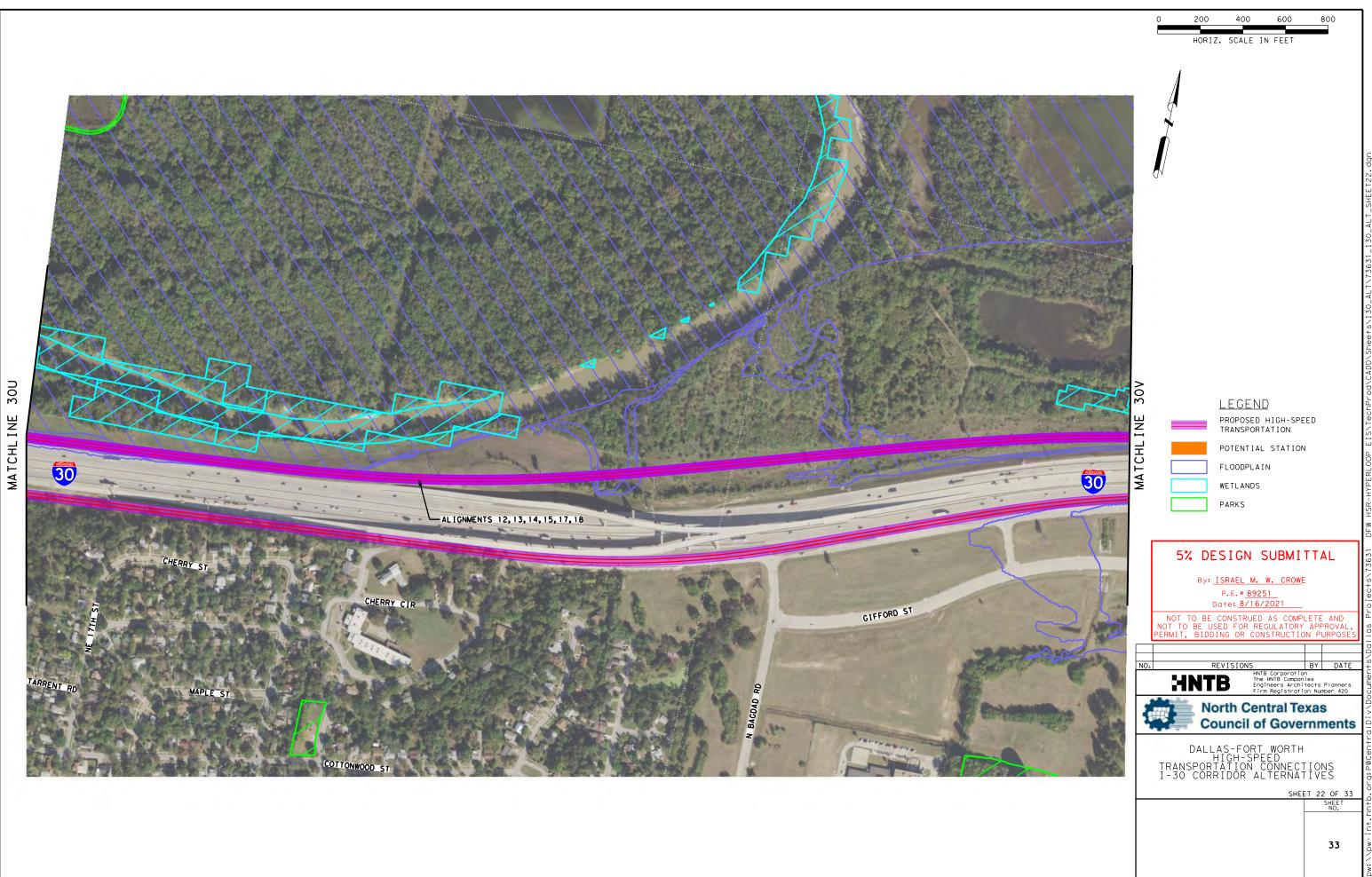
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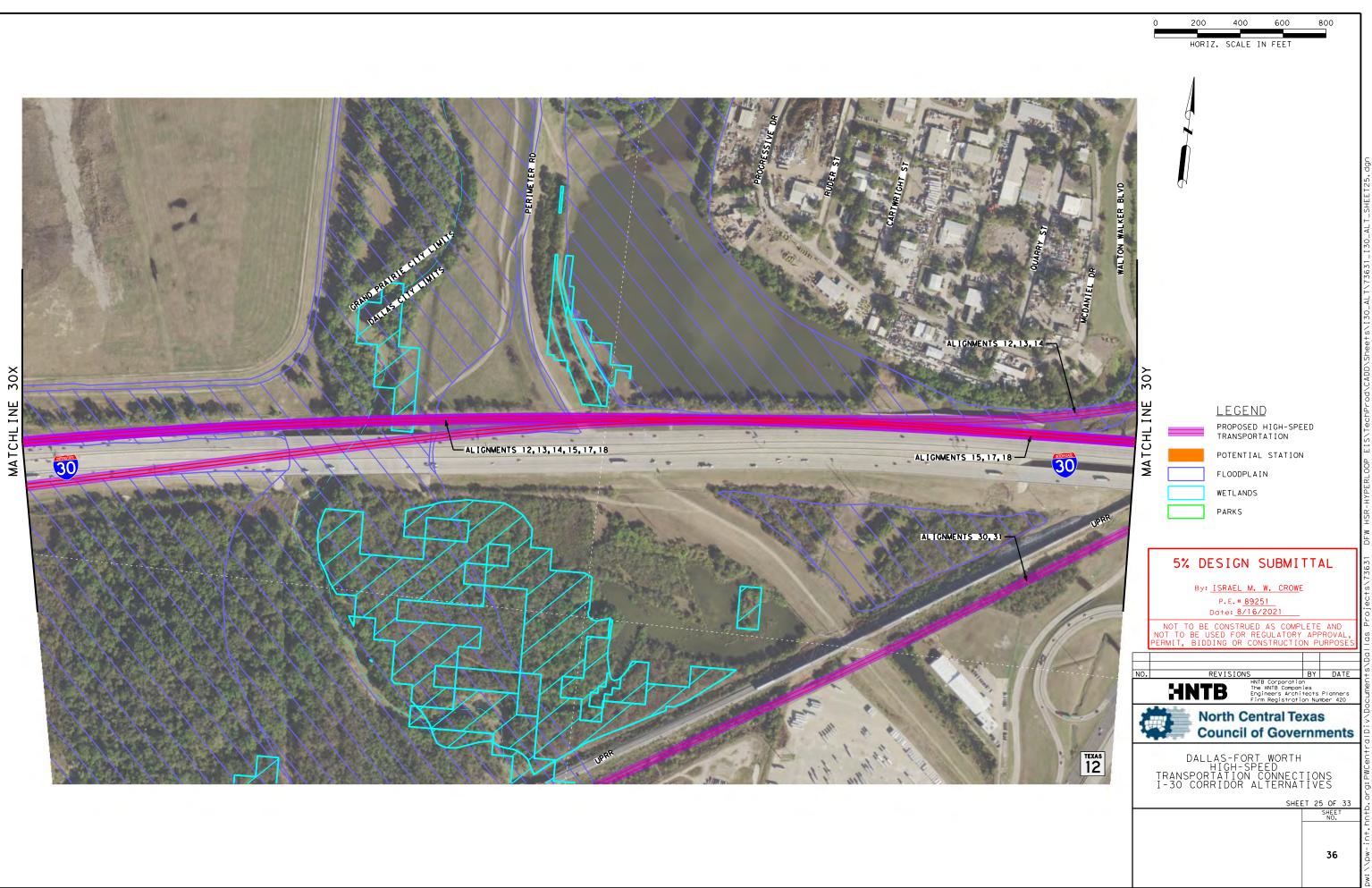


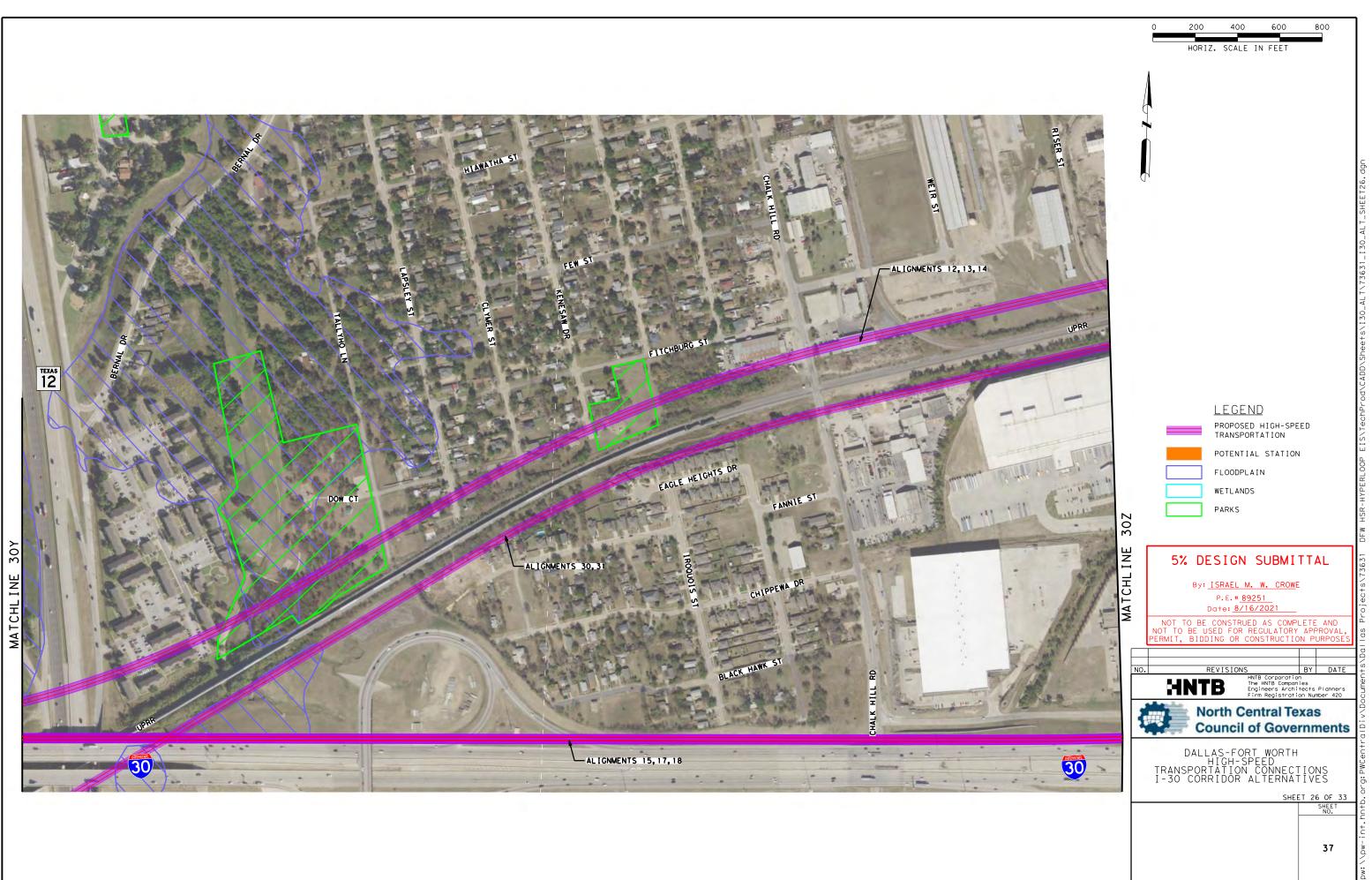


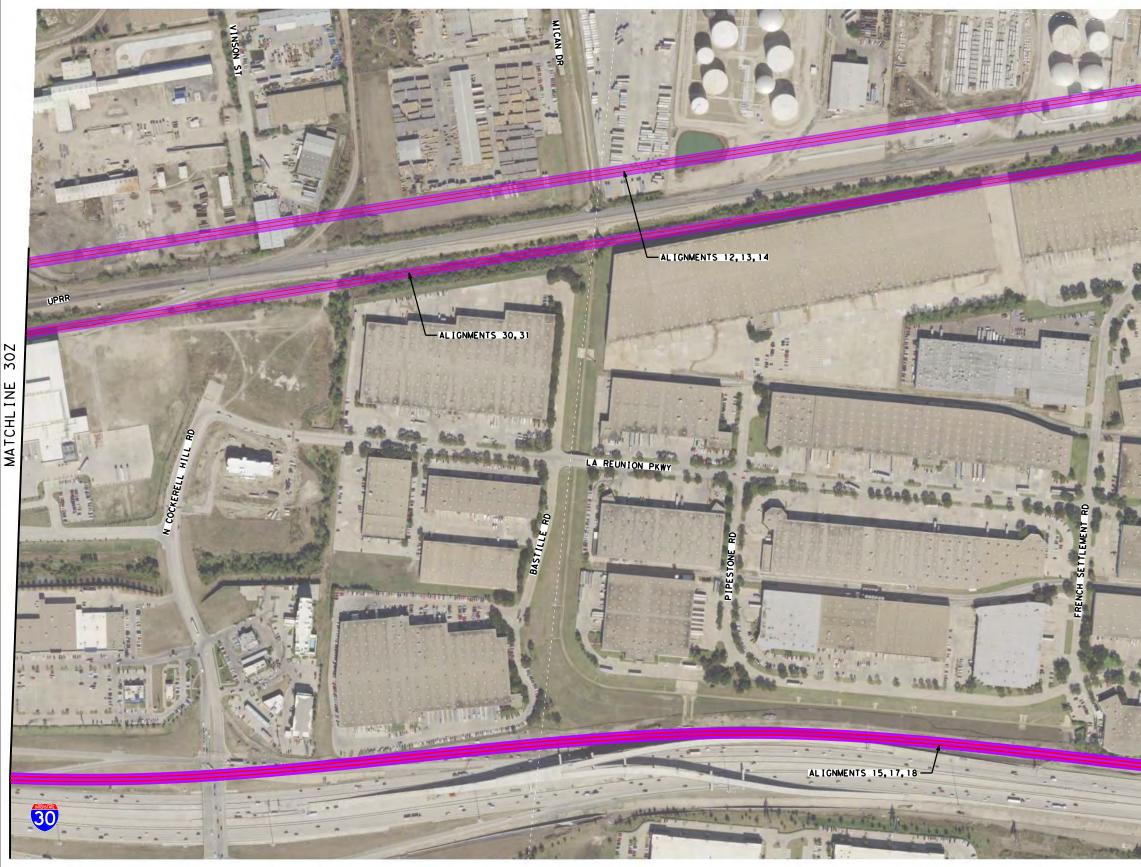


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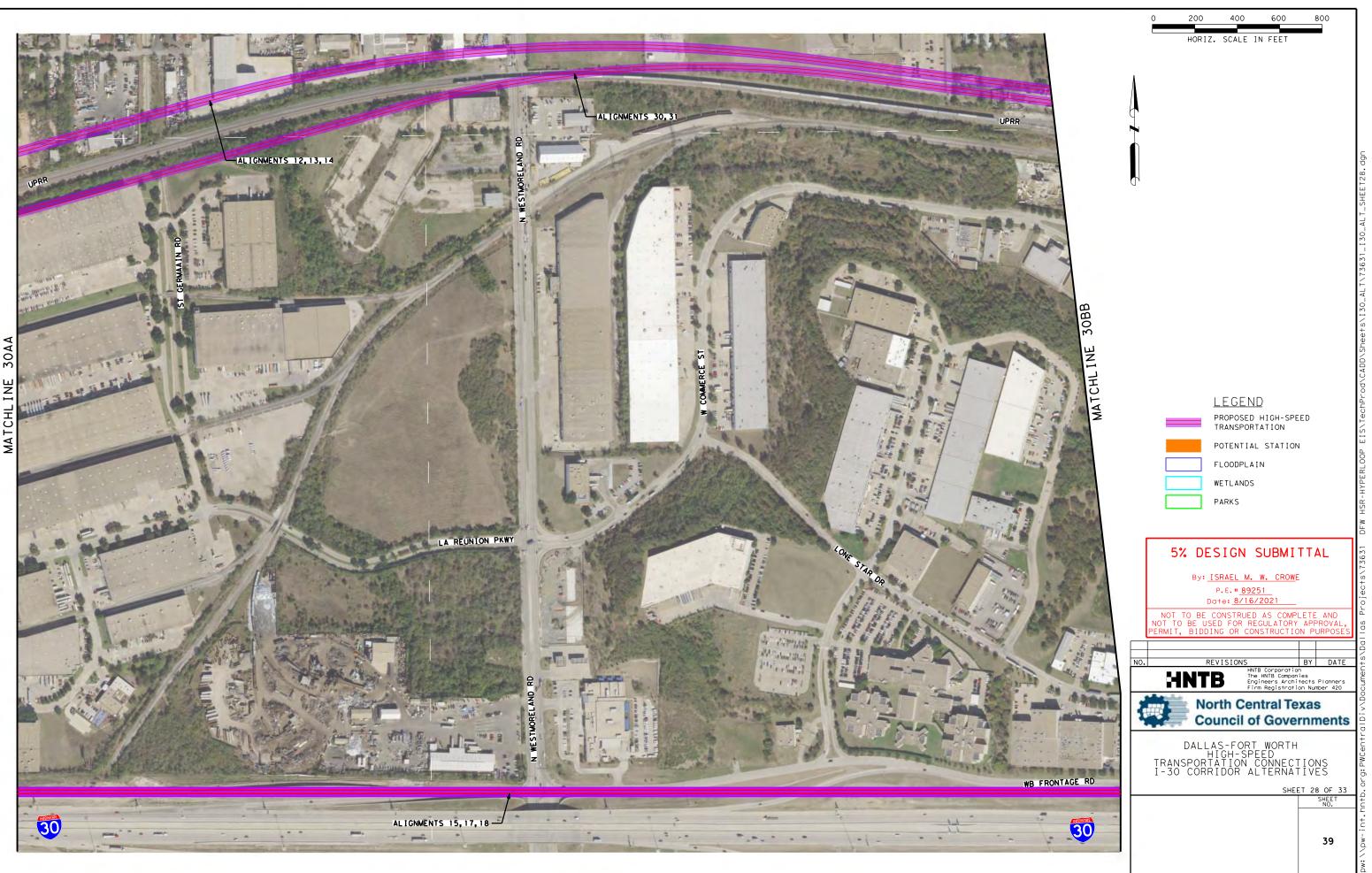


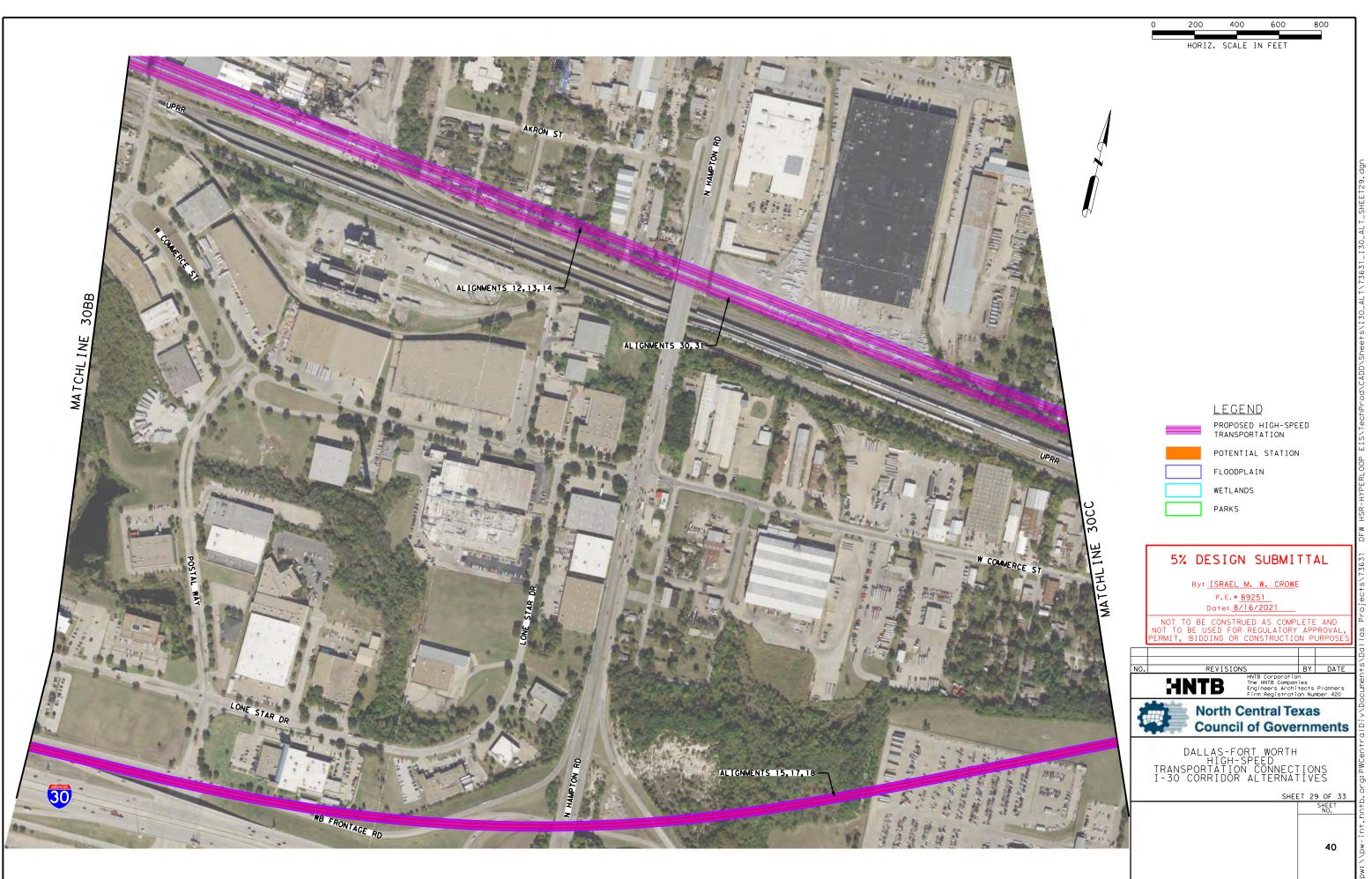




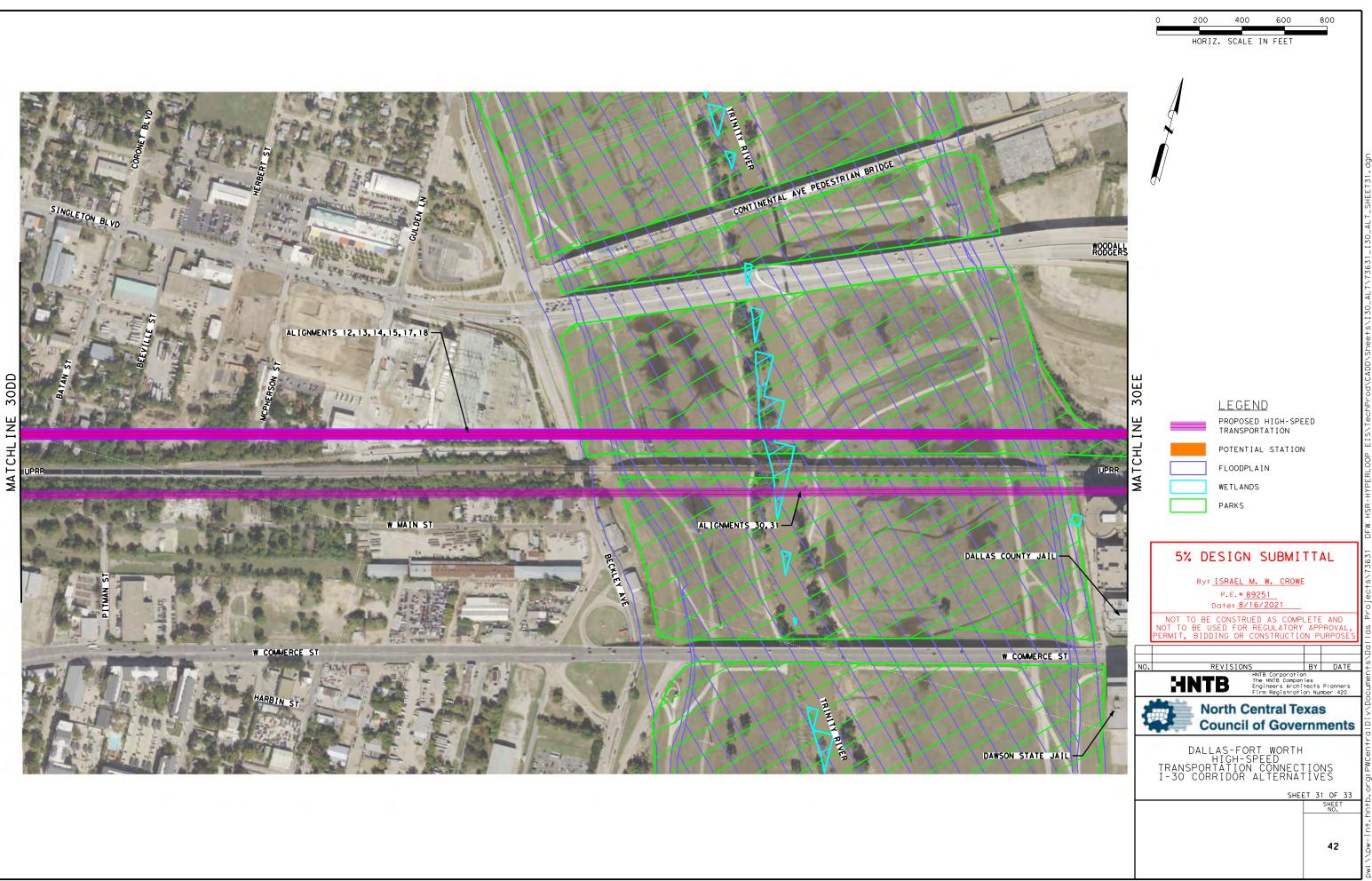


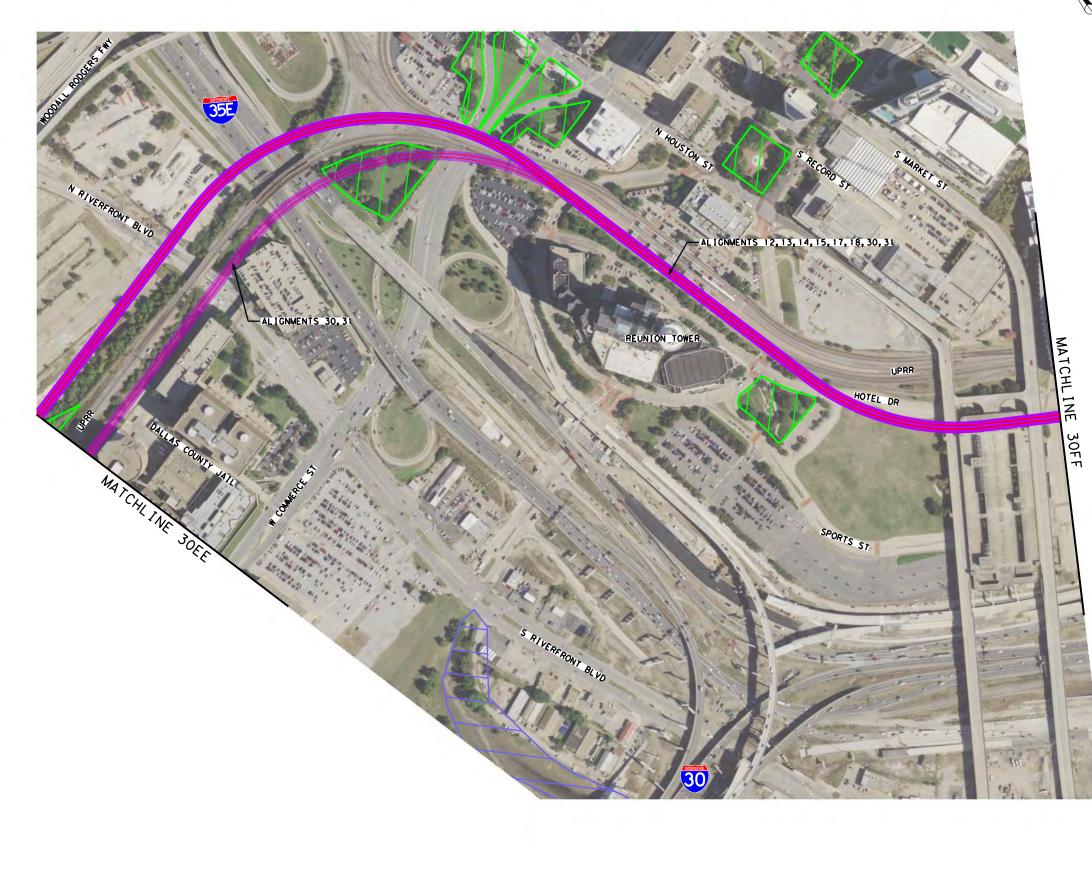
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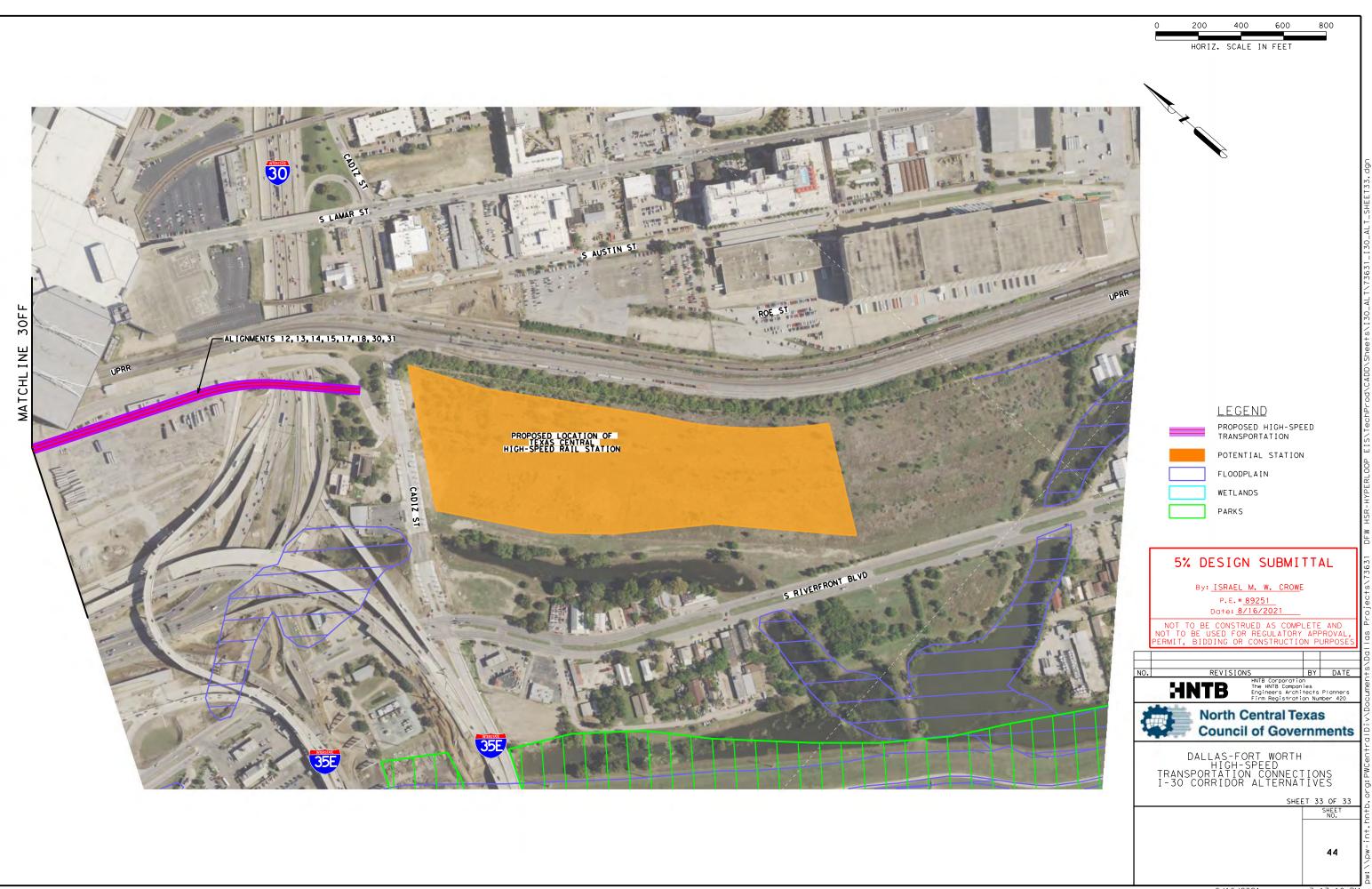


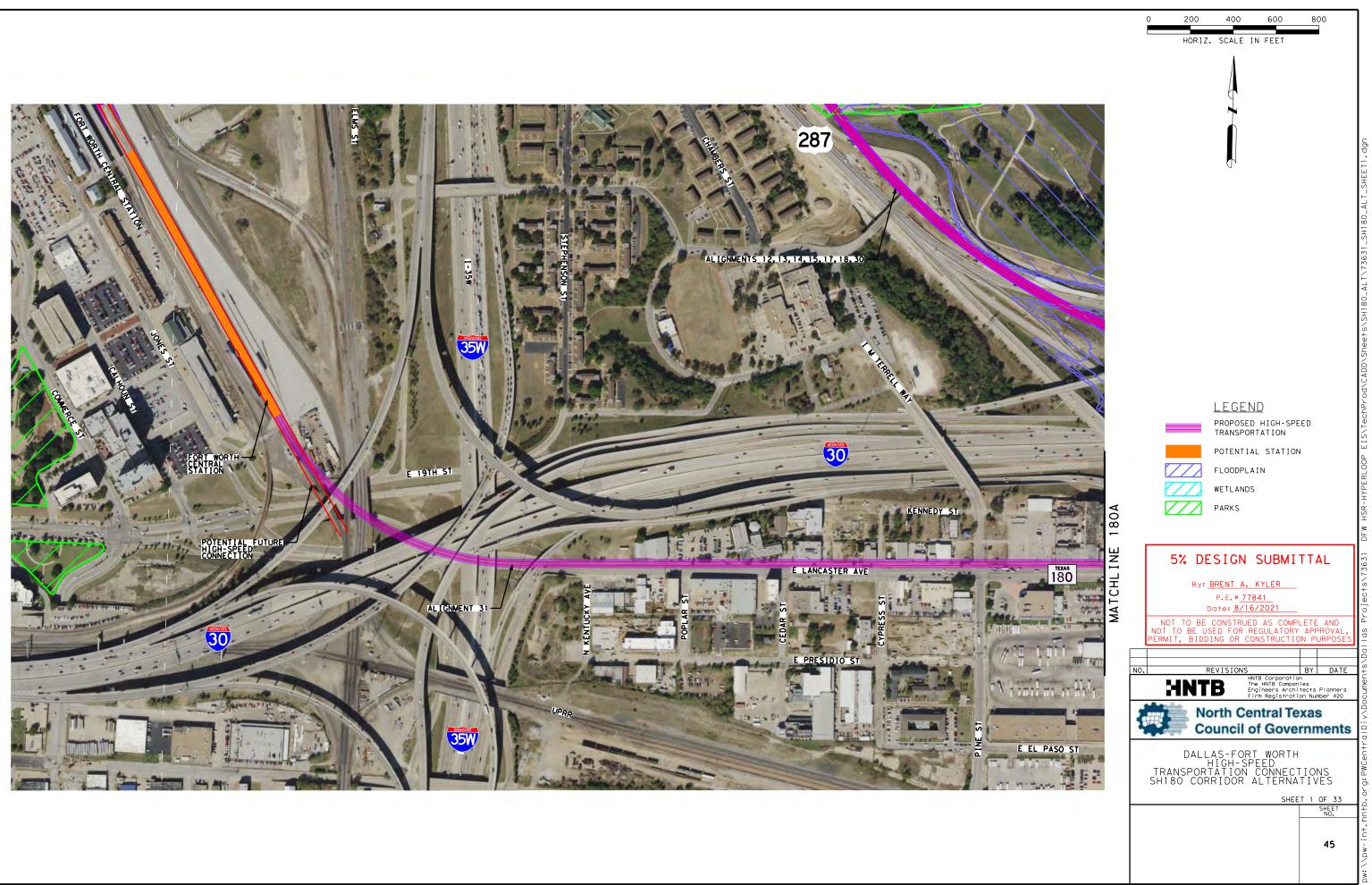


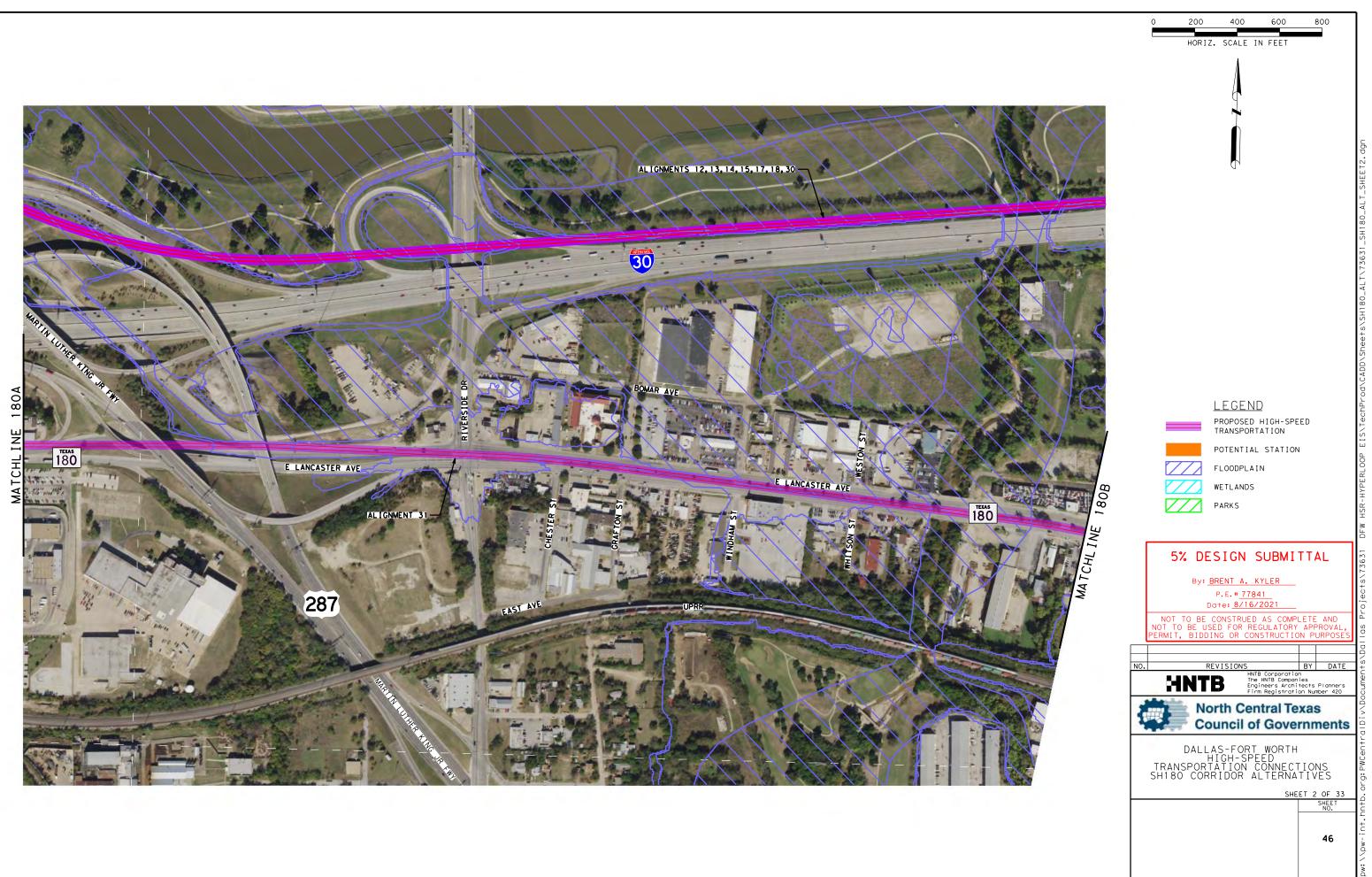




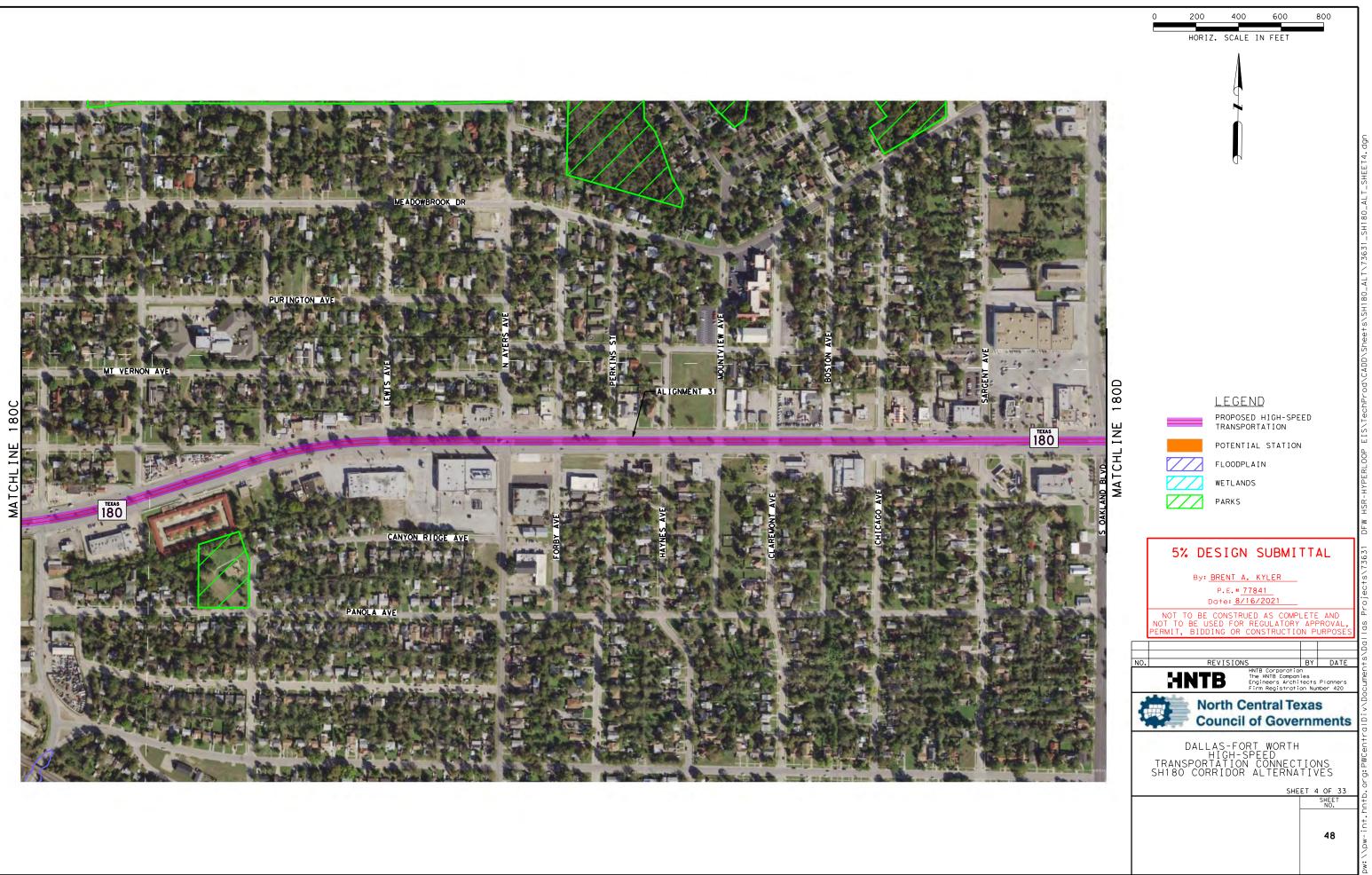
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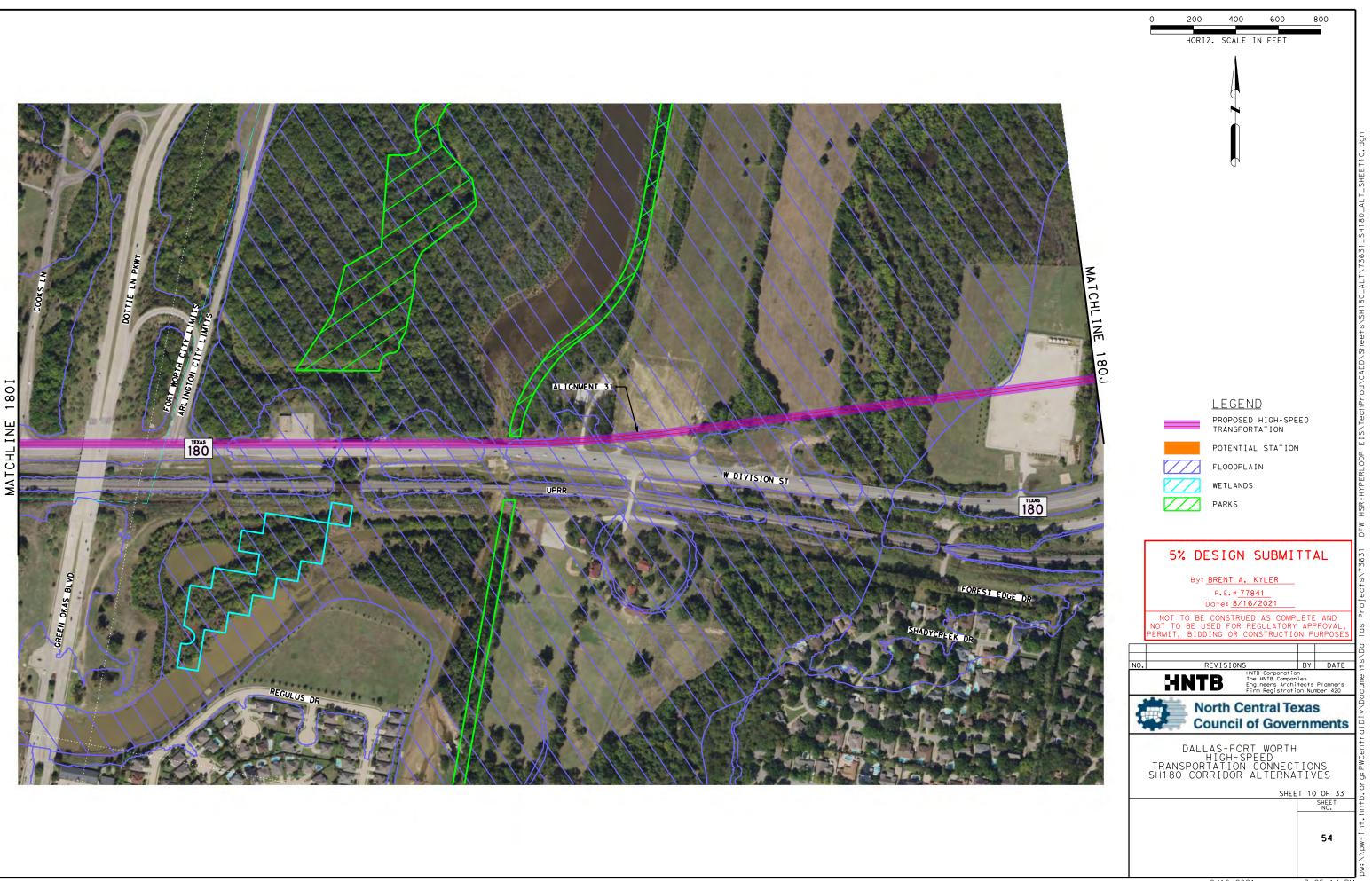




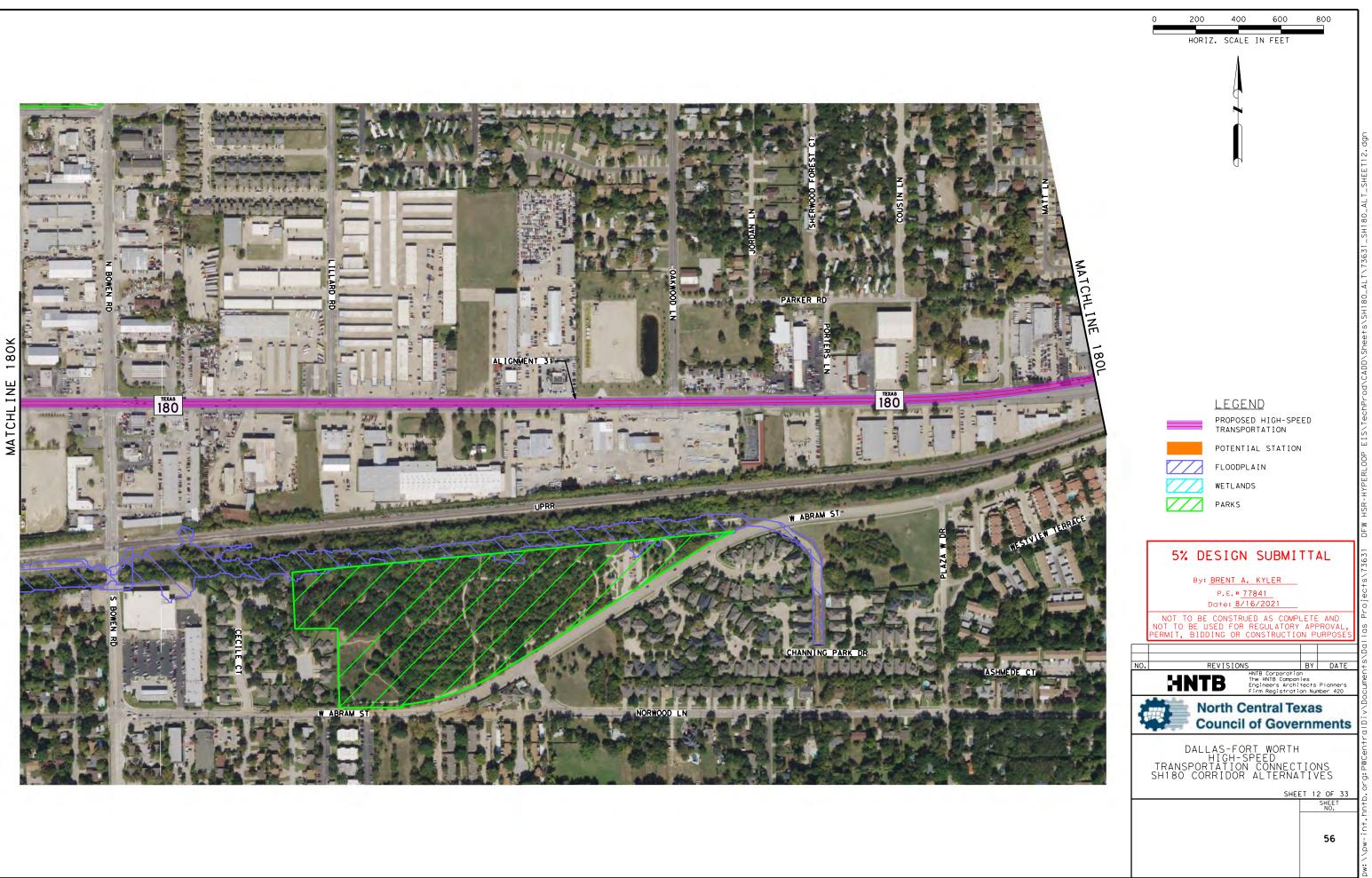


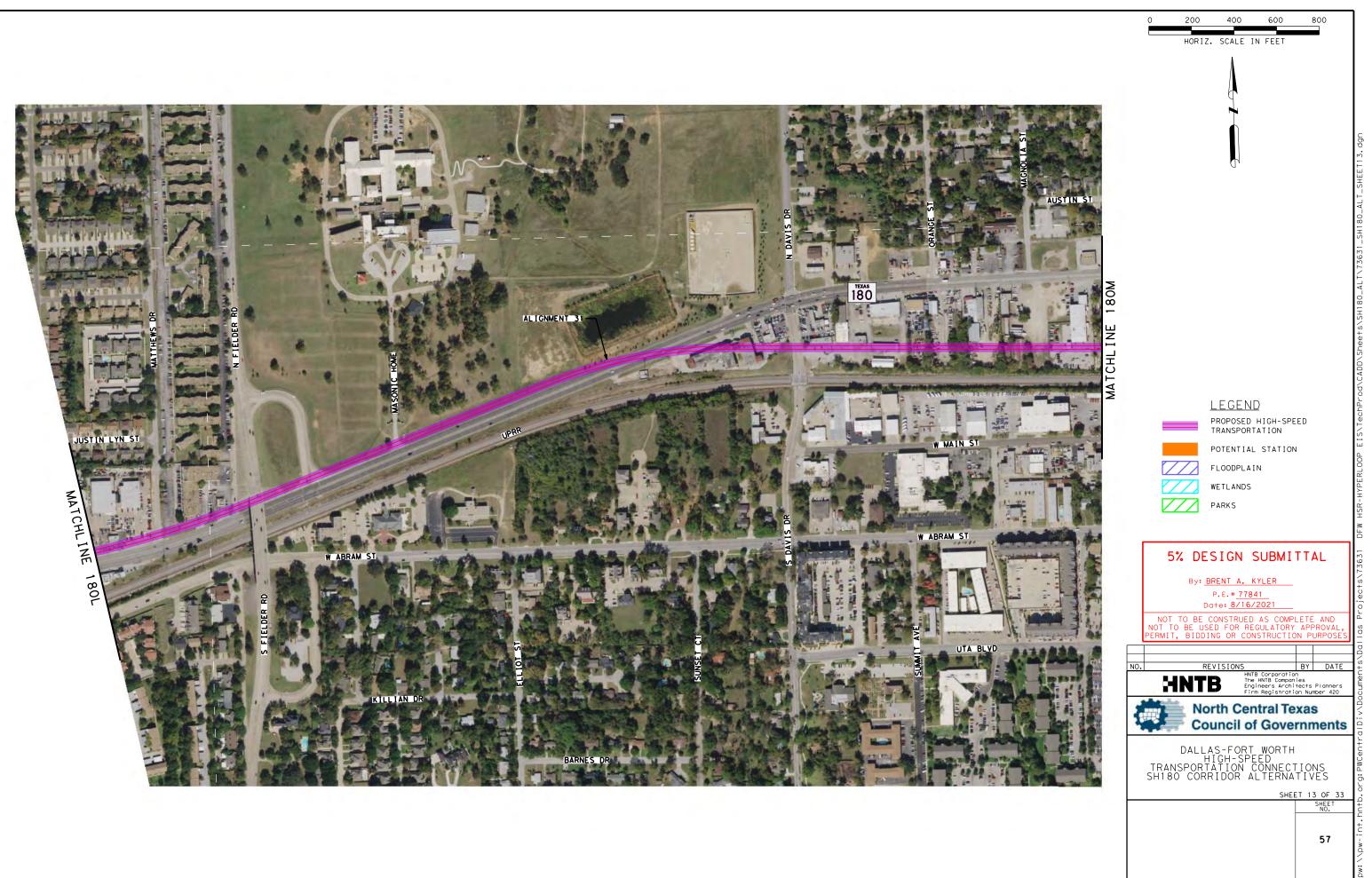








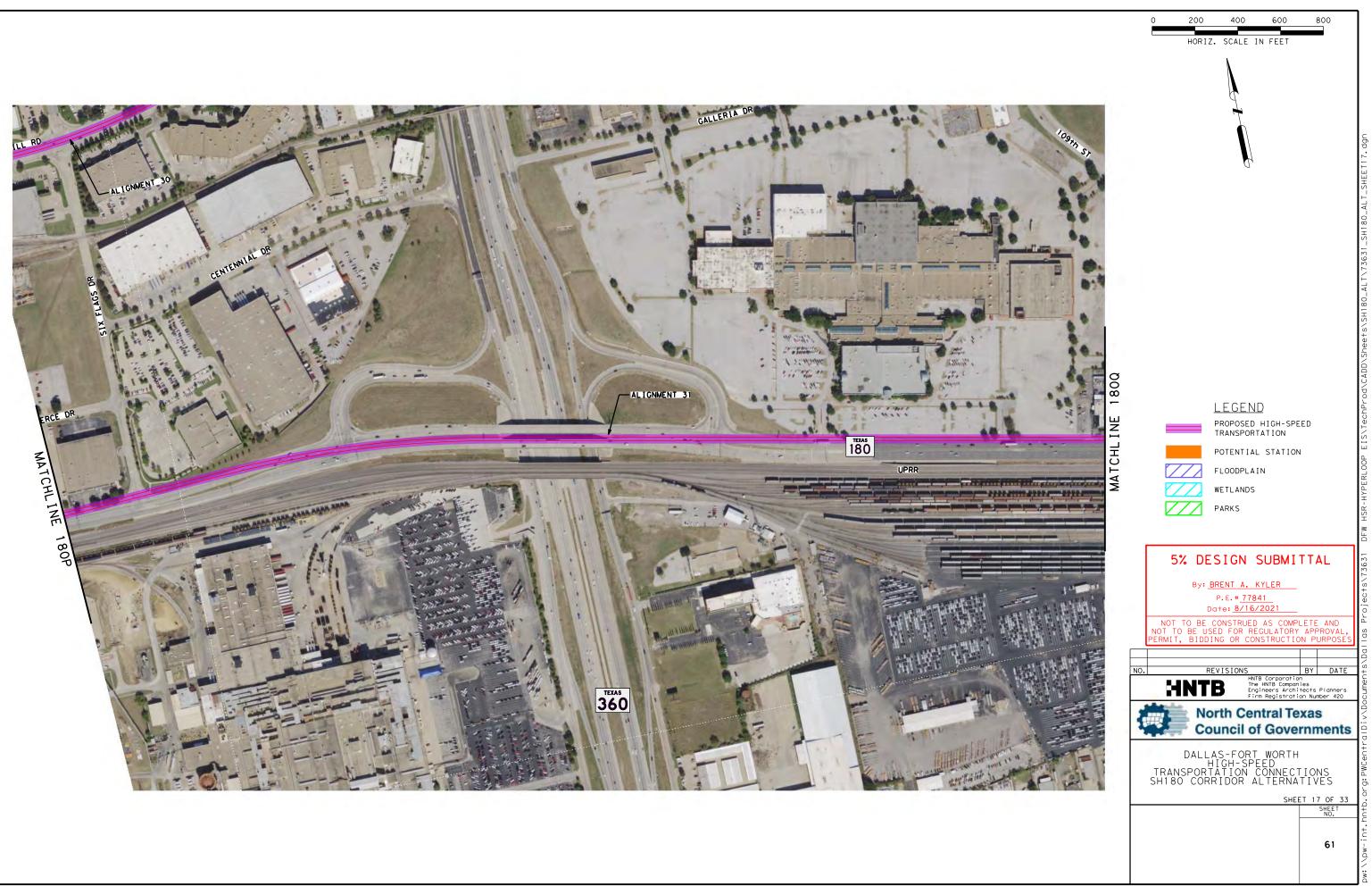


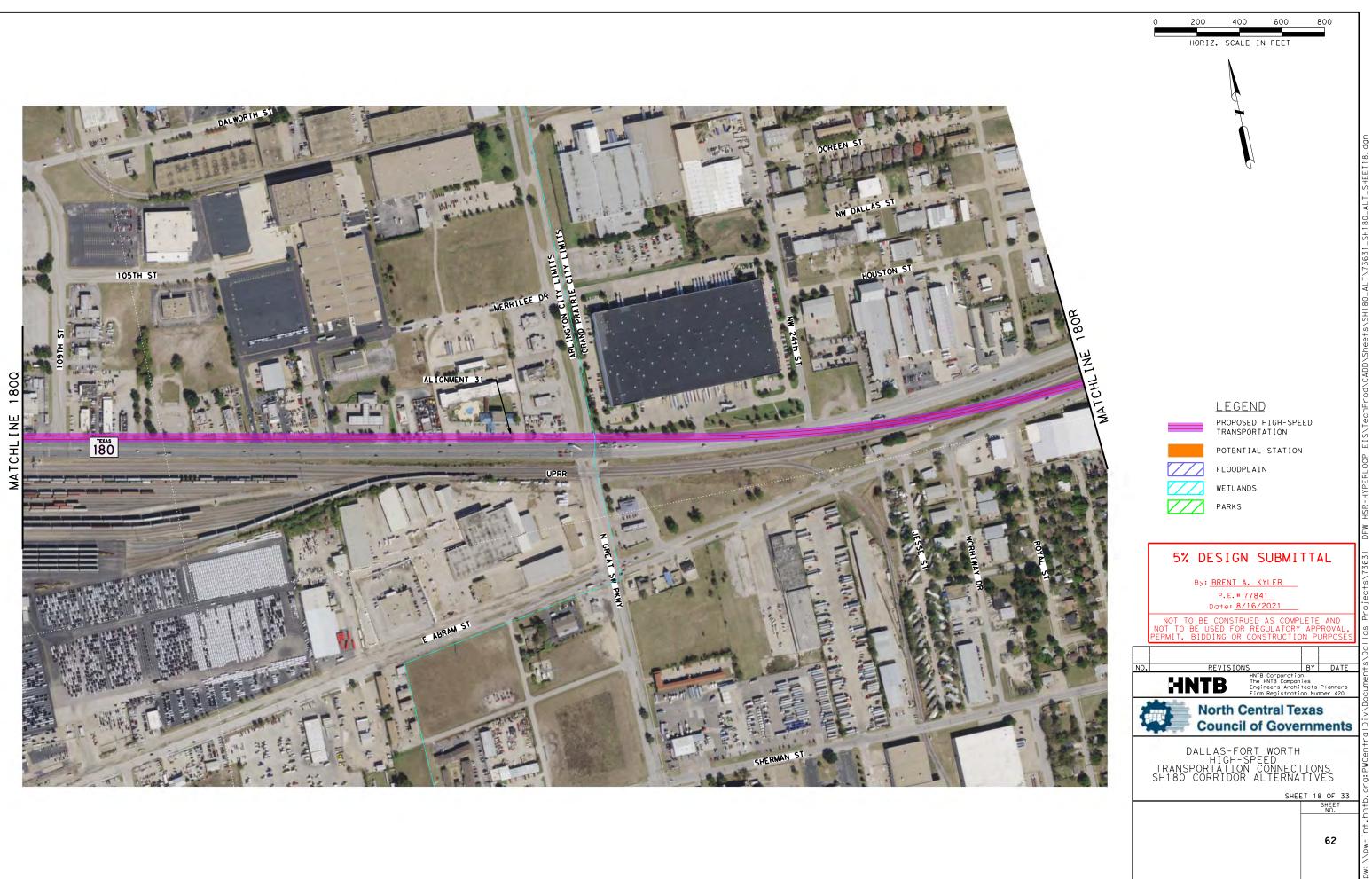




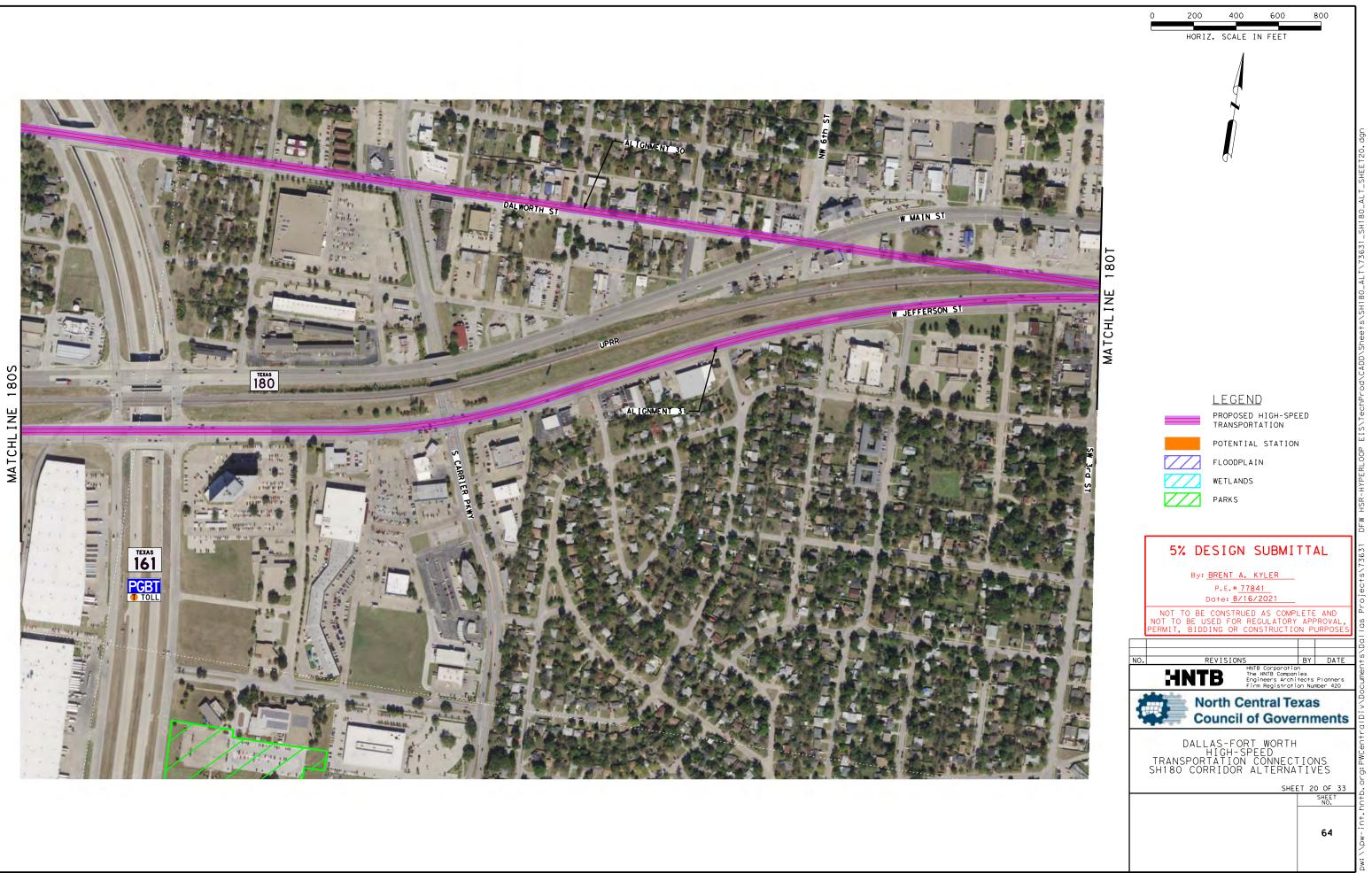






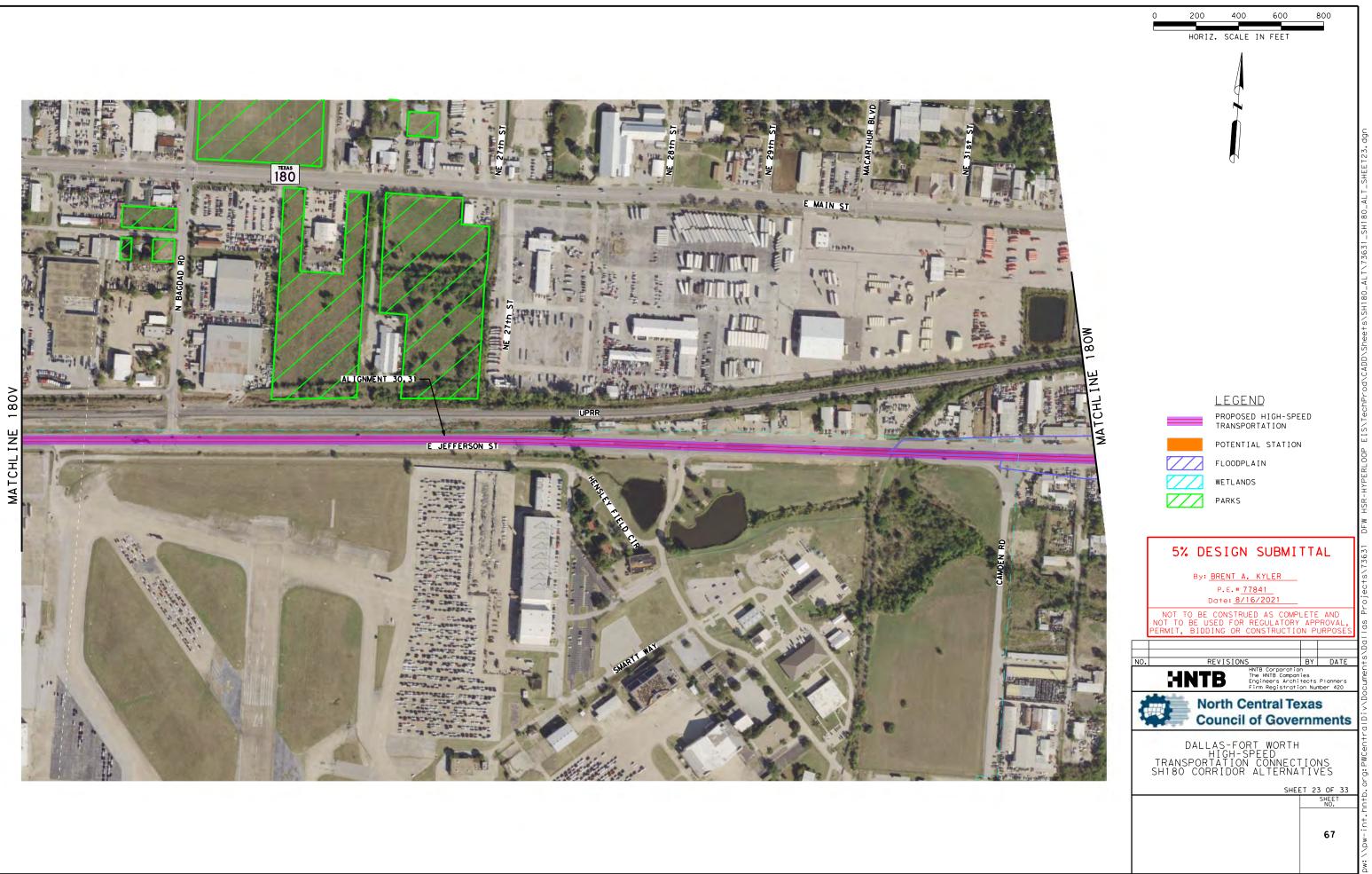




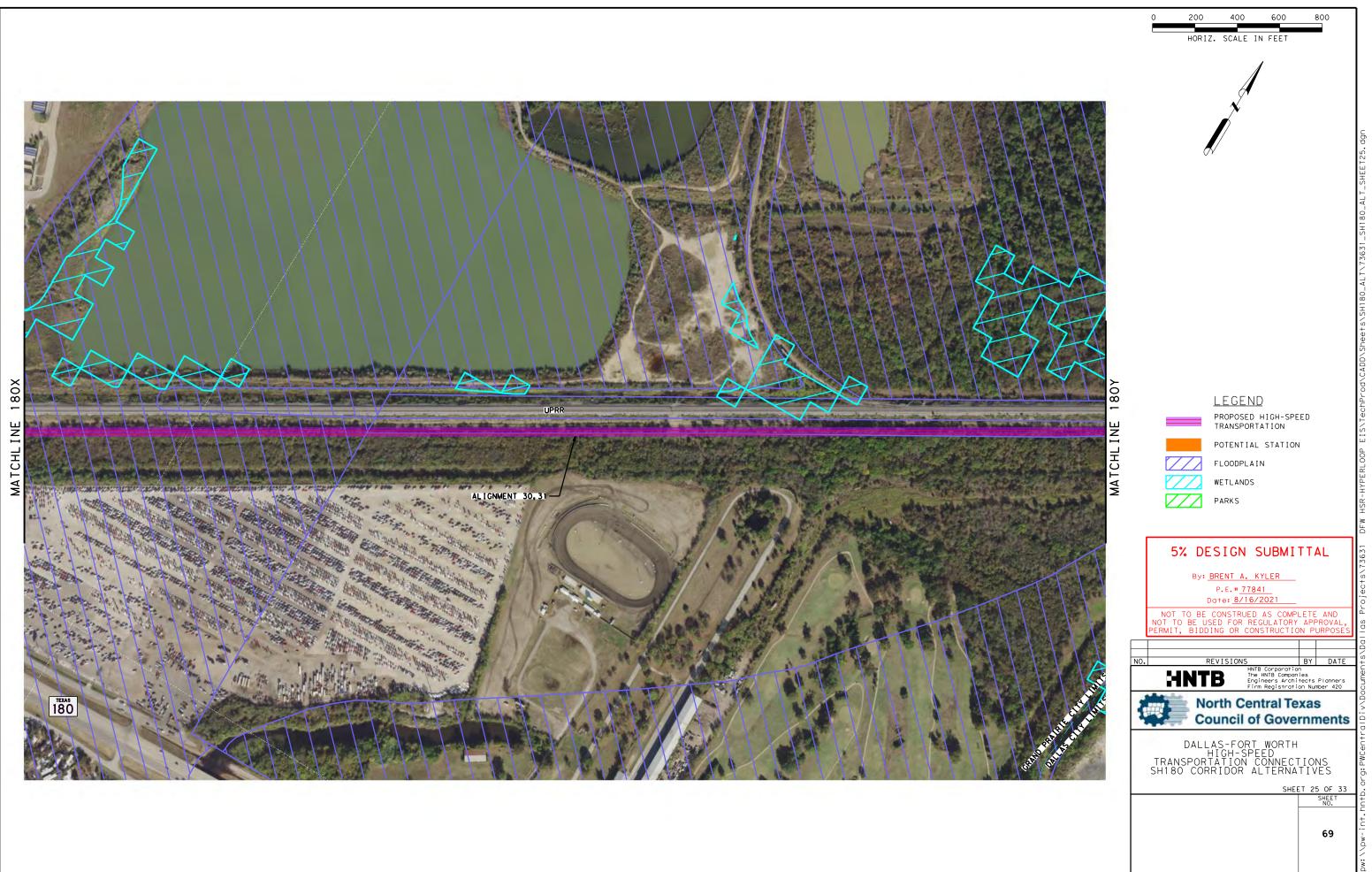


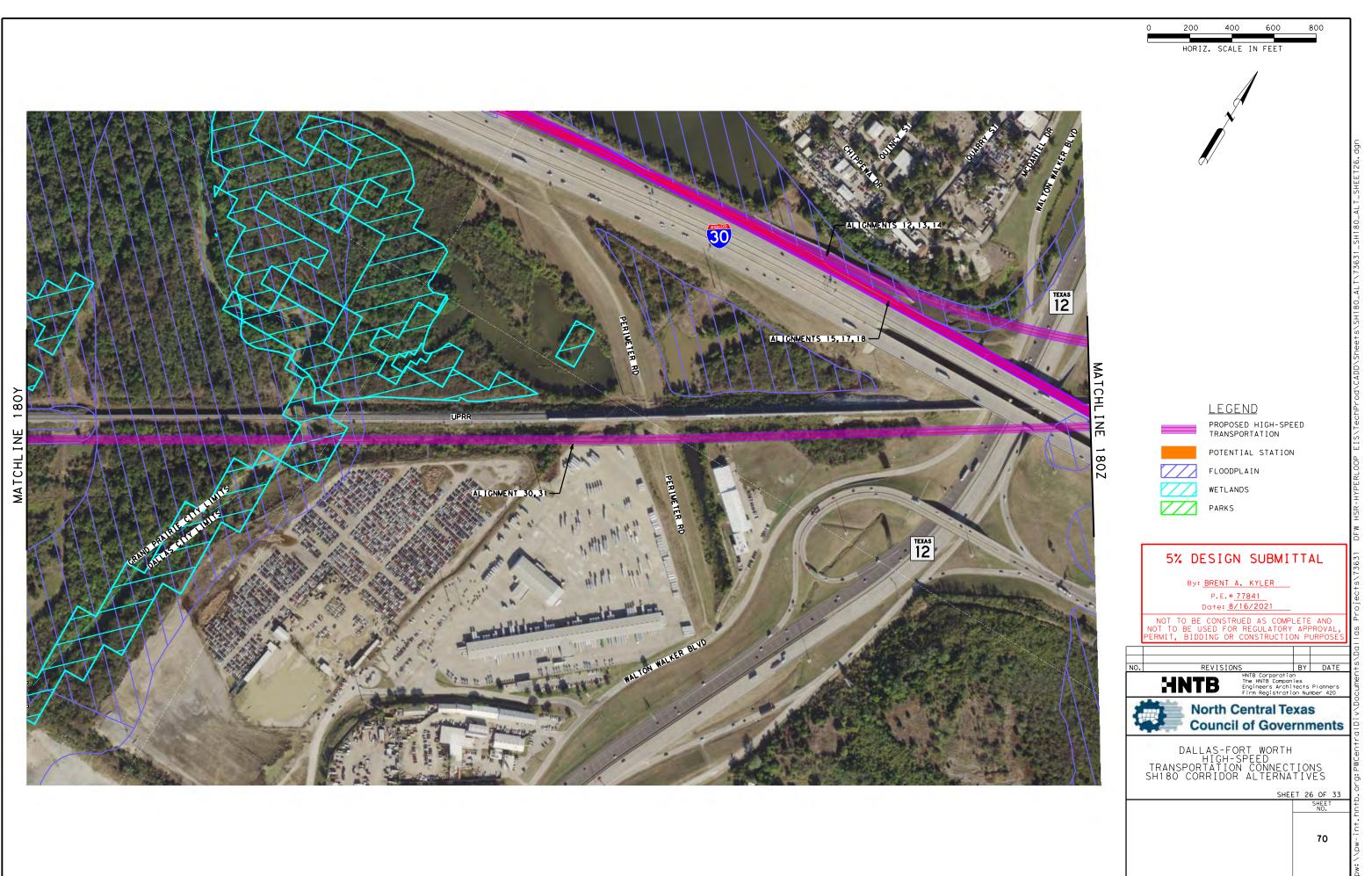








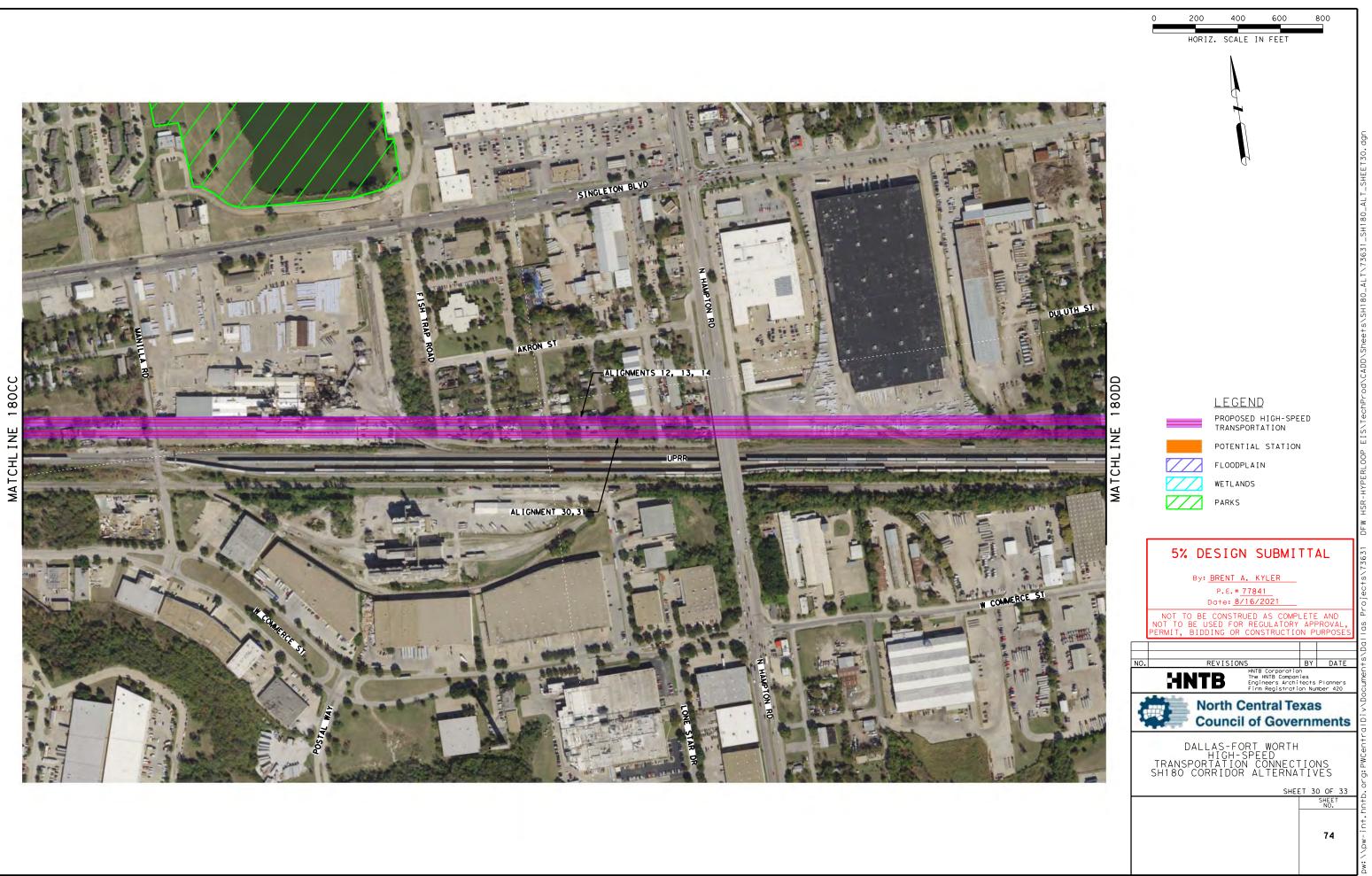






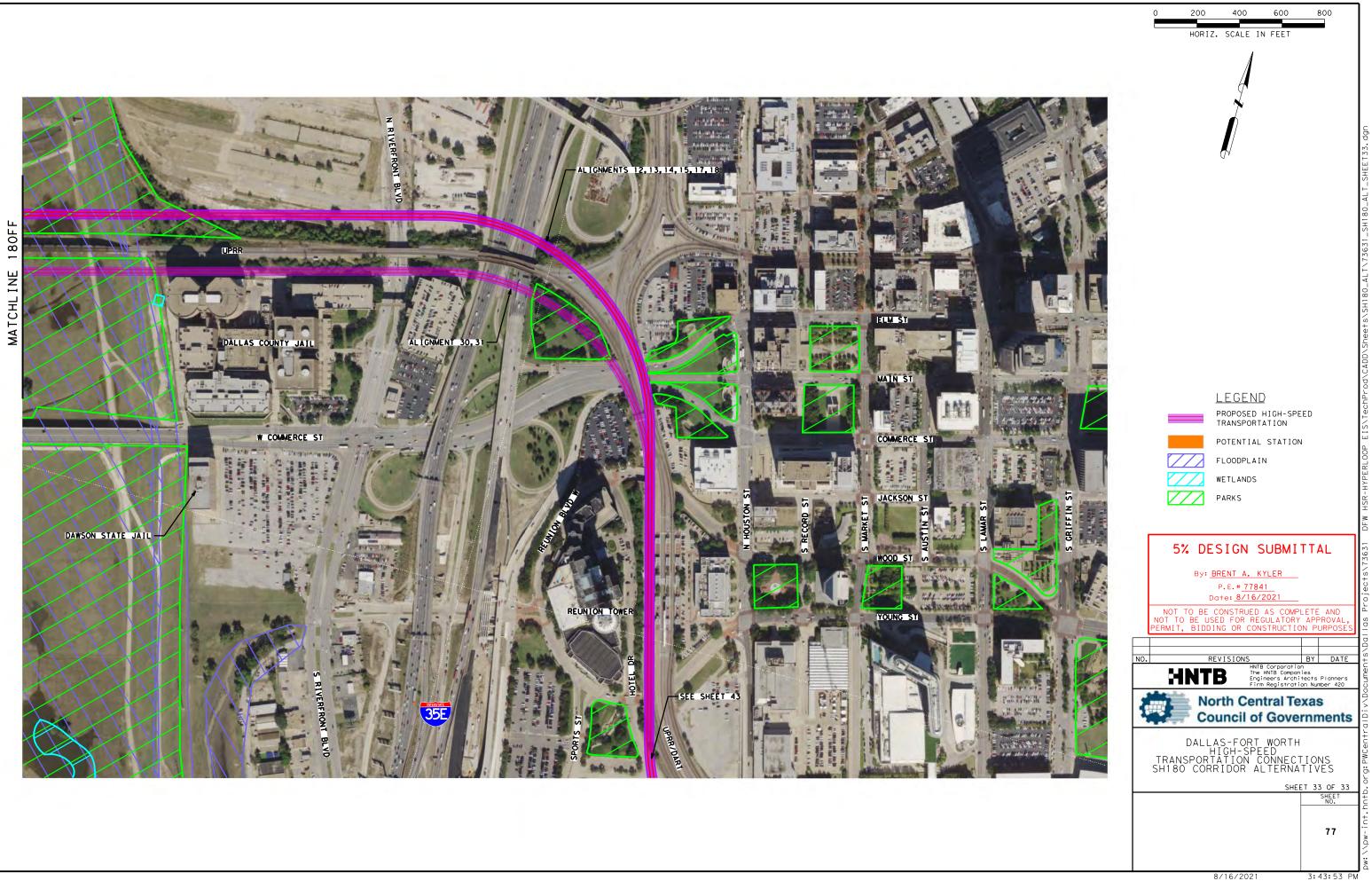






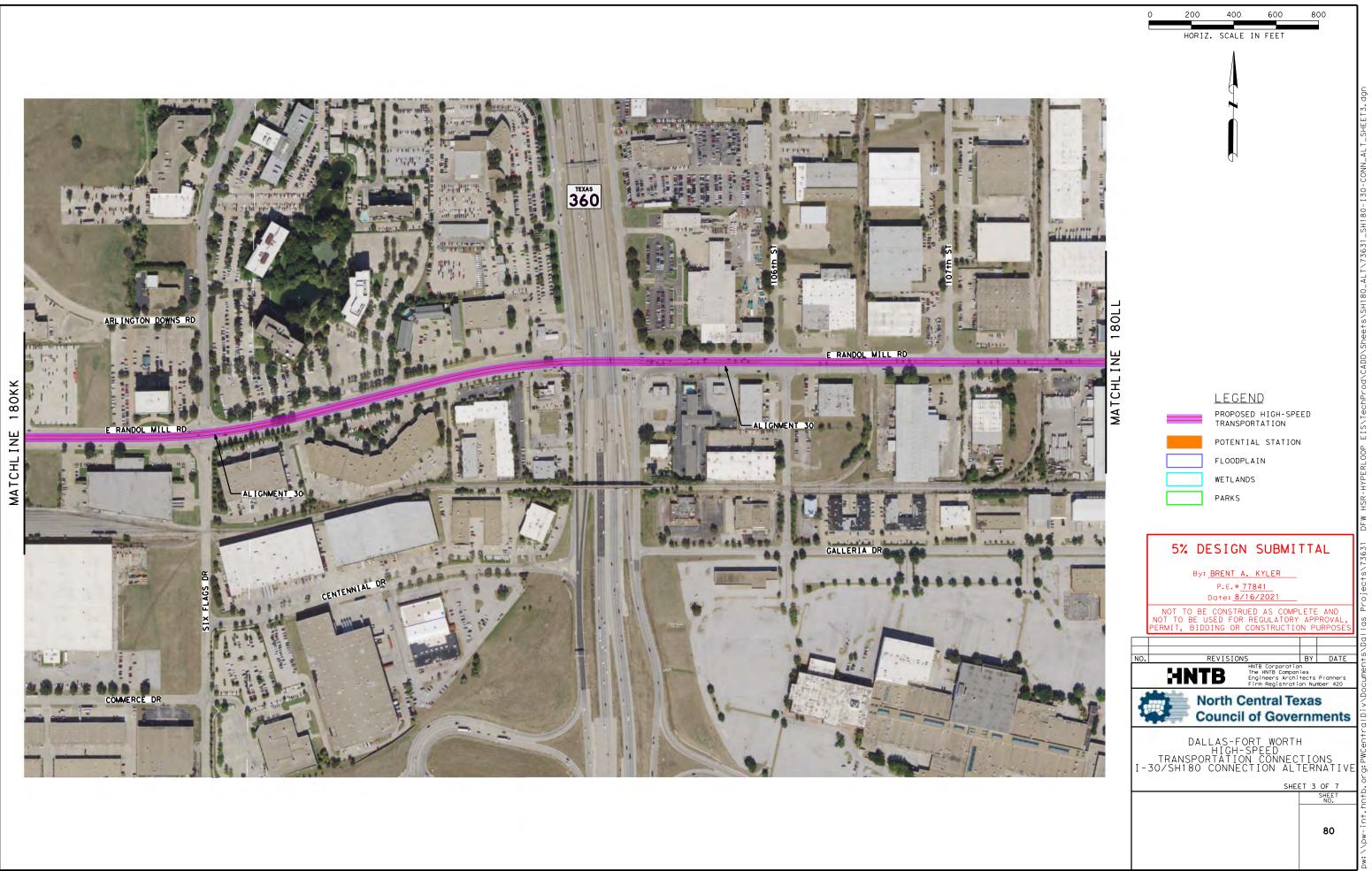




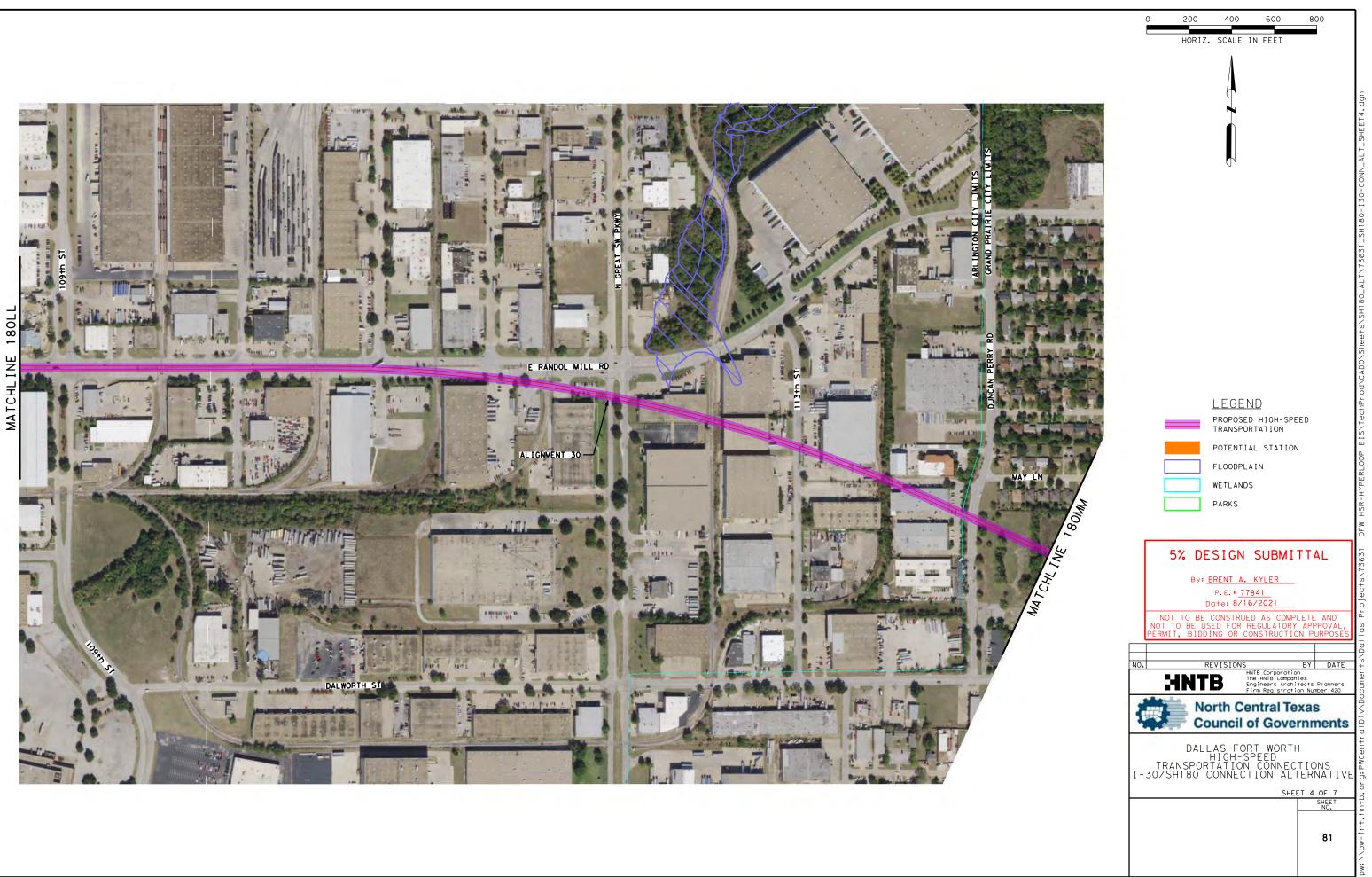


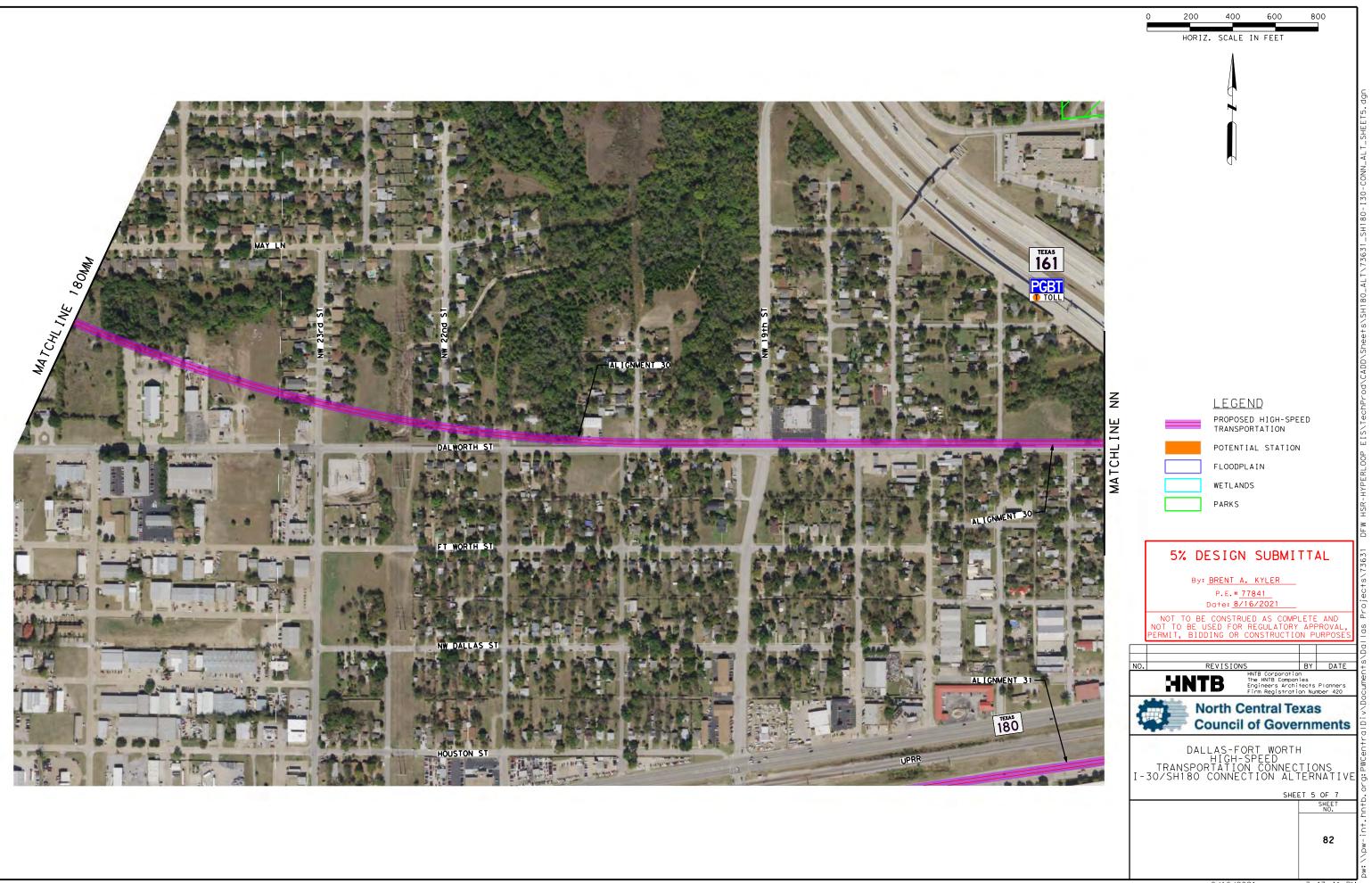






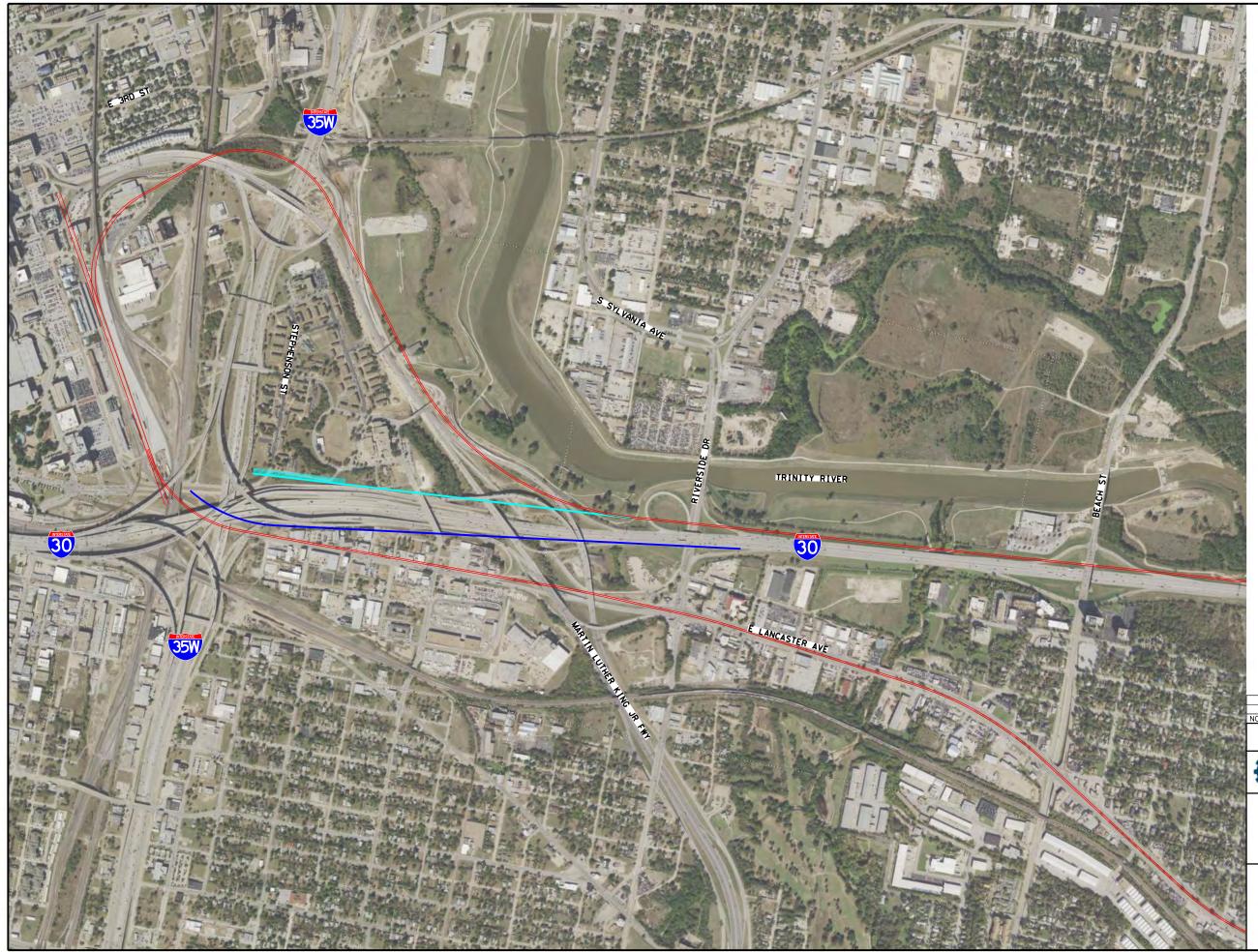
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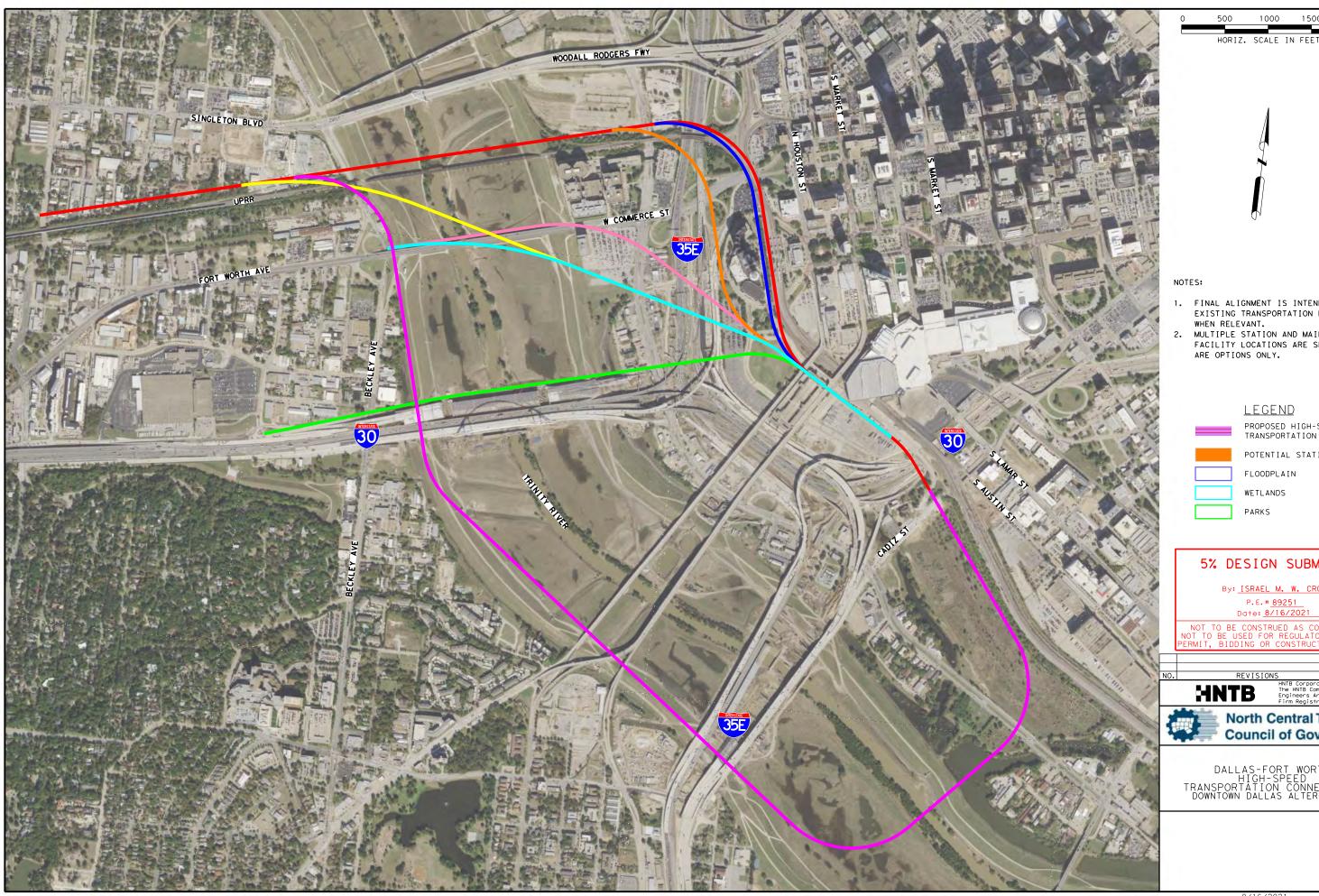








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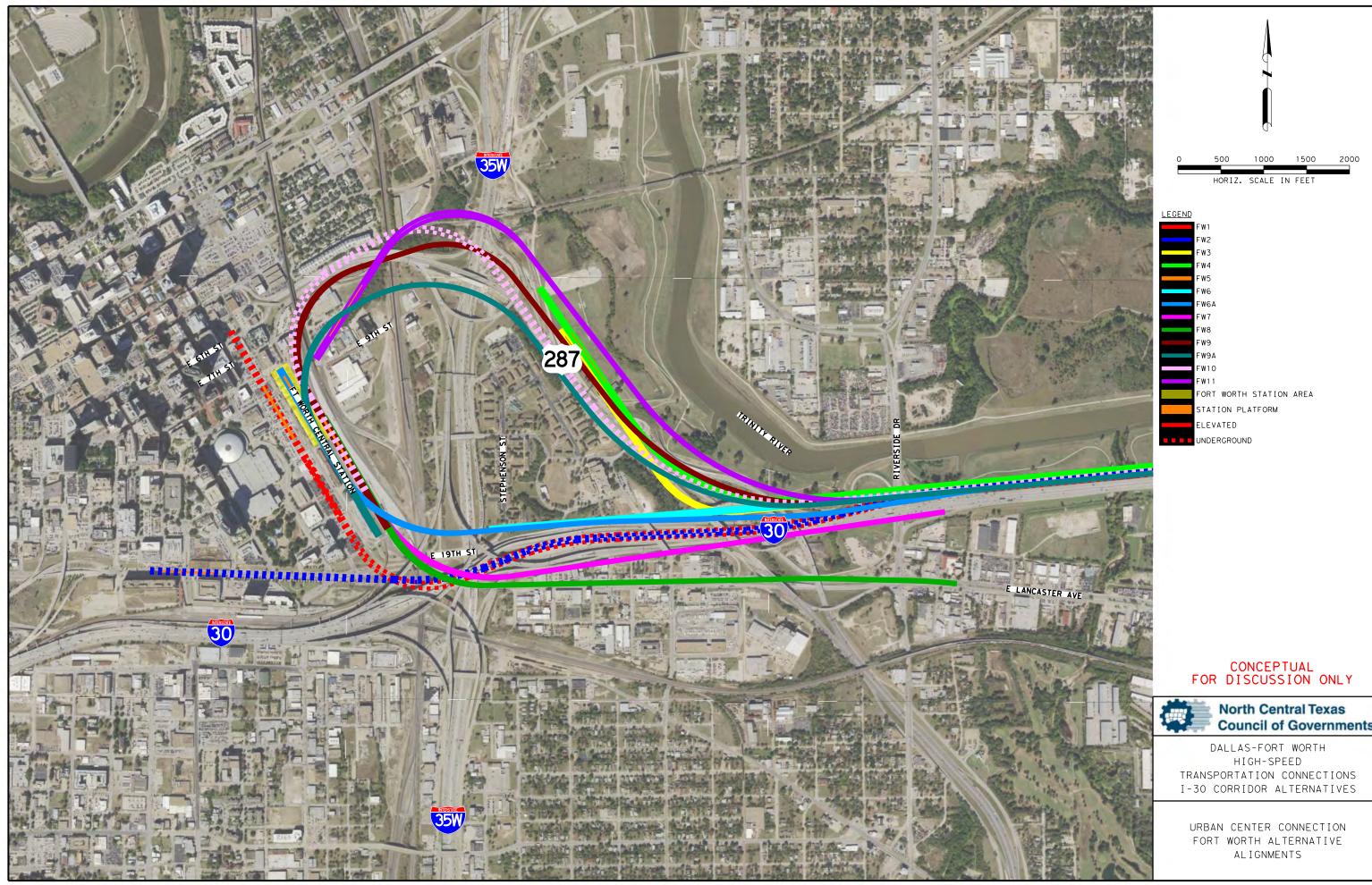
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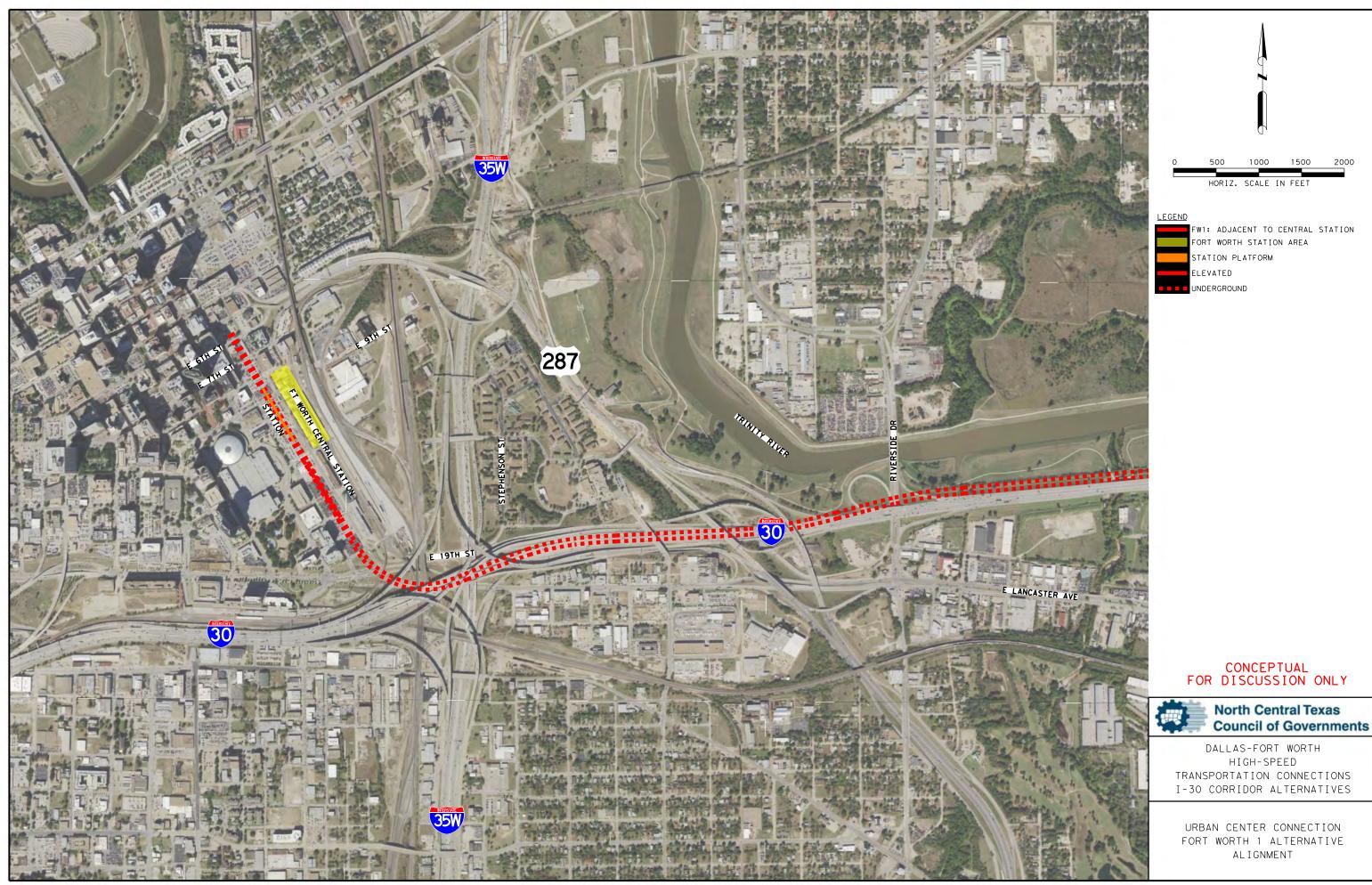
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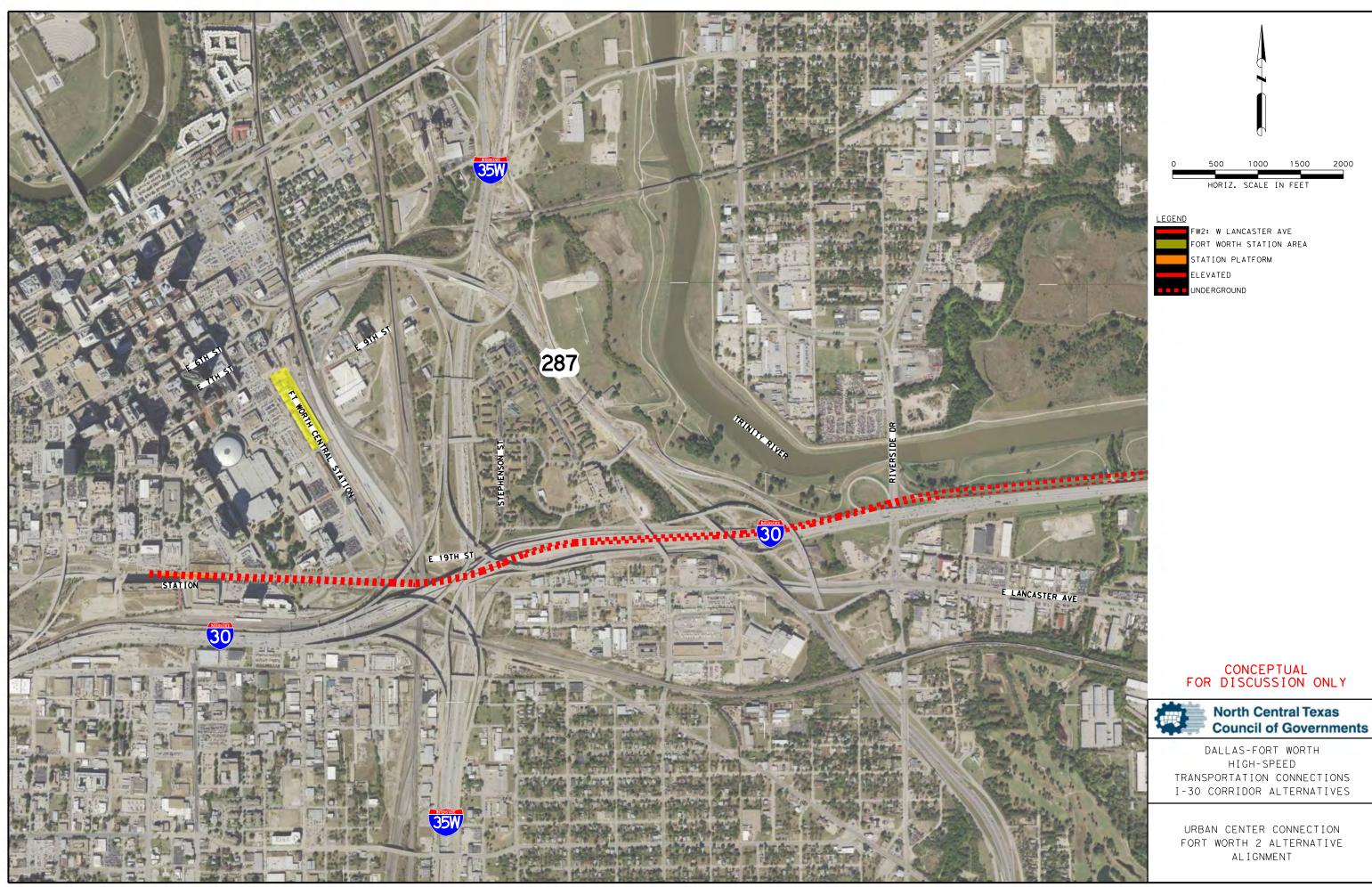
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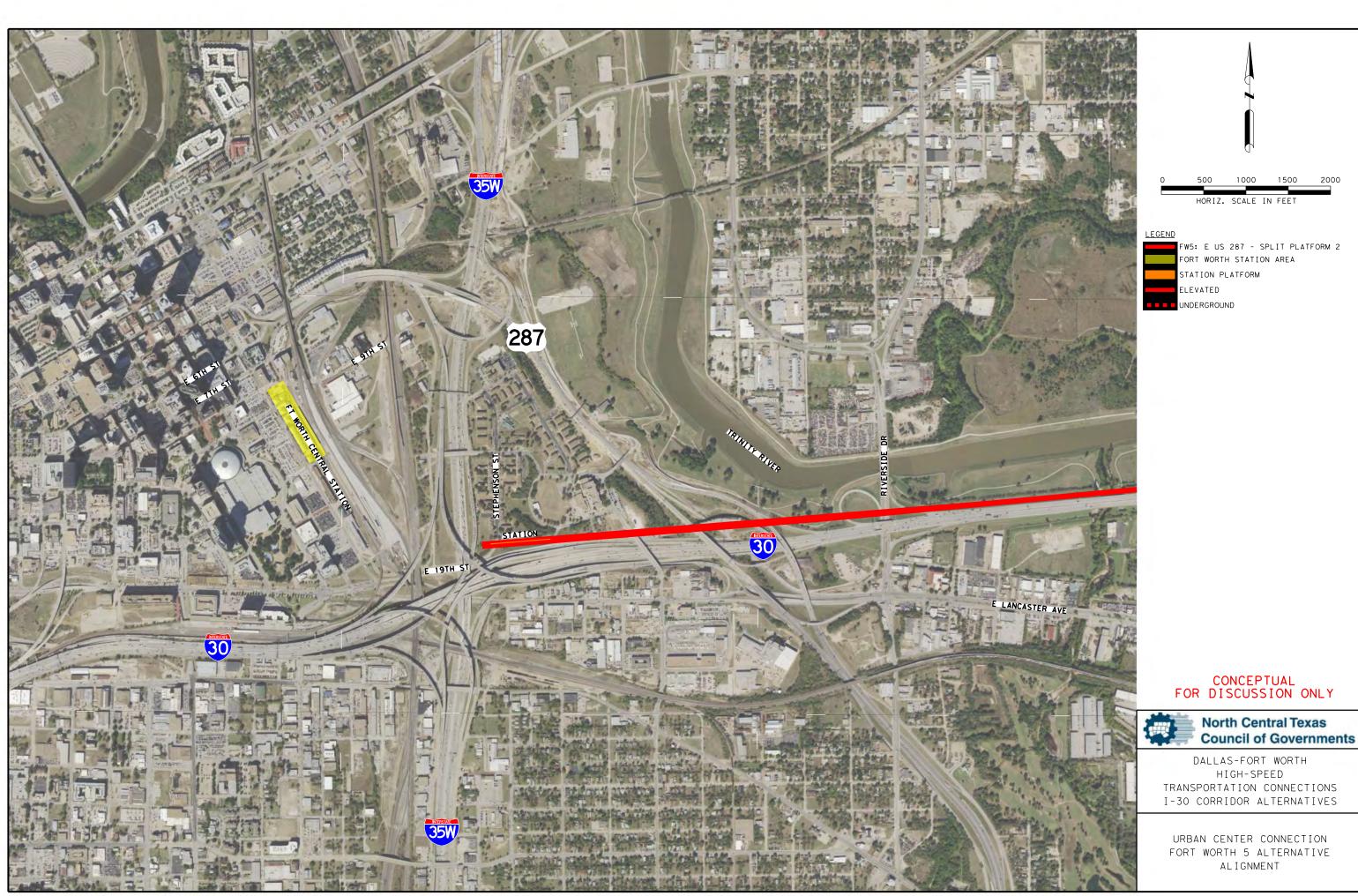
Council of Governments

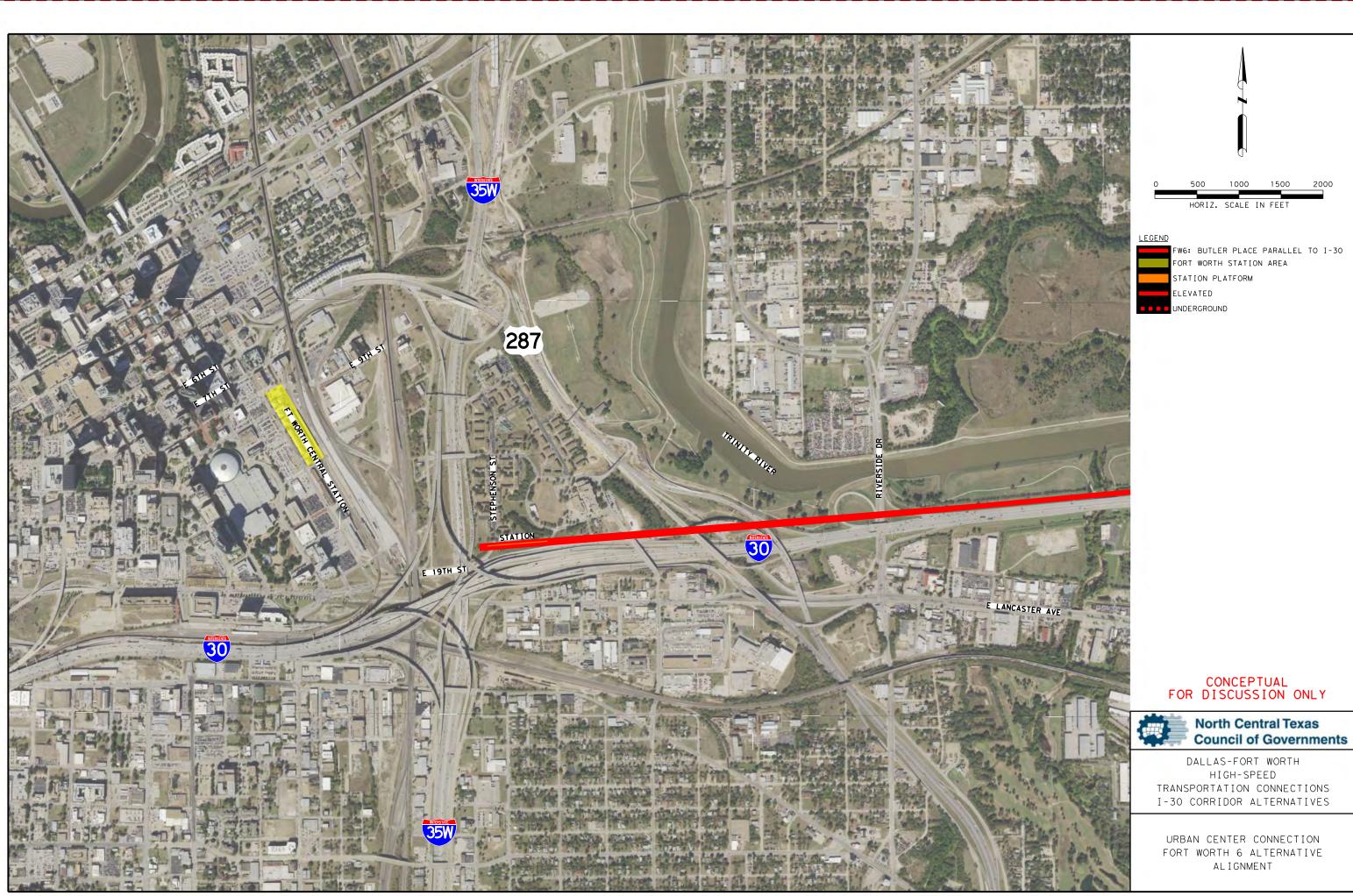


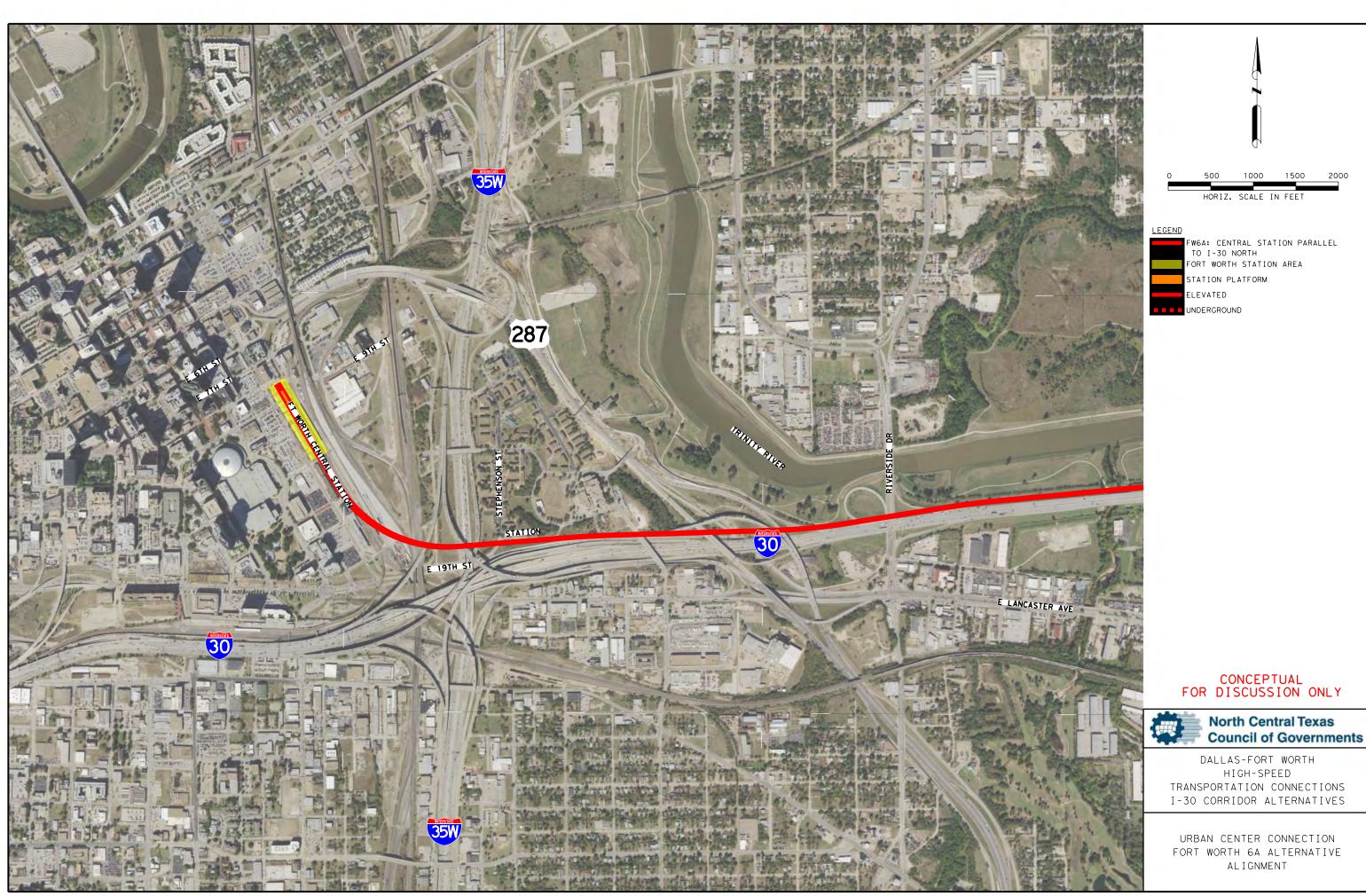


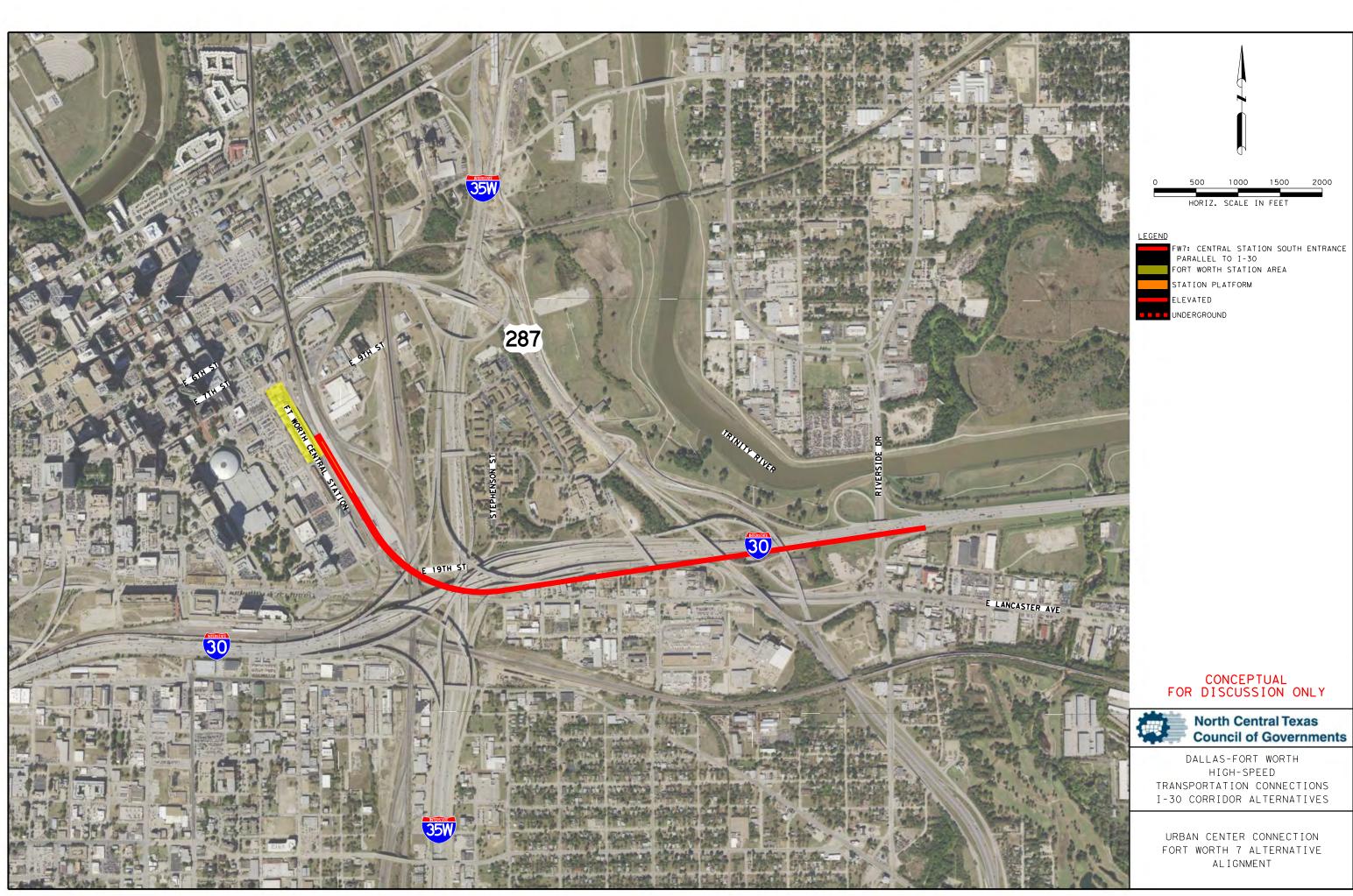




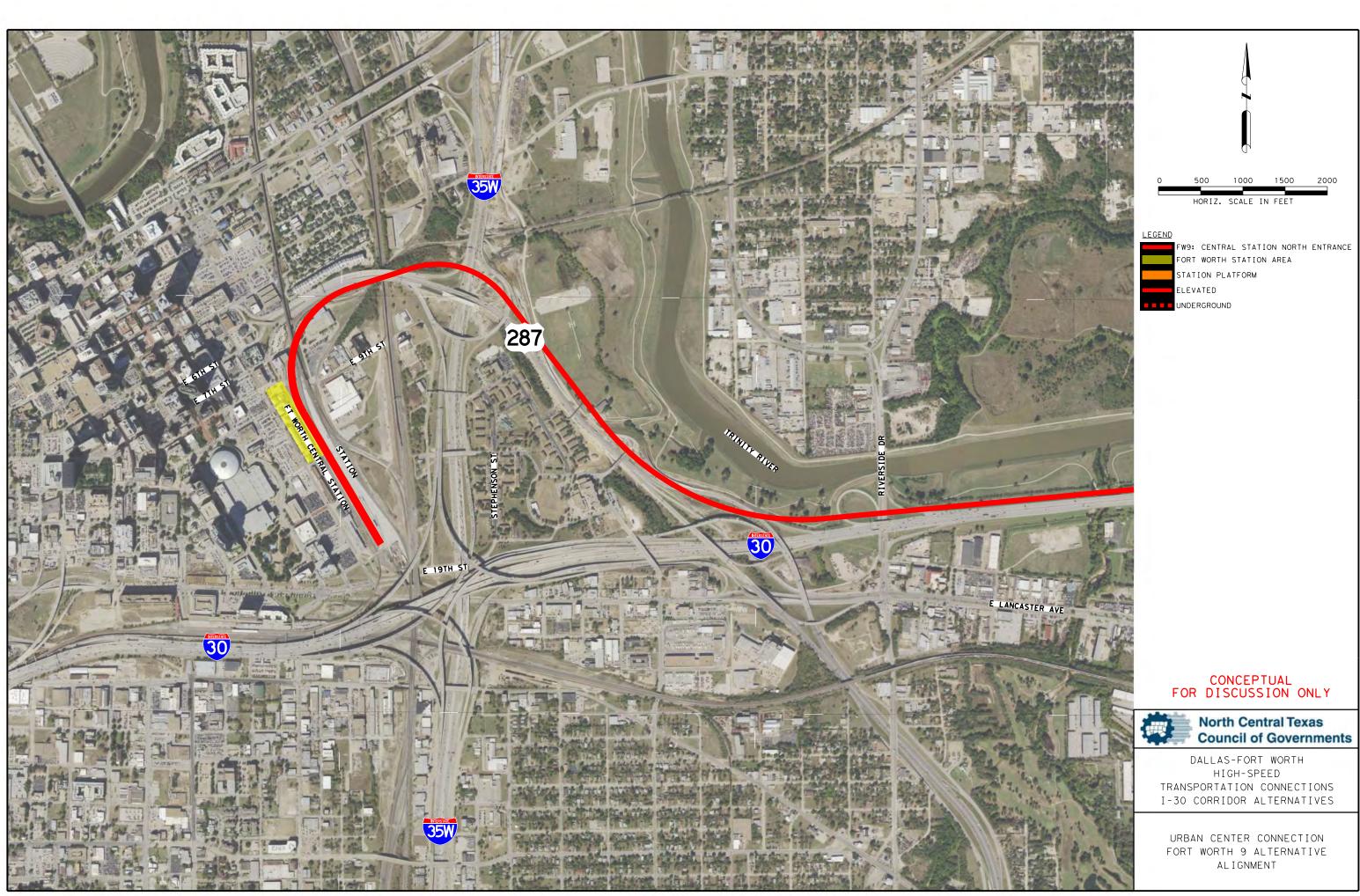




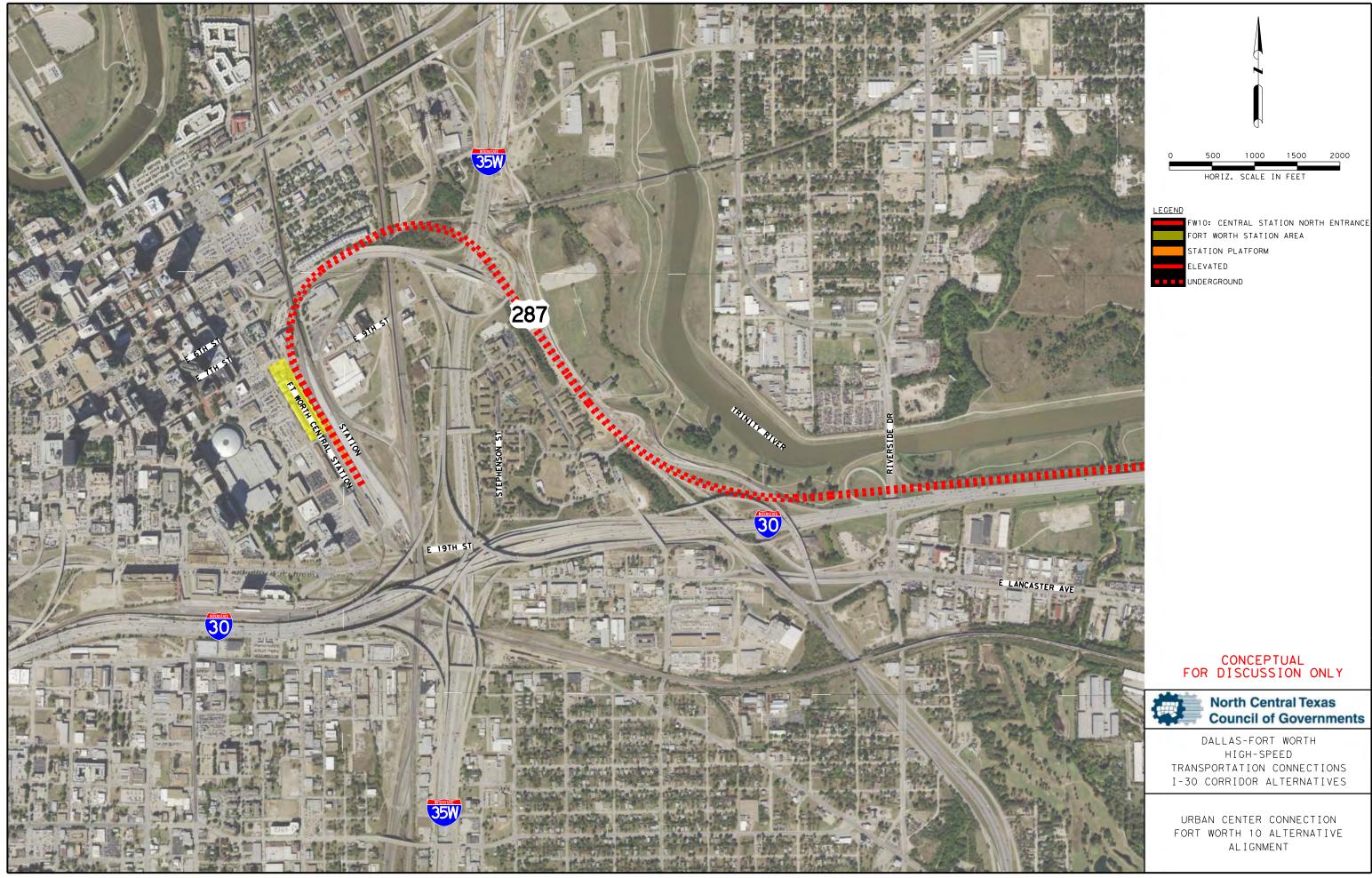


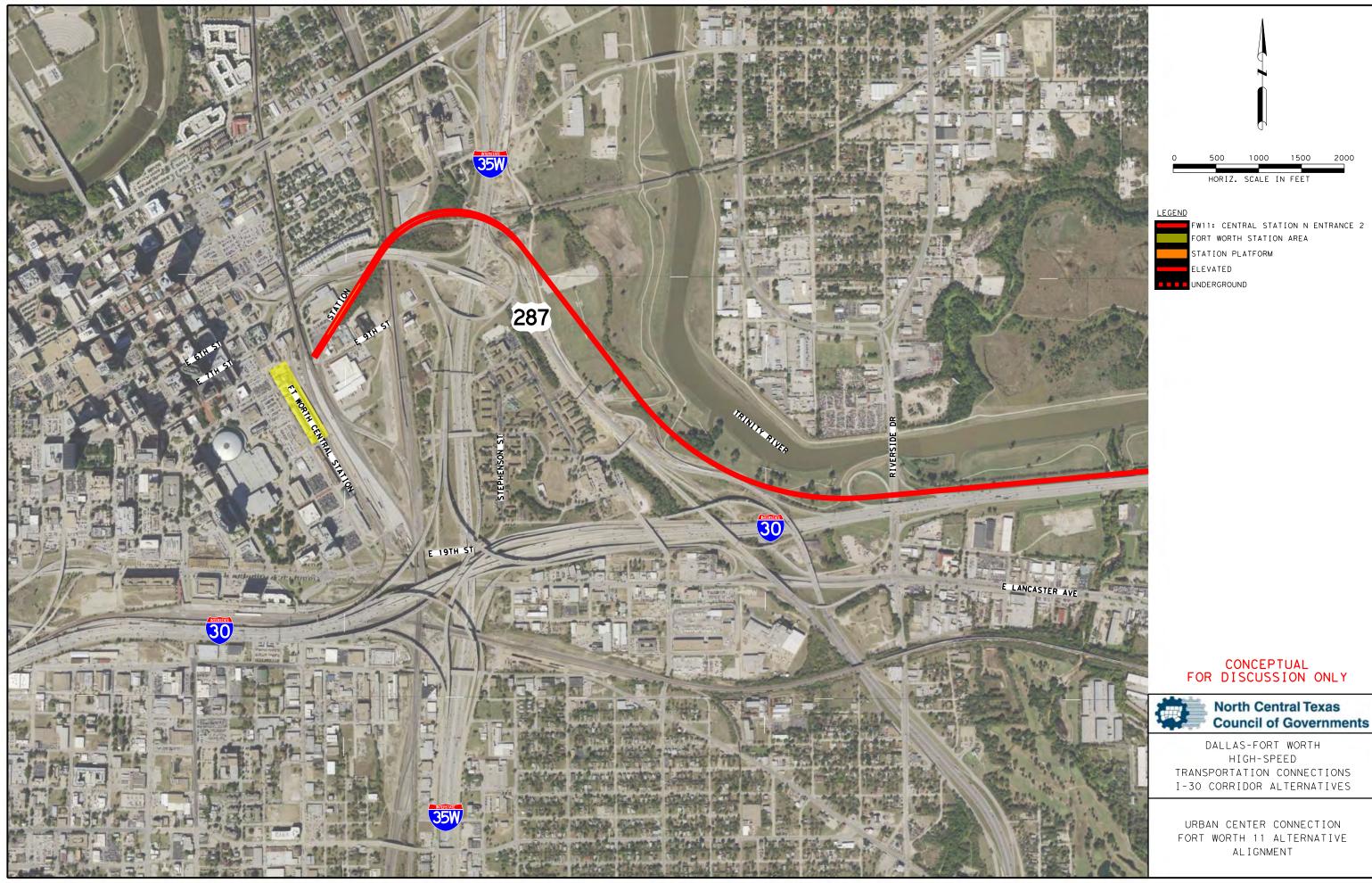








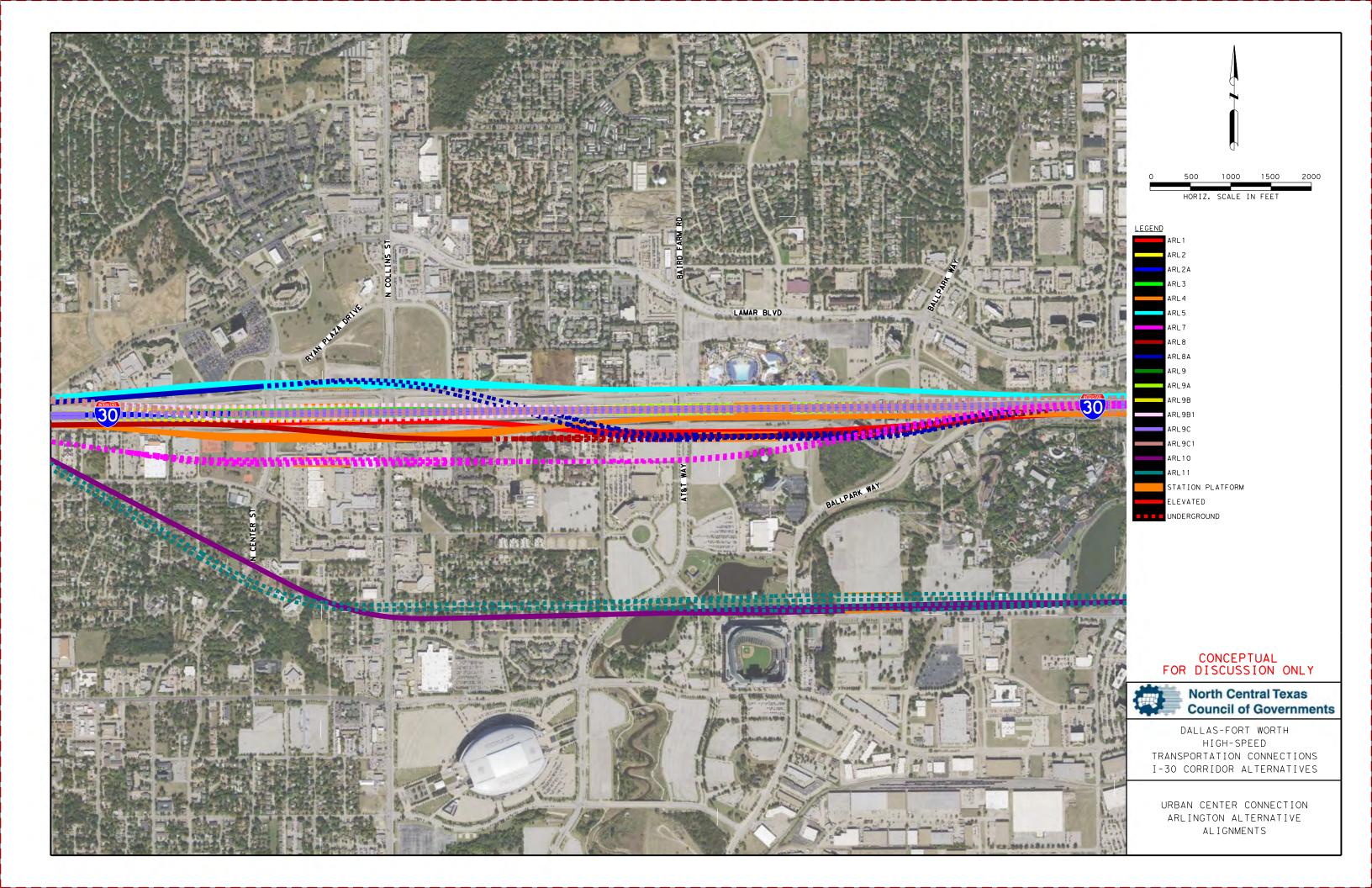


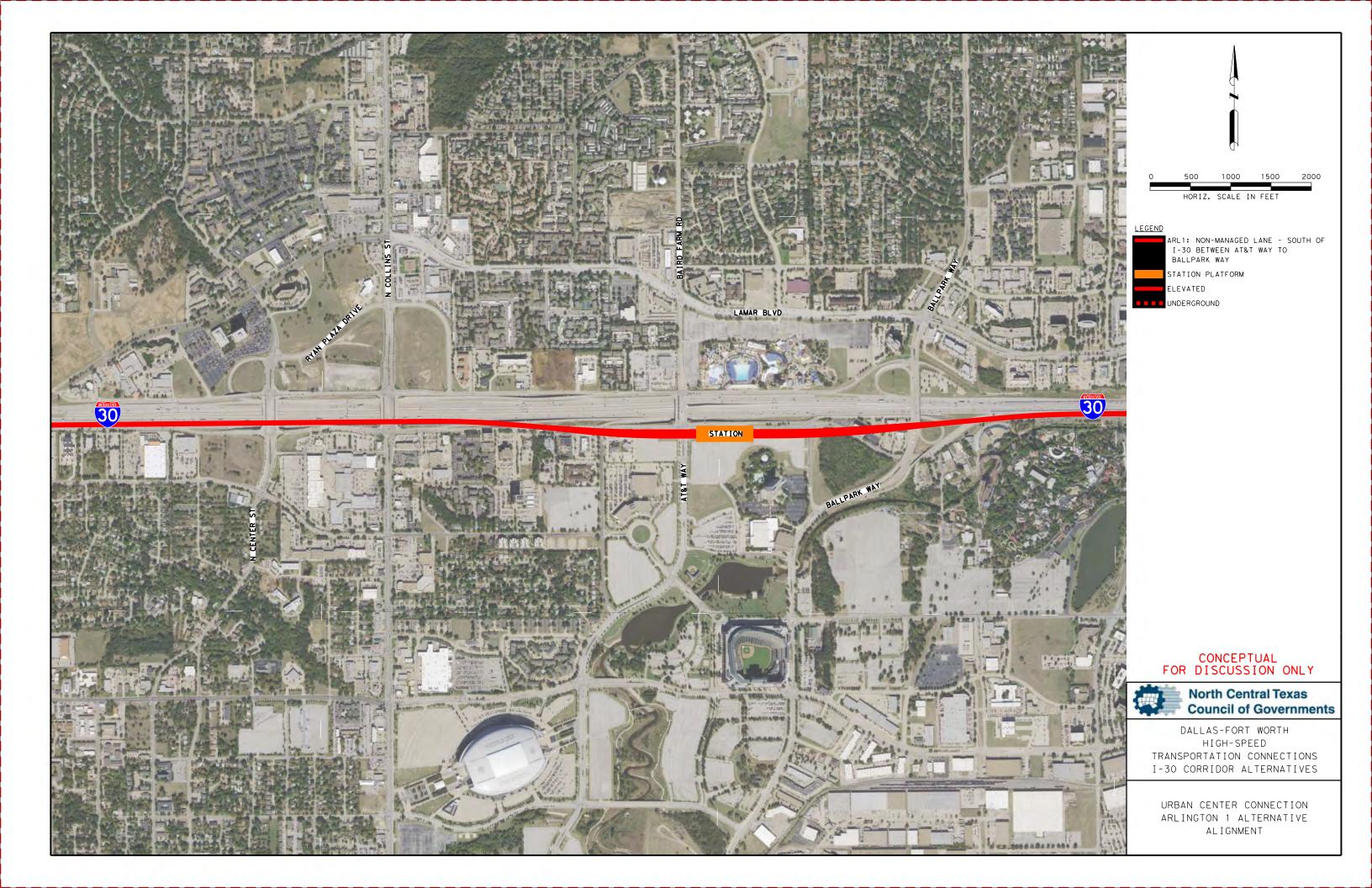


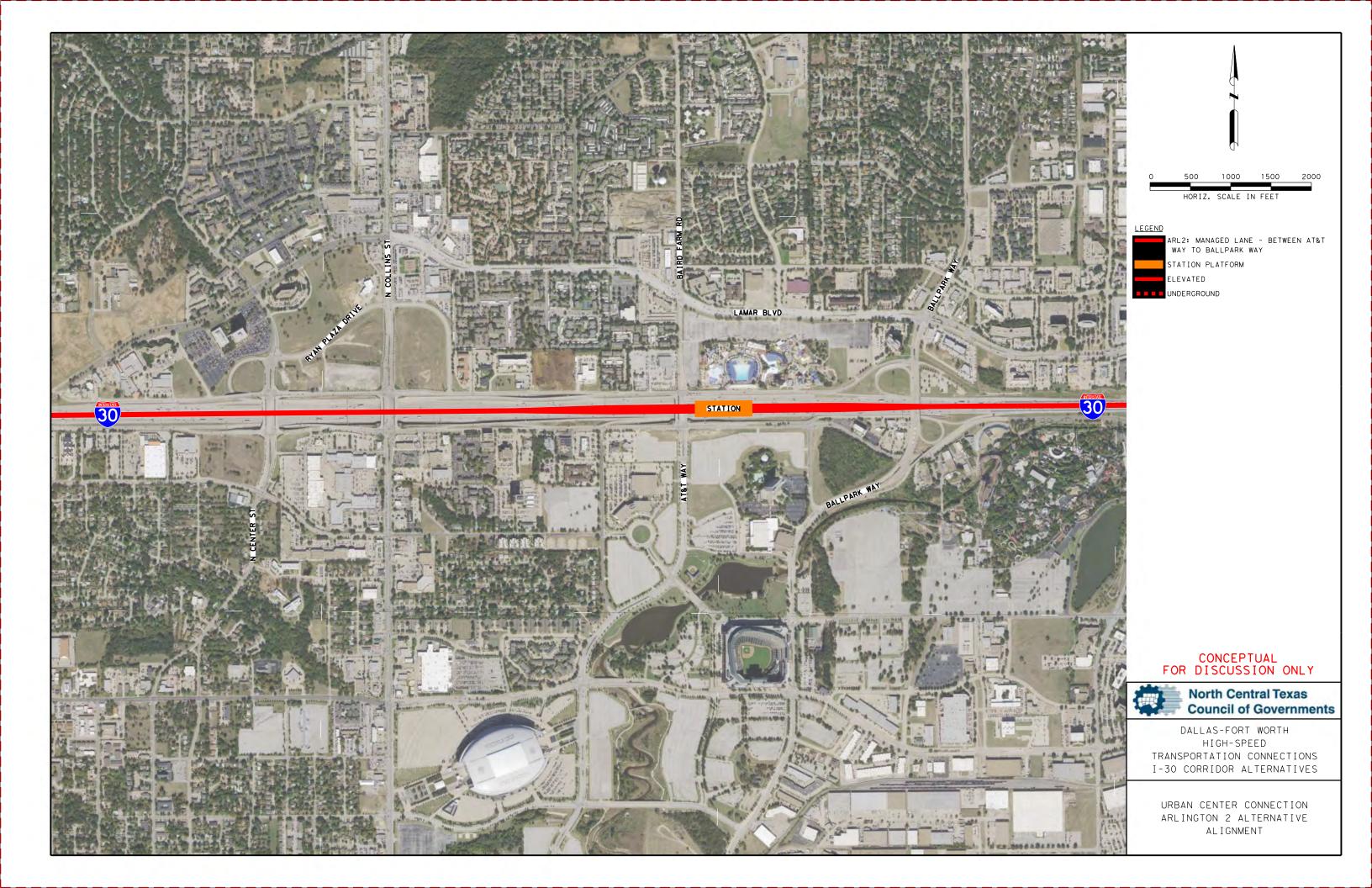
Phase 1 Alternative Analysis Final Report Volume II

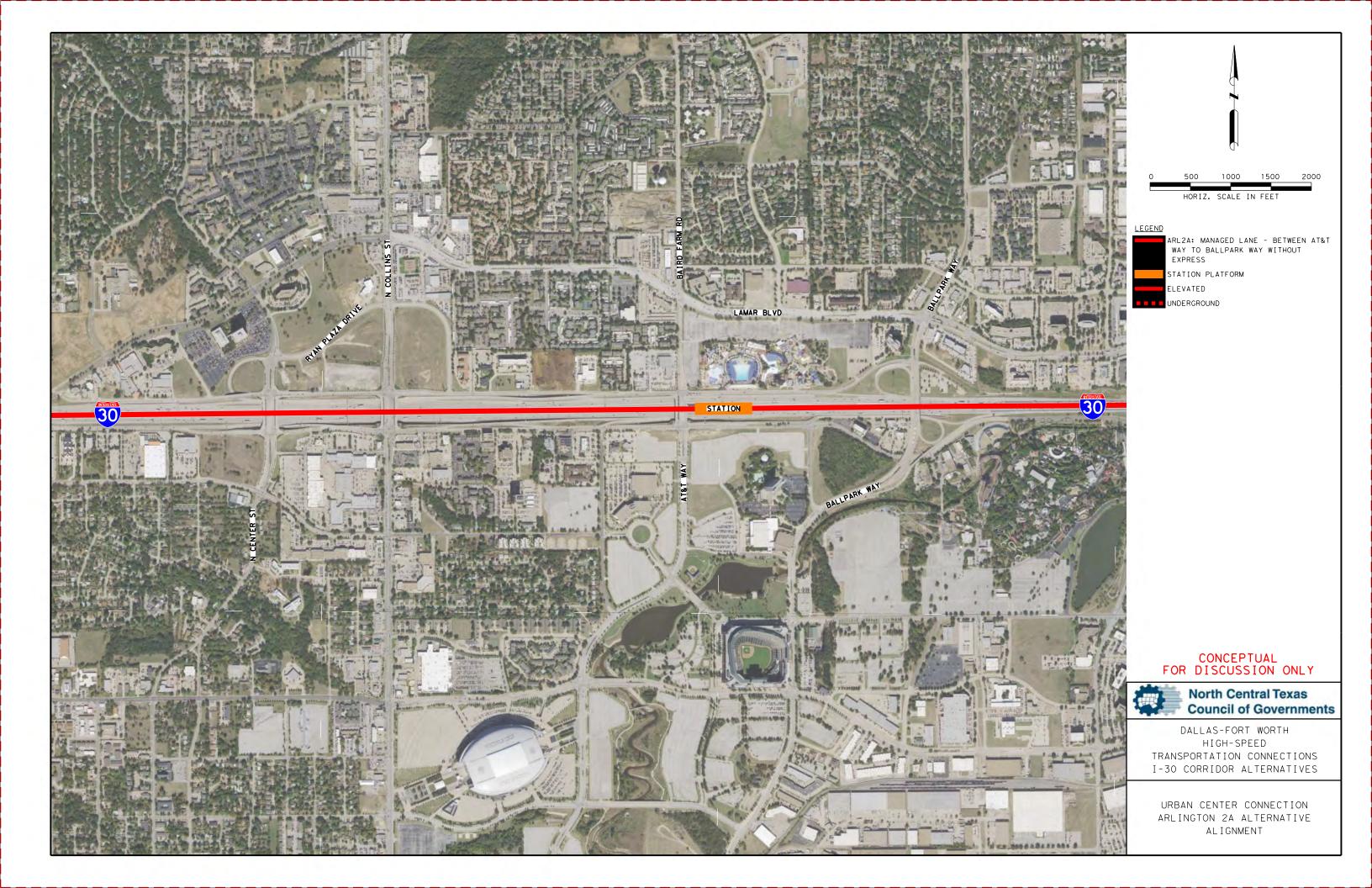
> Appendix II-G Arlington Station Connection Concepts

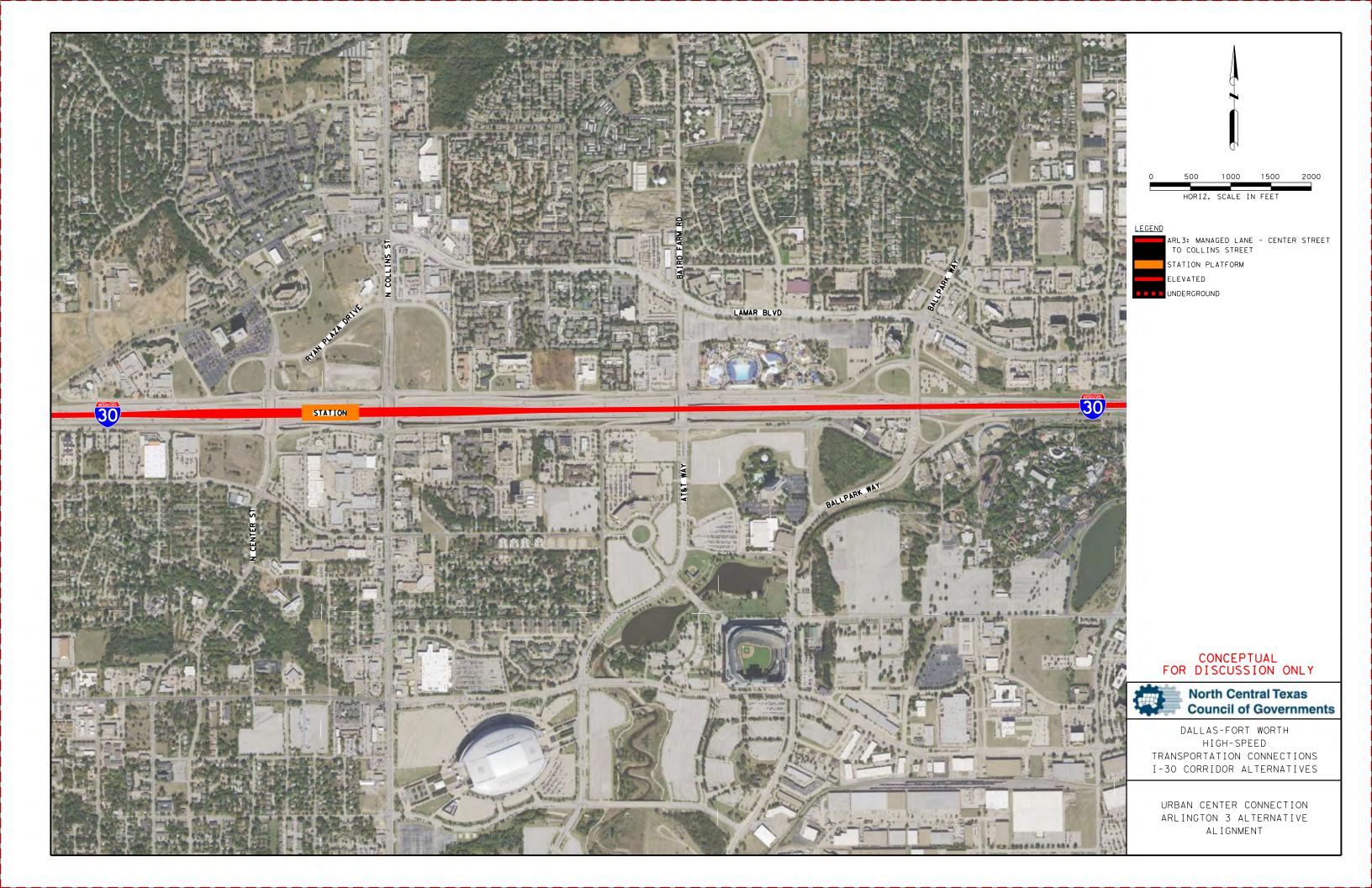


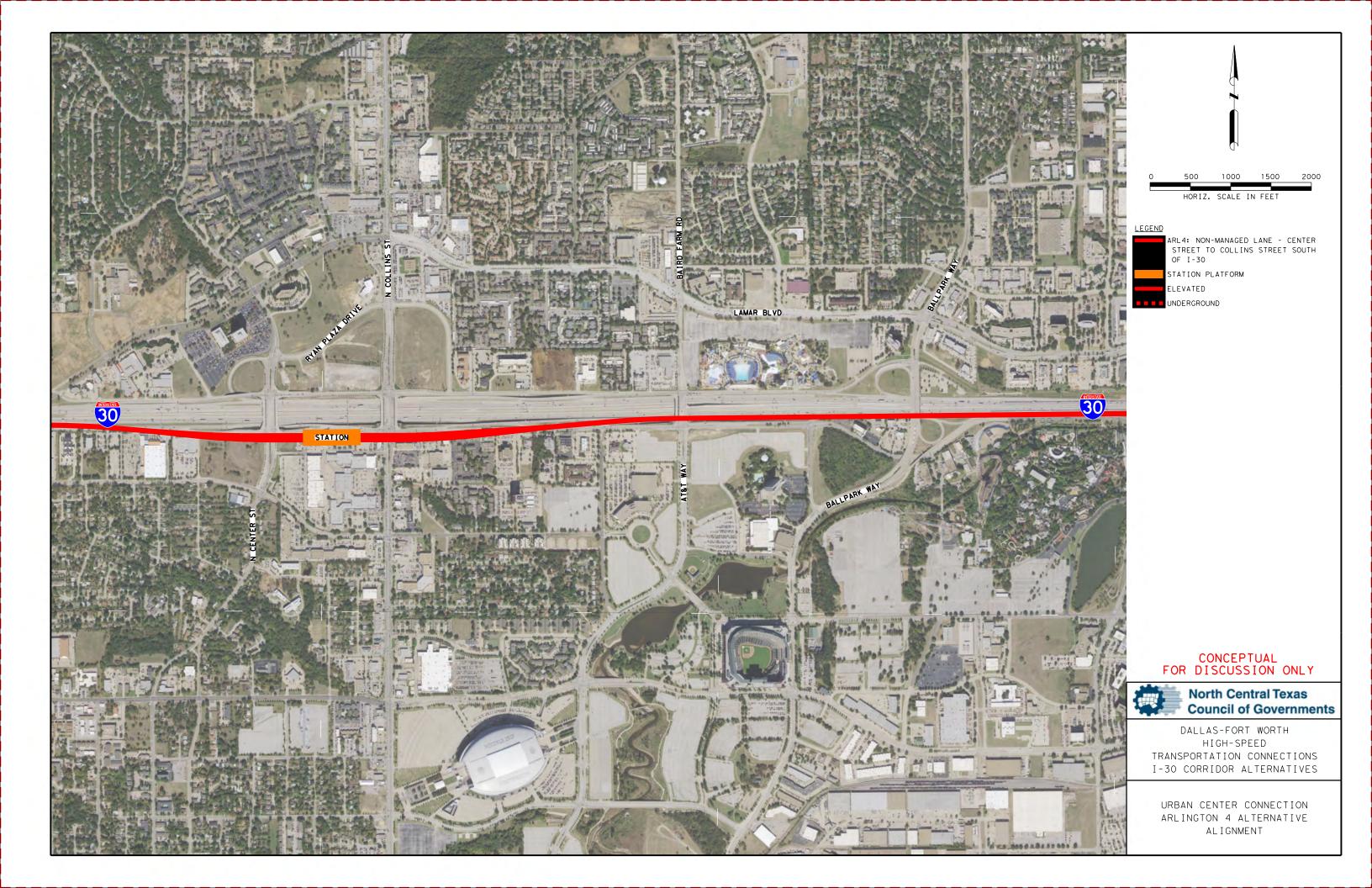


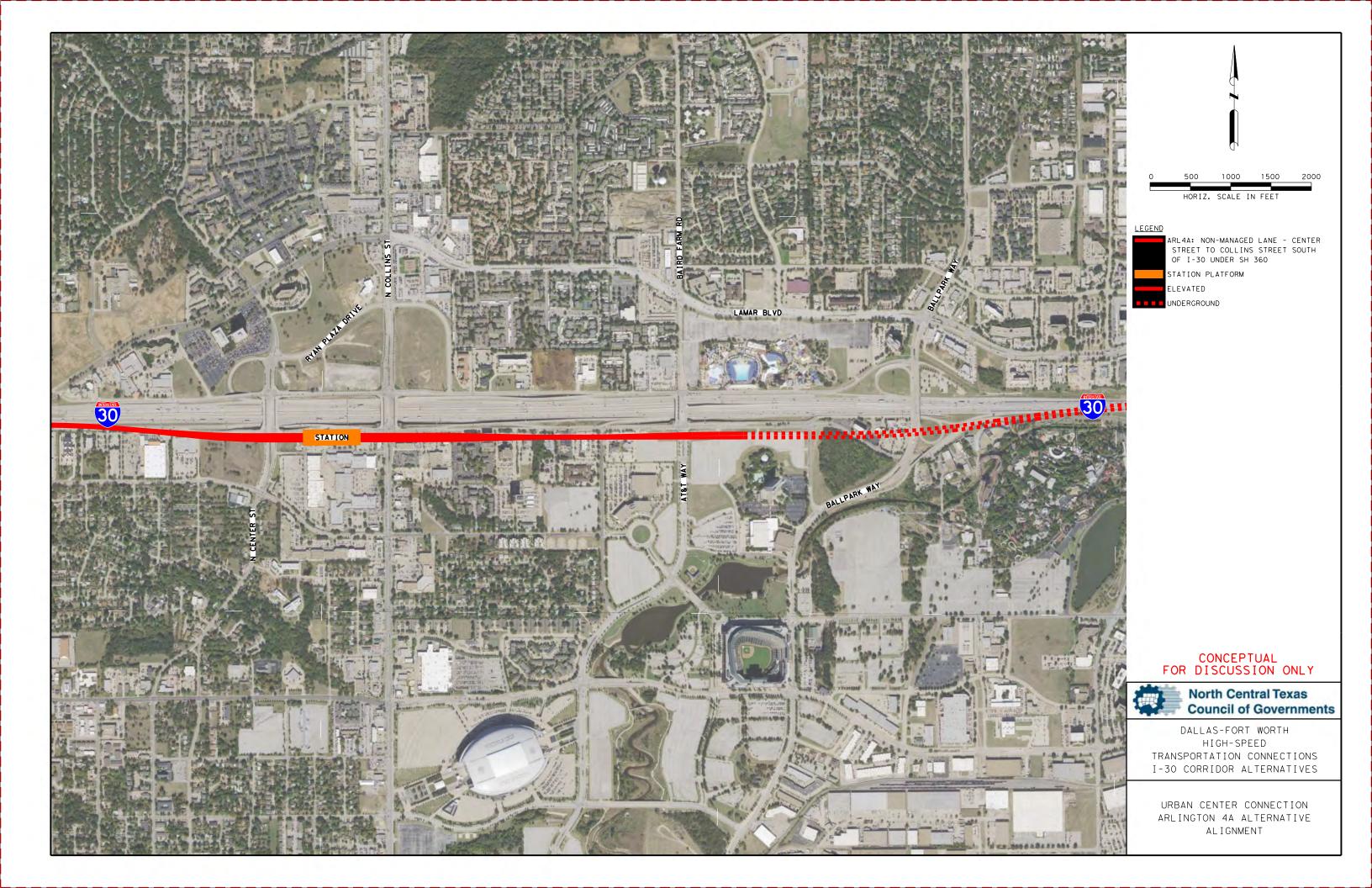


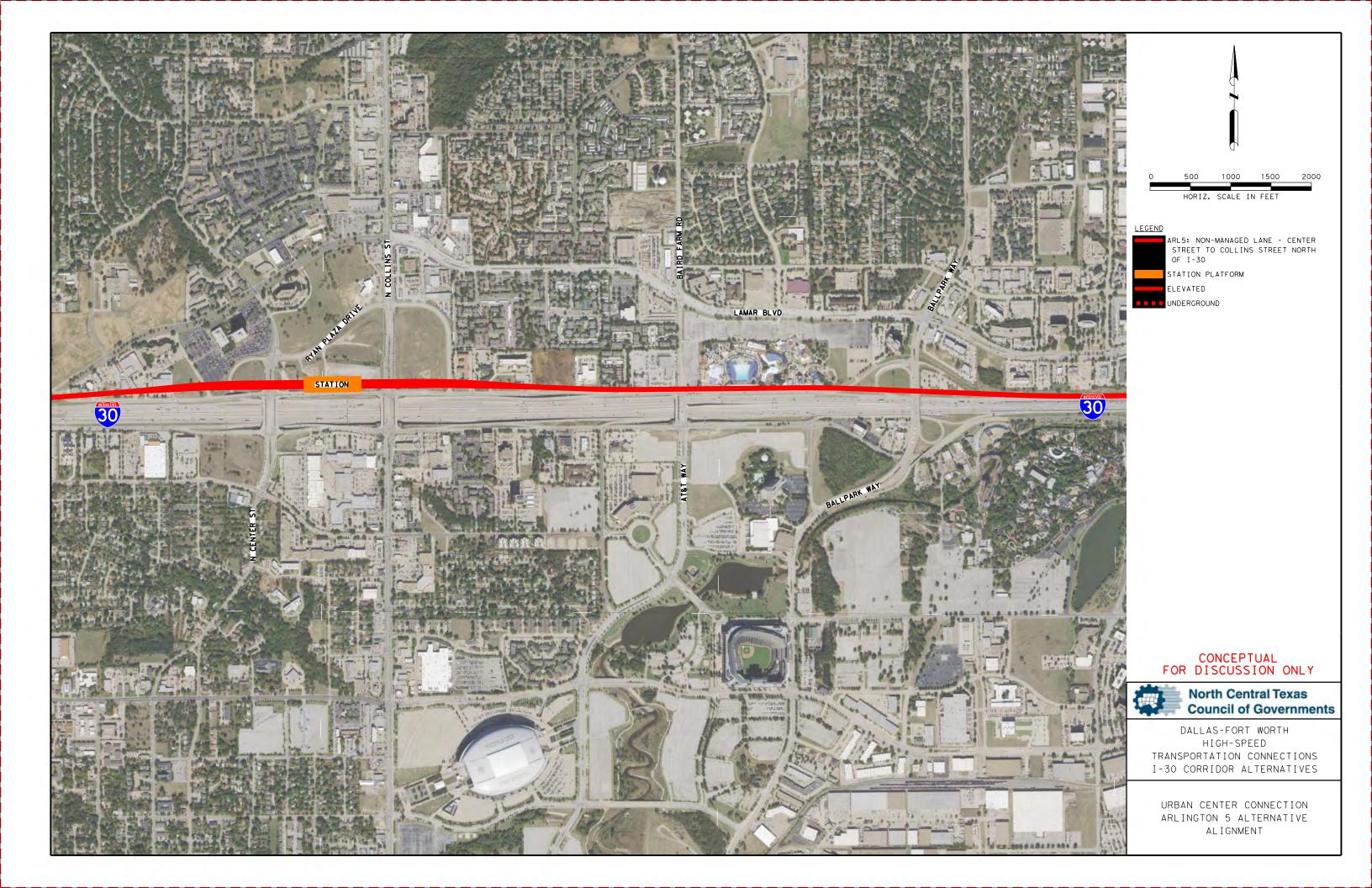


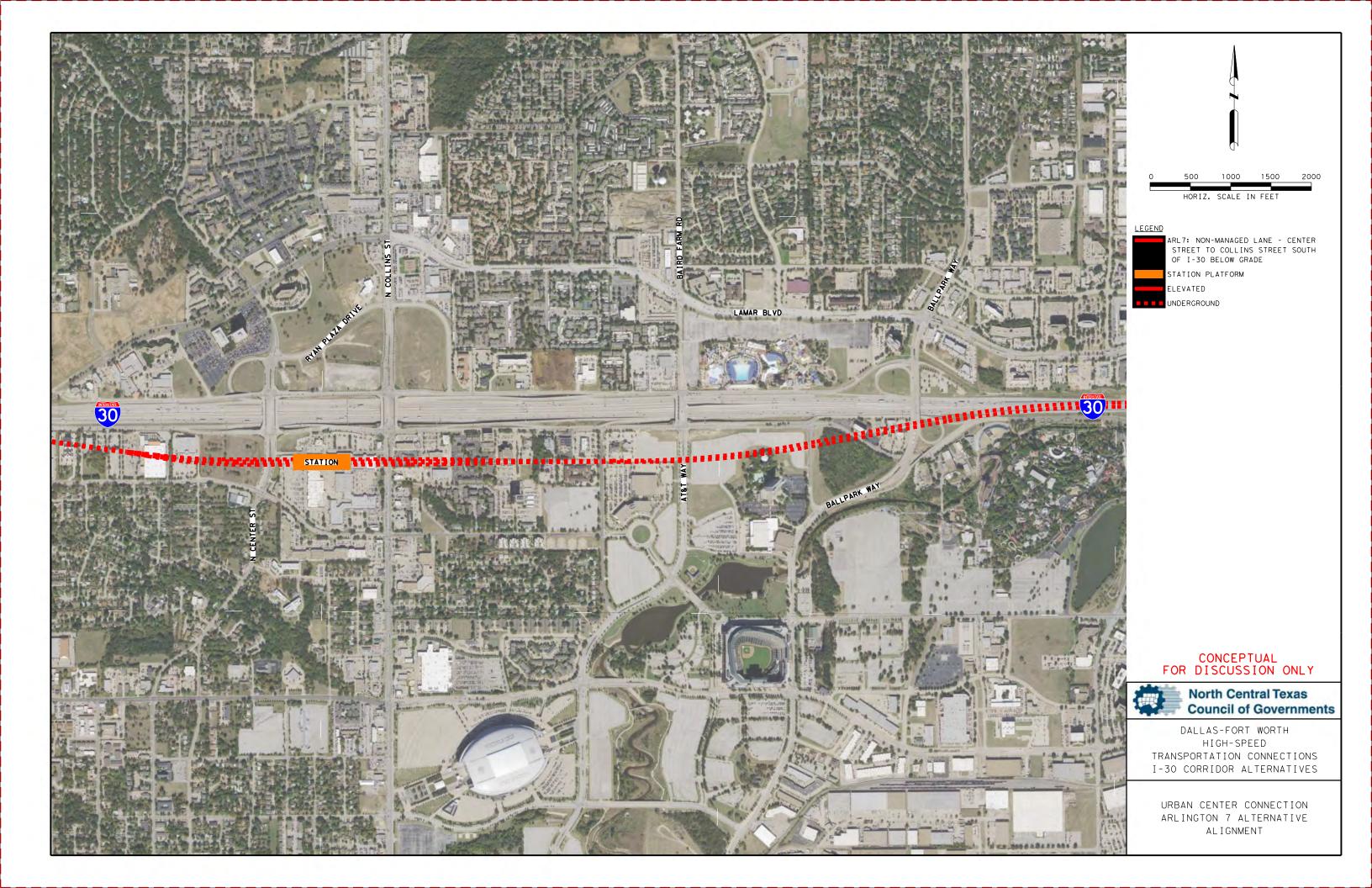


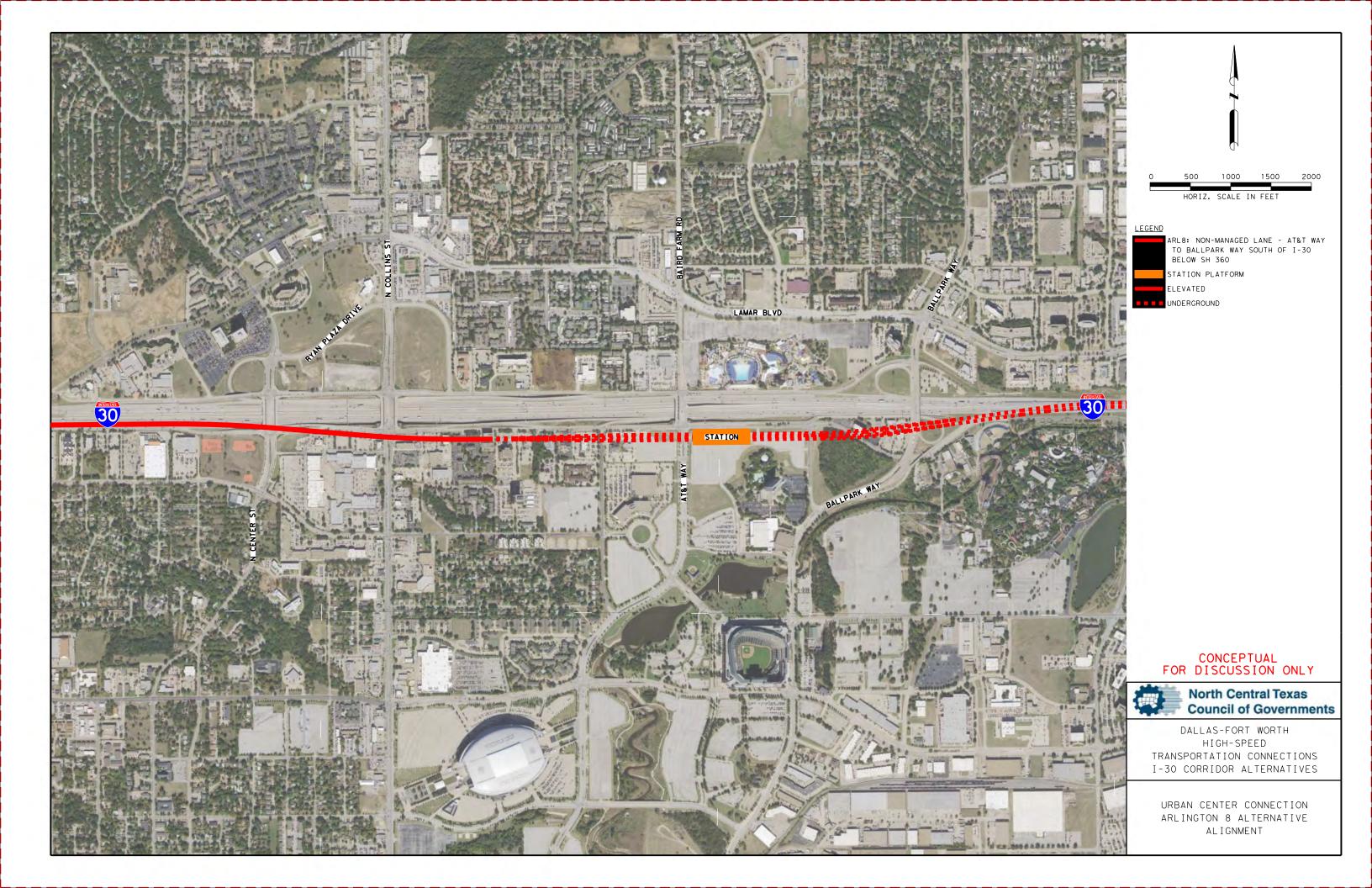


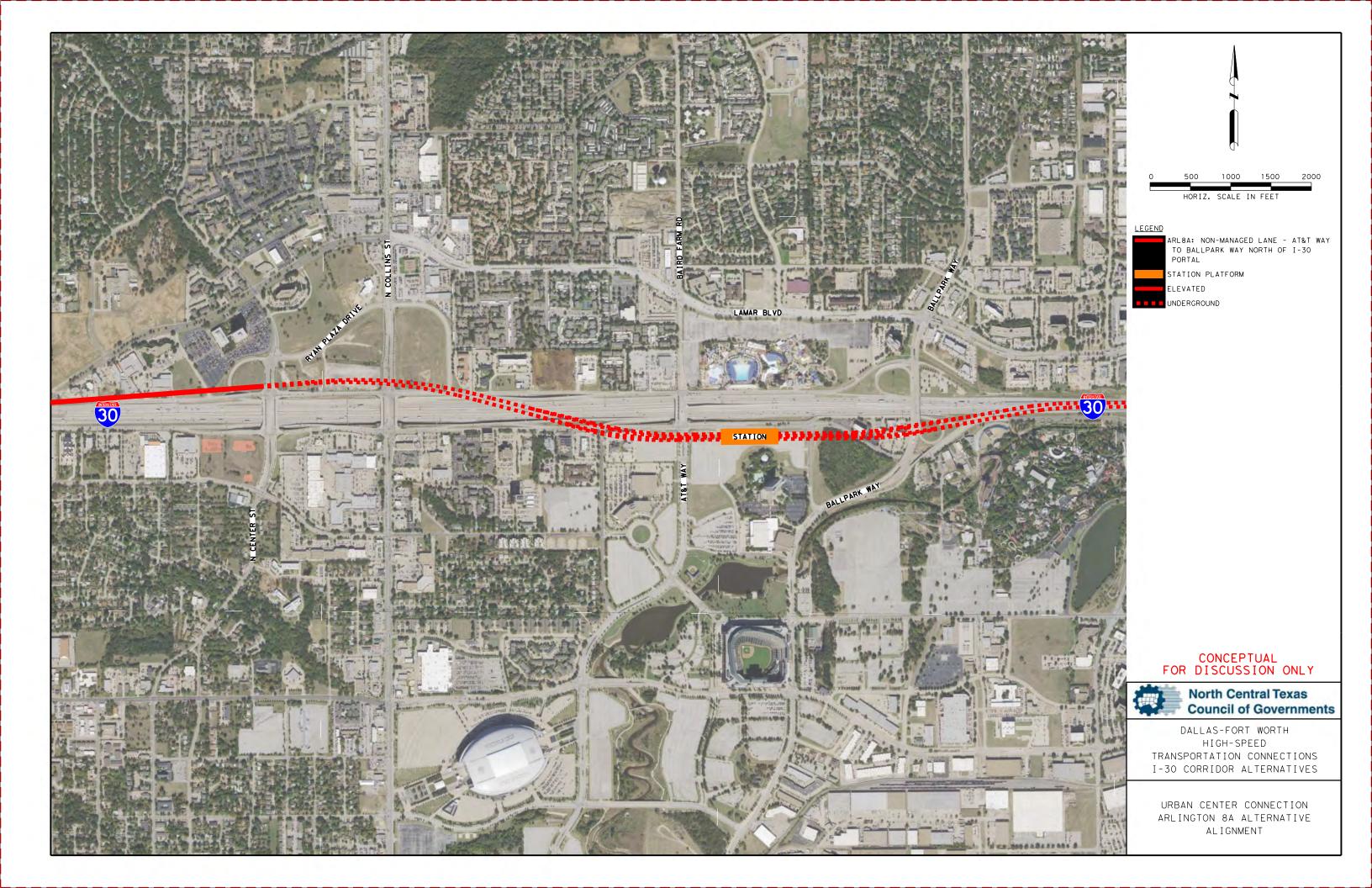


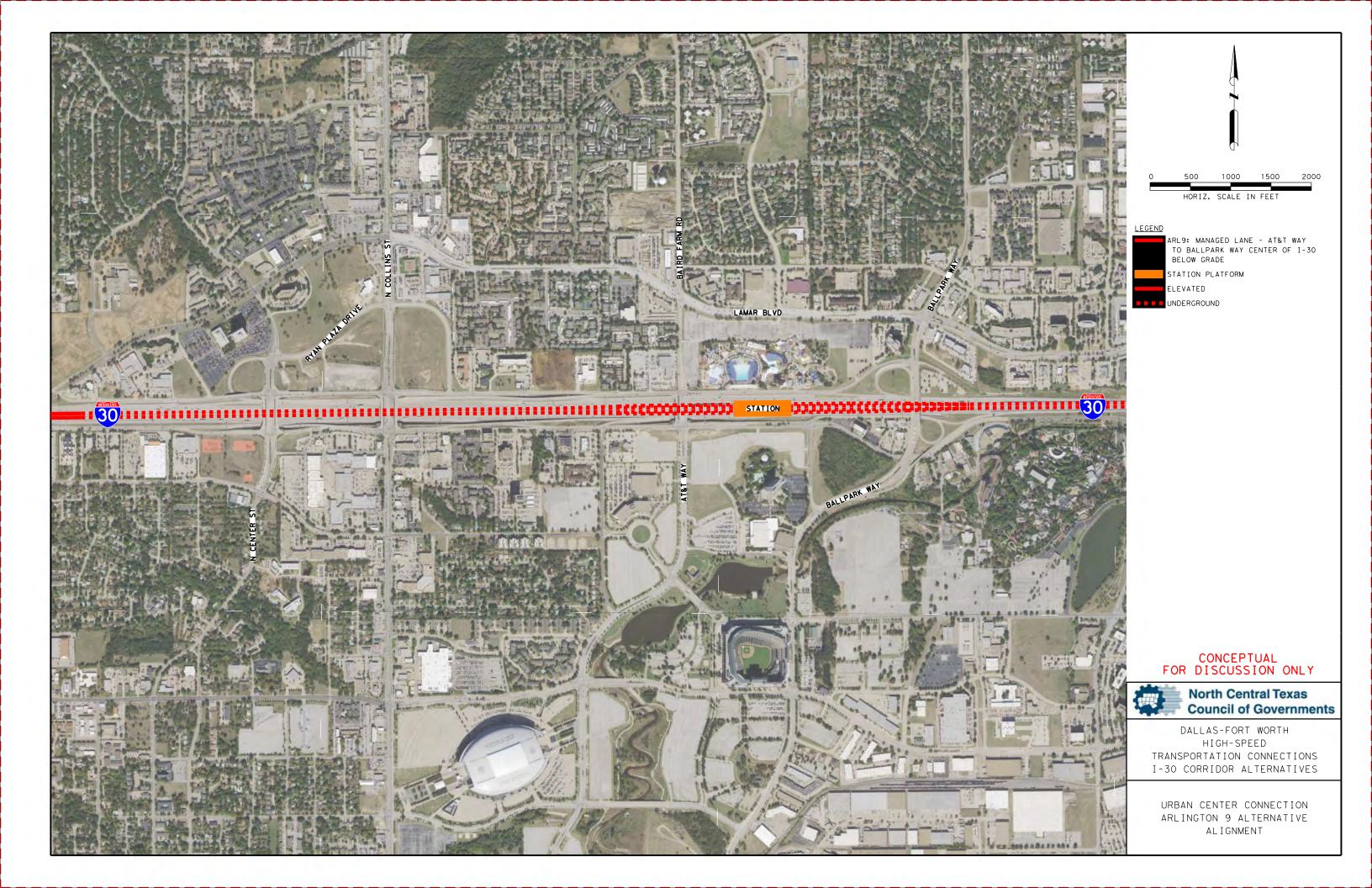


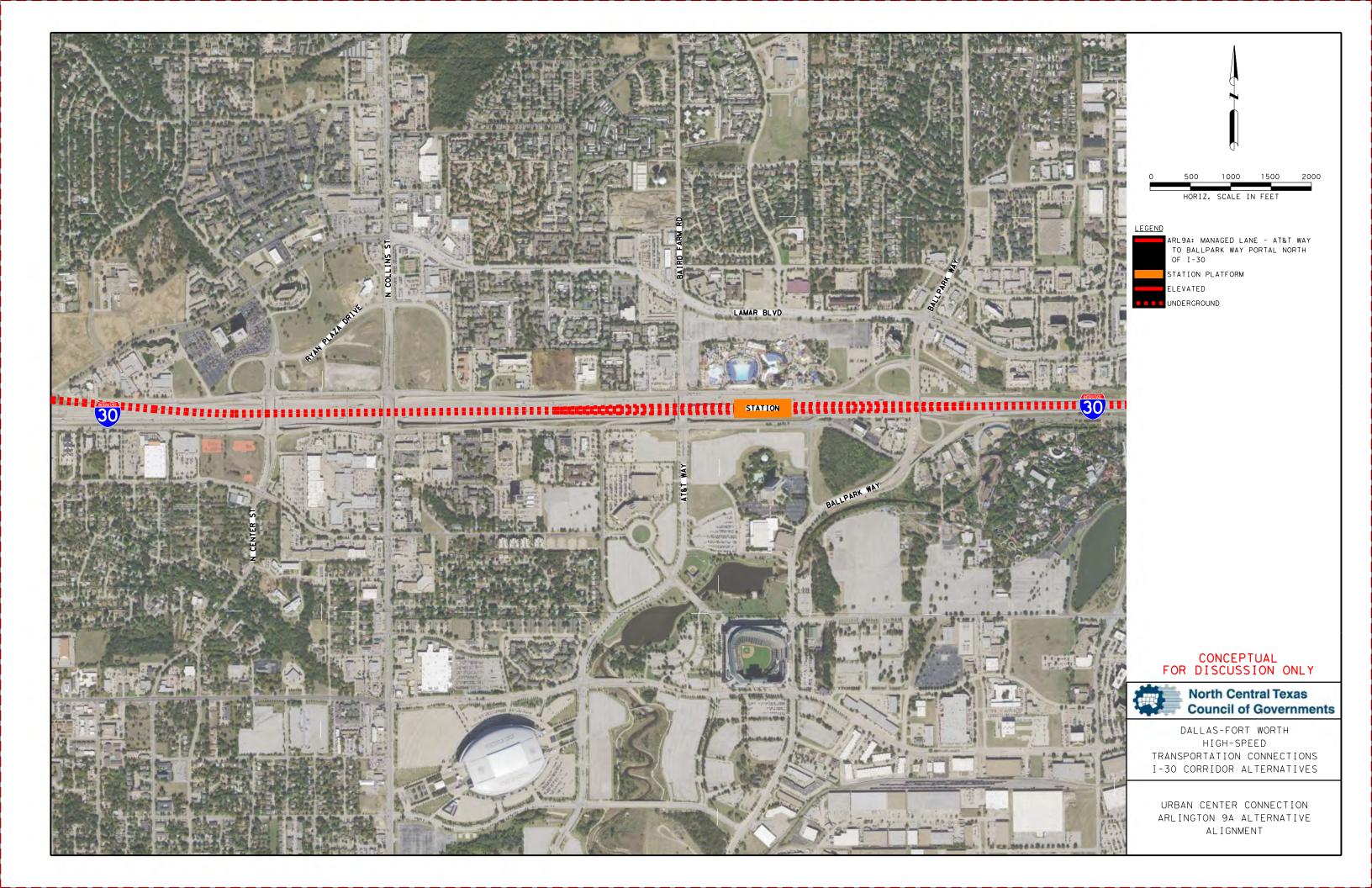


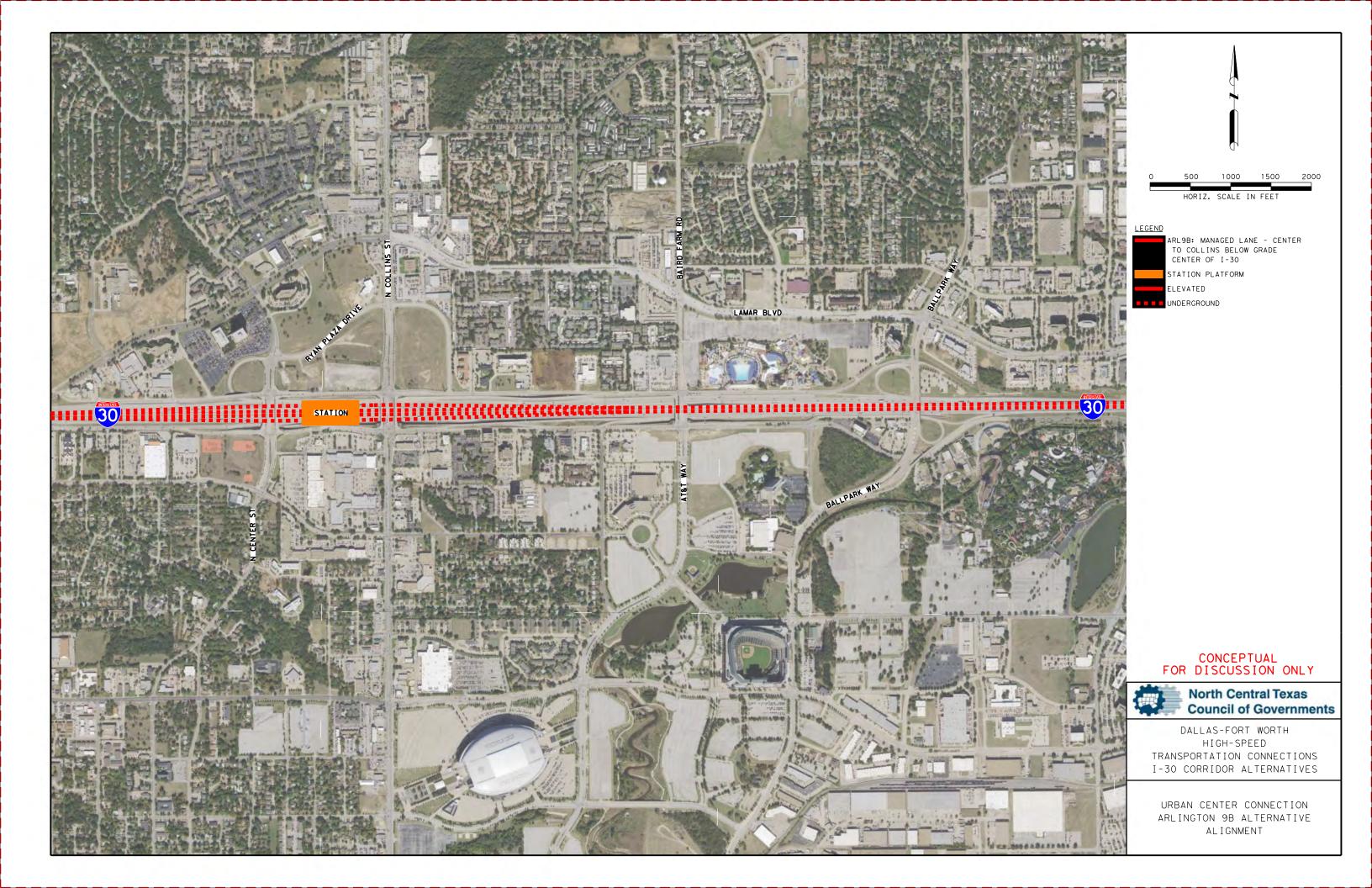


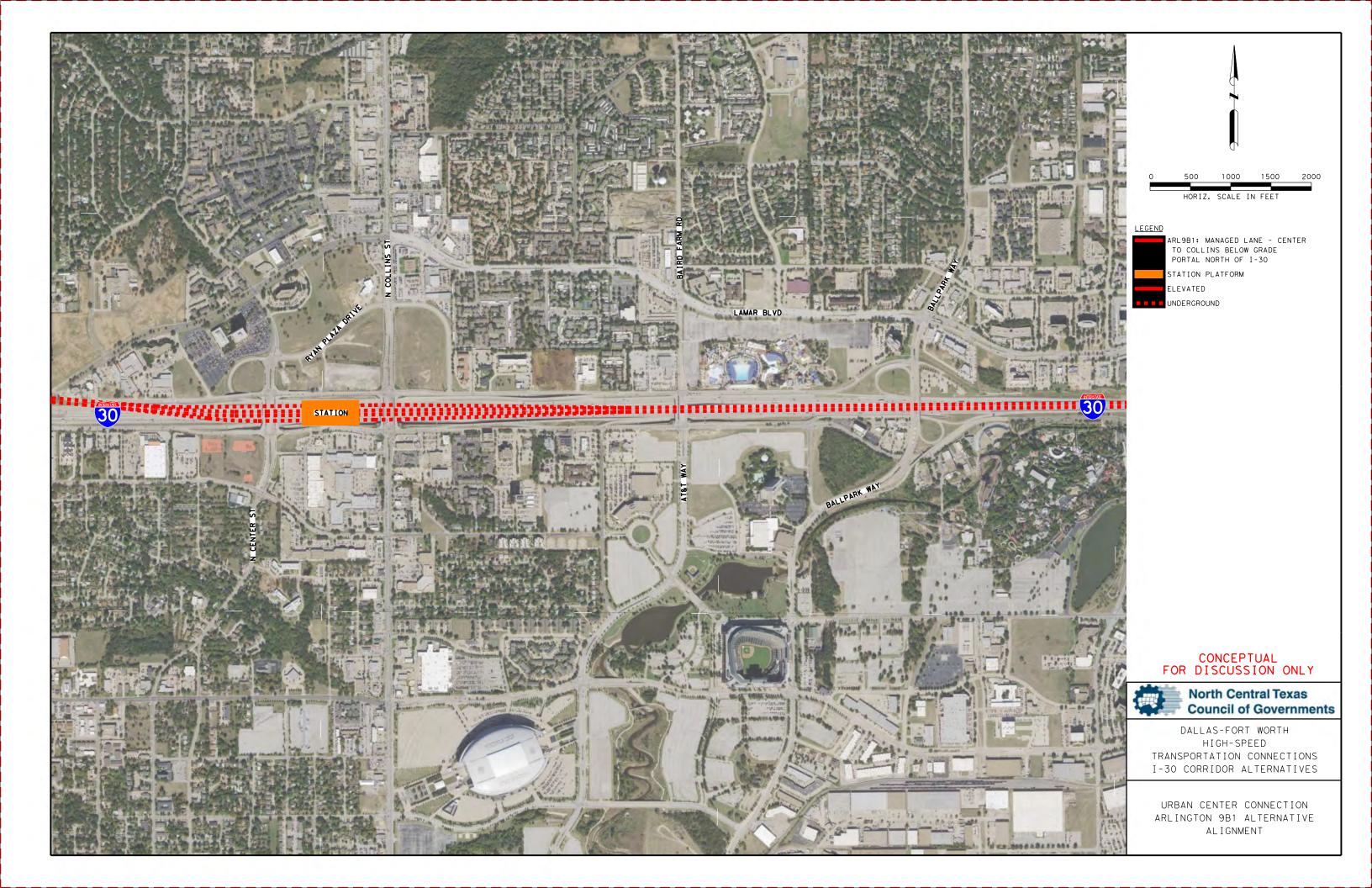


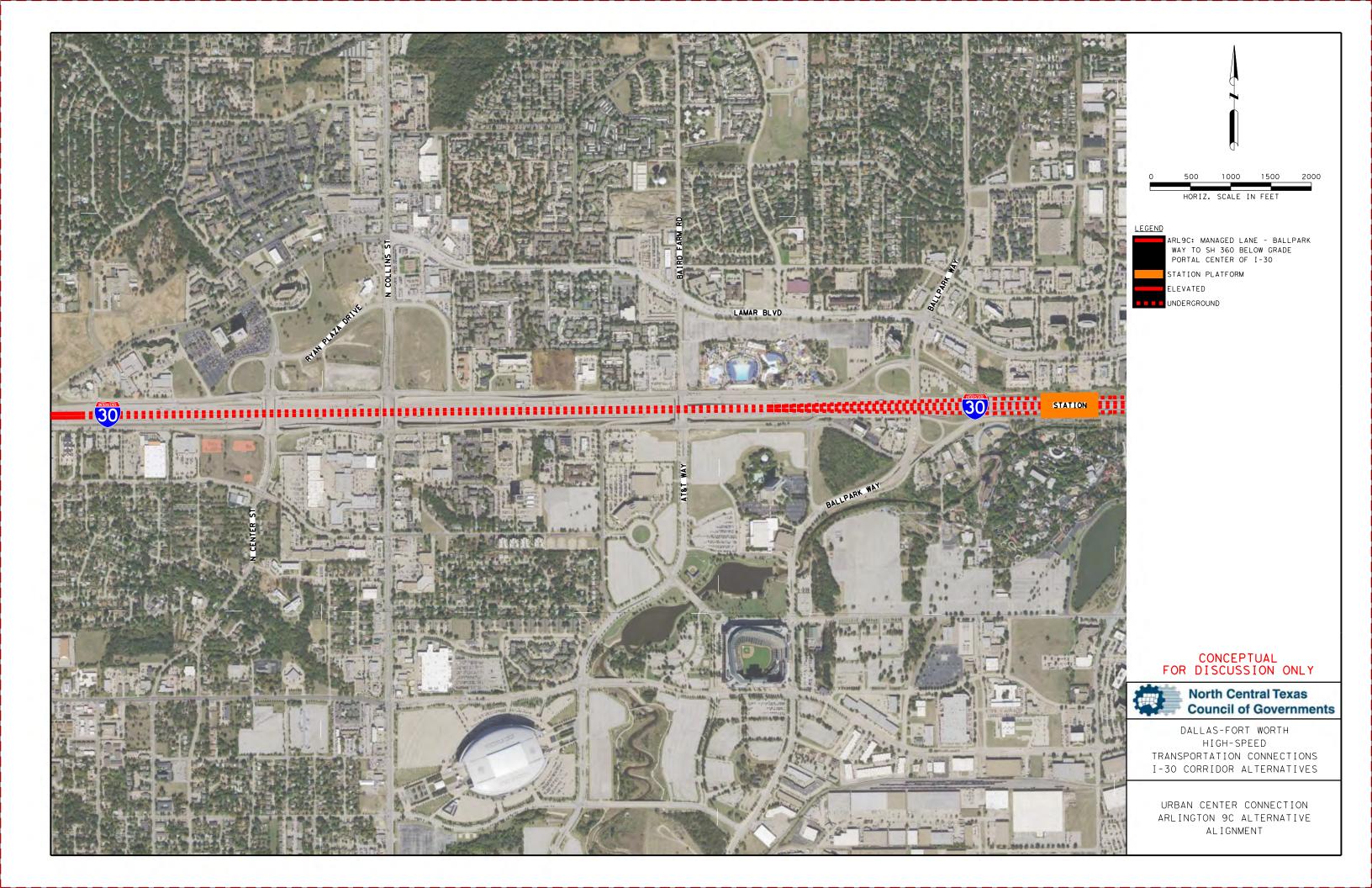


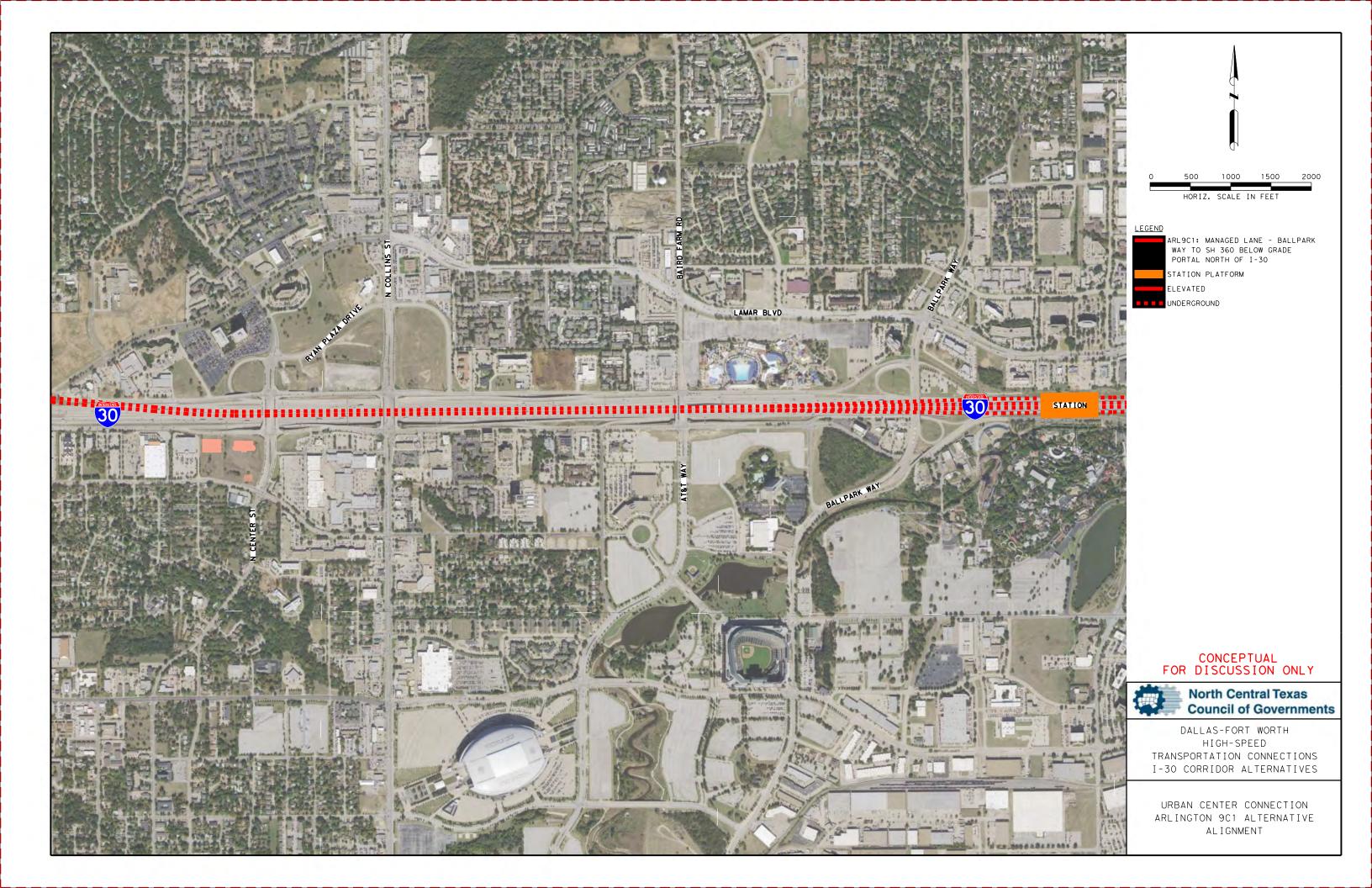




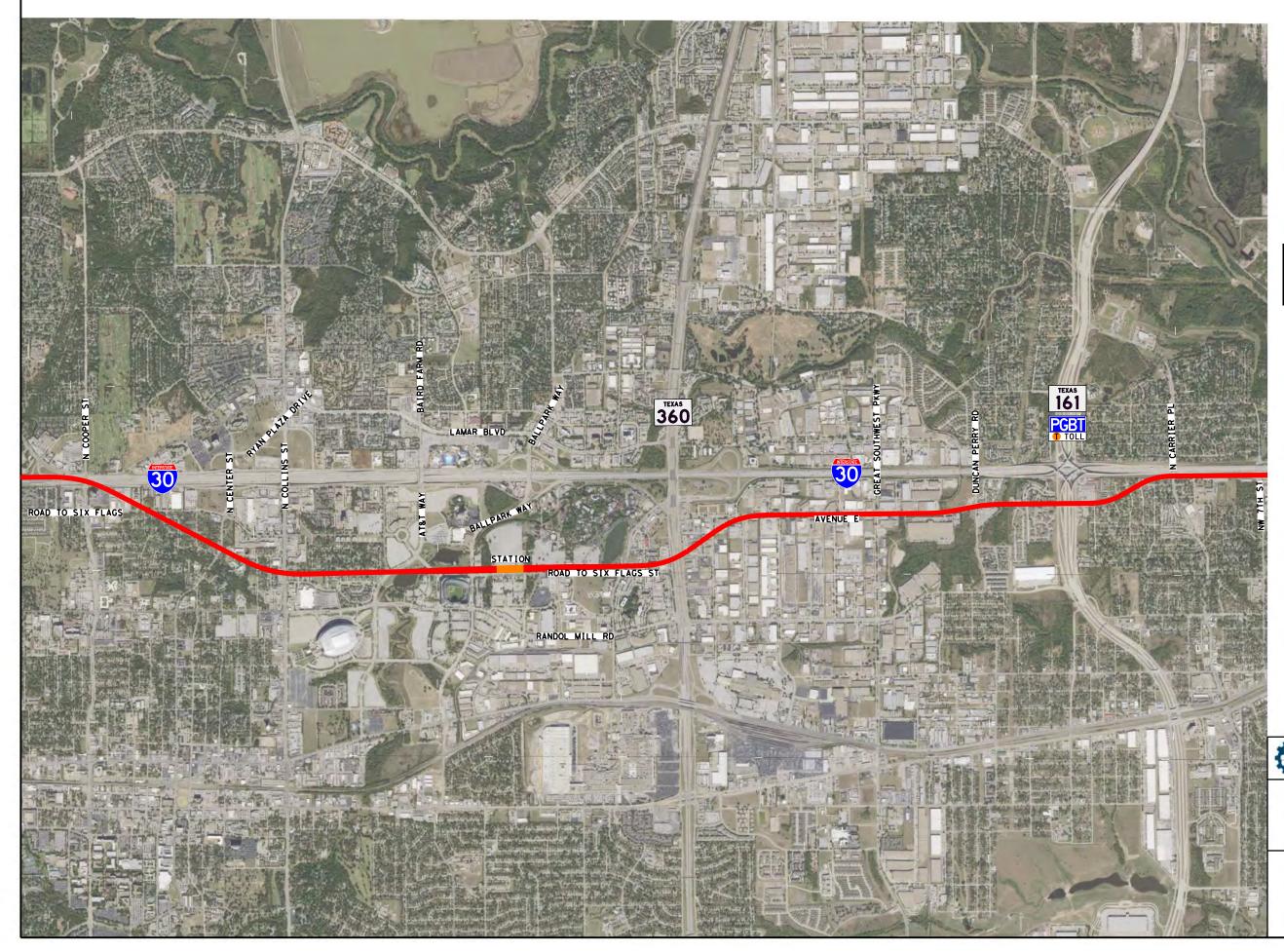


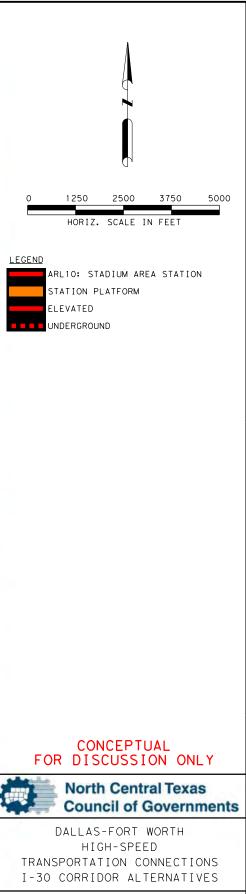




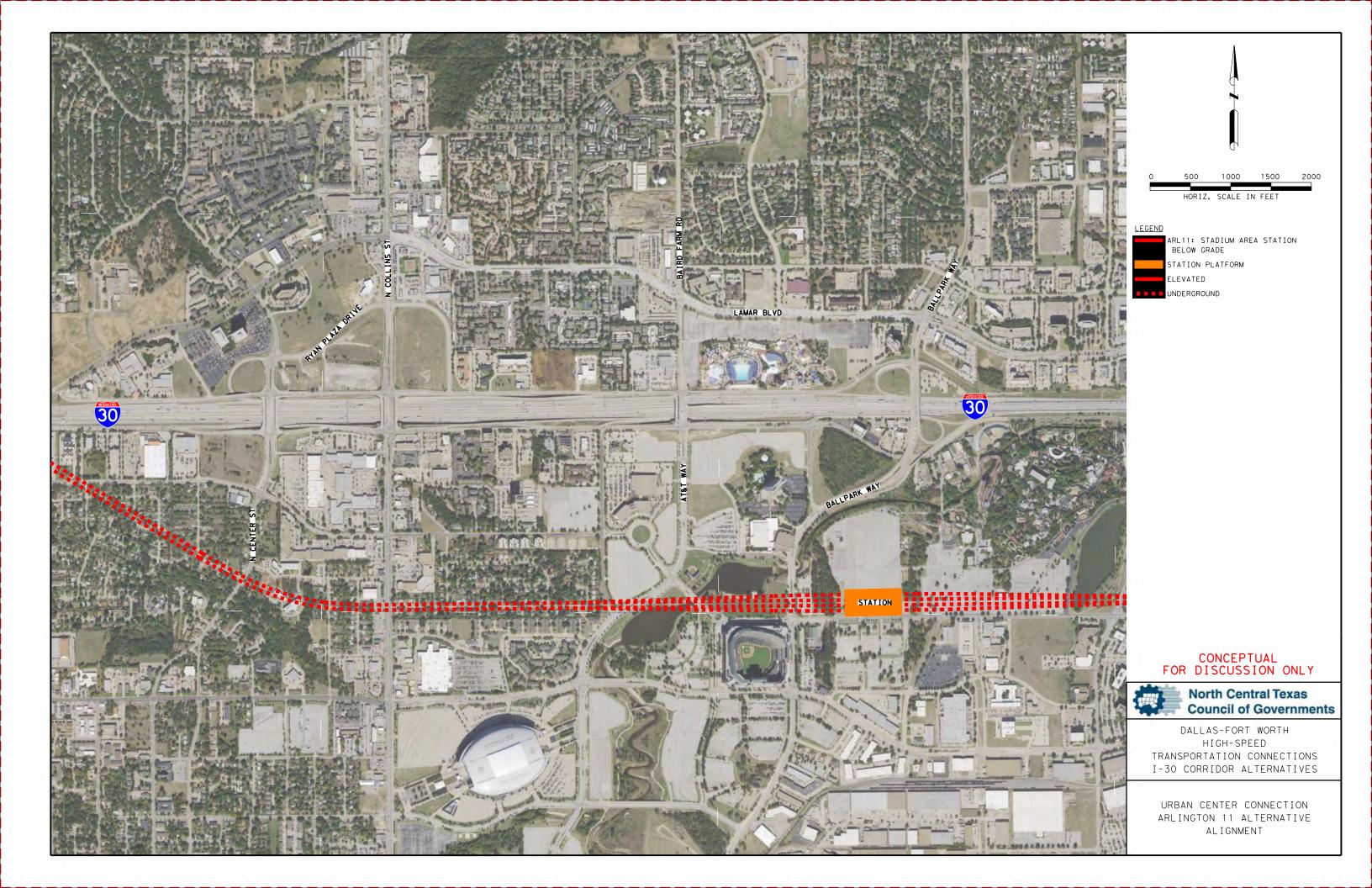


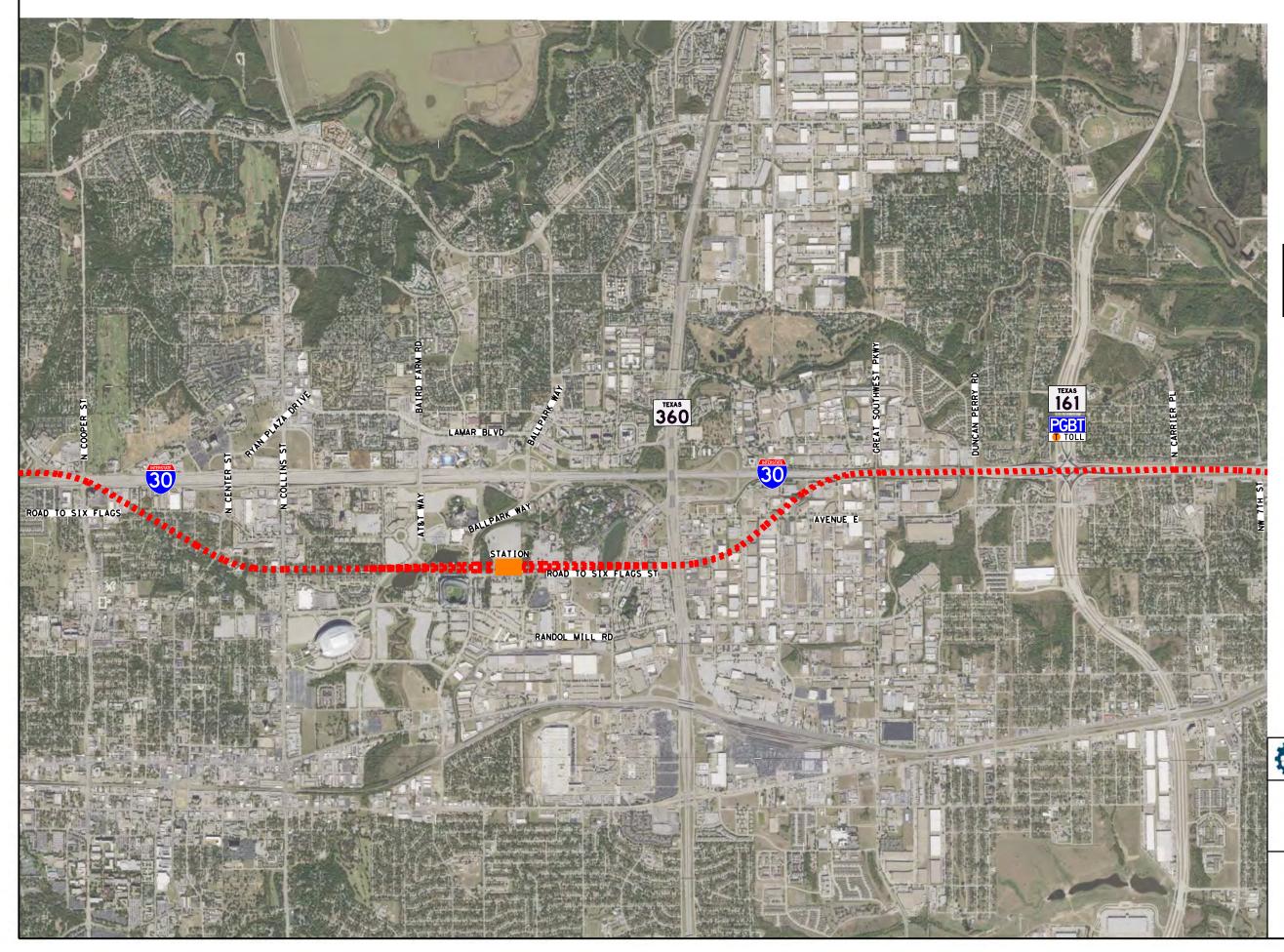


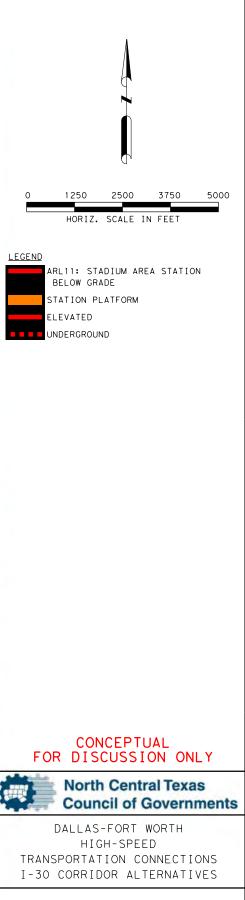




URBAN CENTER CONNECTION ARLINGTON 10 ALTERNATIVE ALIGNMENT



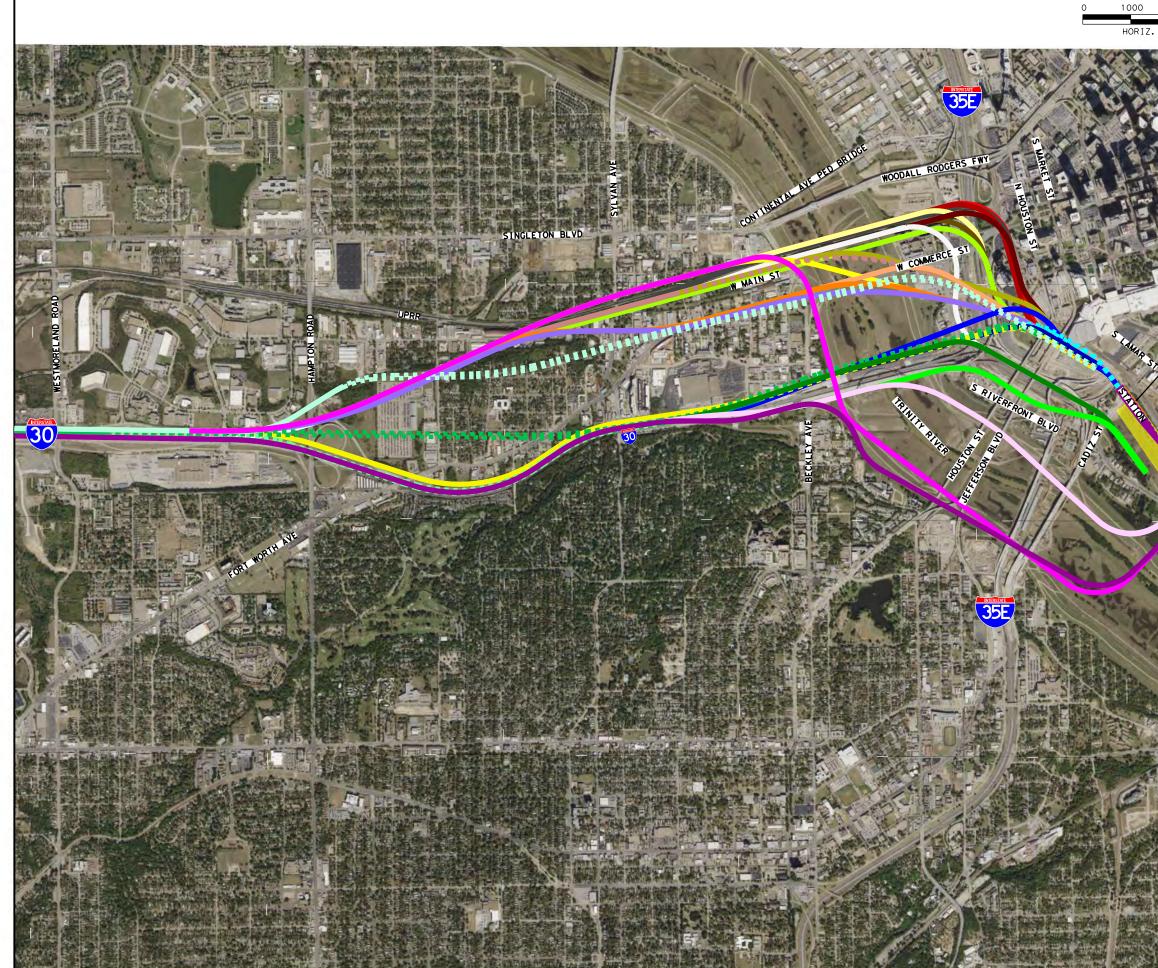




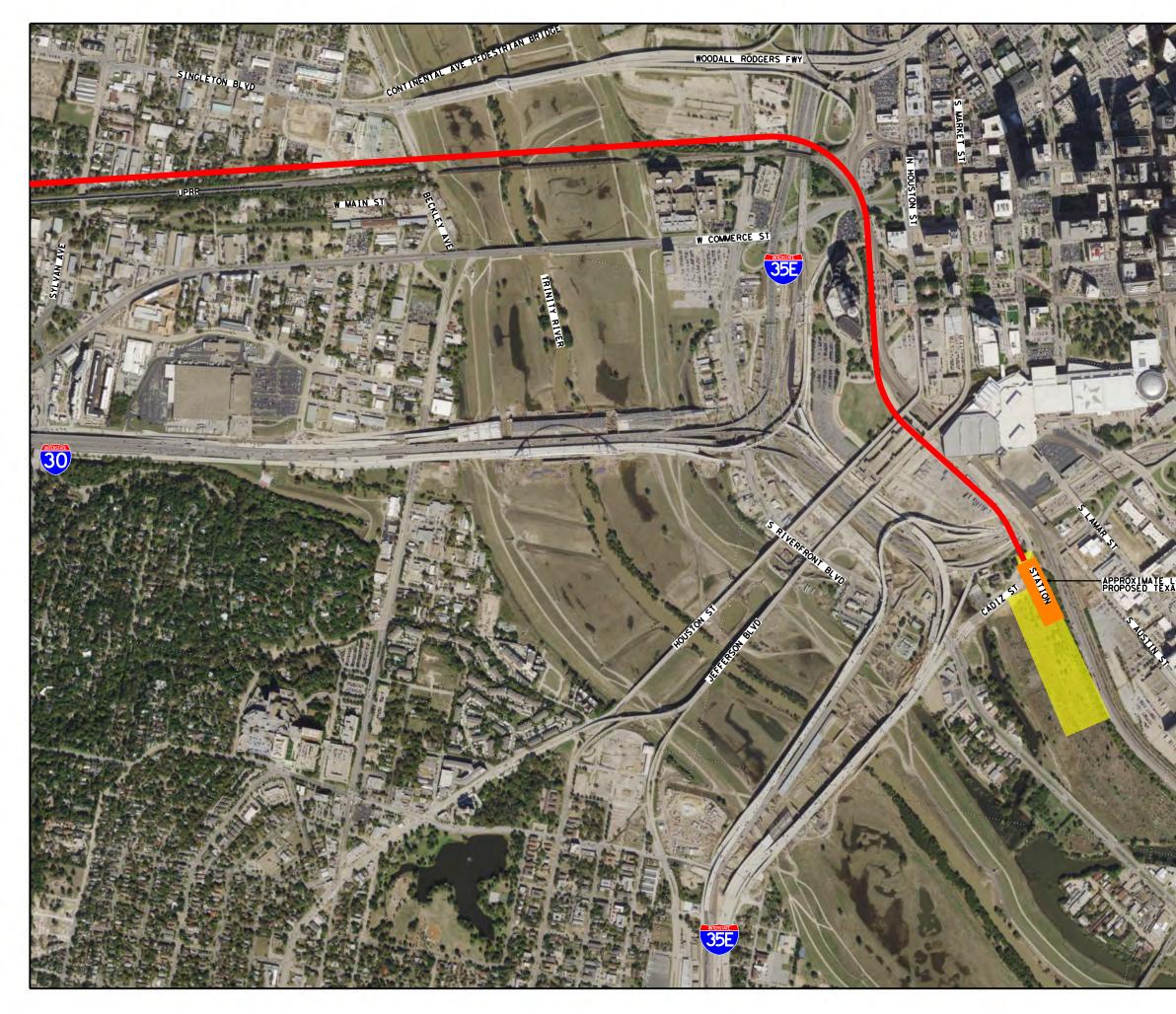
URBAN CENTER CONNECTION ARLINGTON 11 ALTERNATIVE ALIGNMENT Phase 1 Alternative Analysis Final Report Volume II

> Appendix II-H Dallas Station Connection Concepts

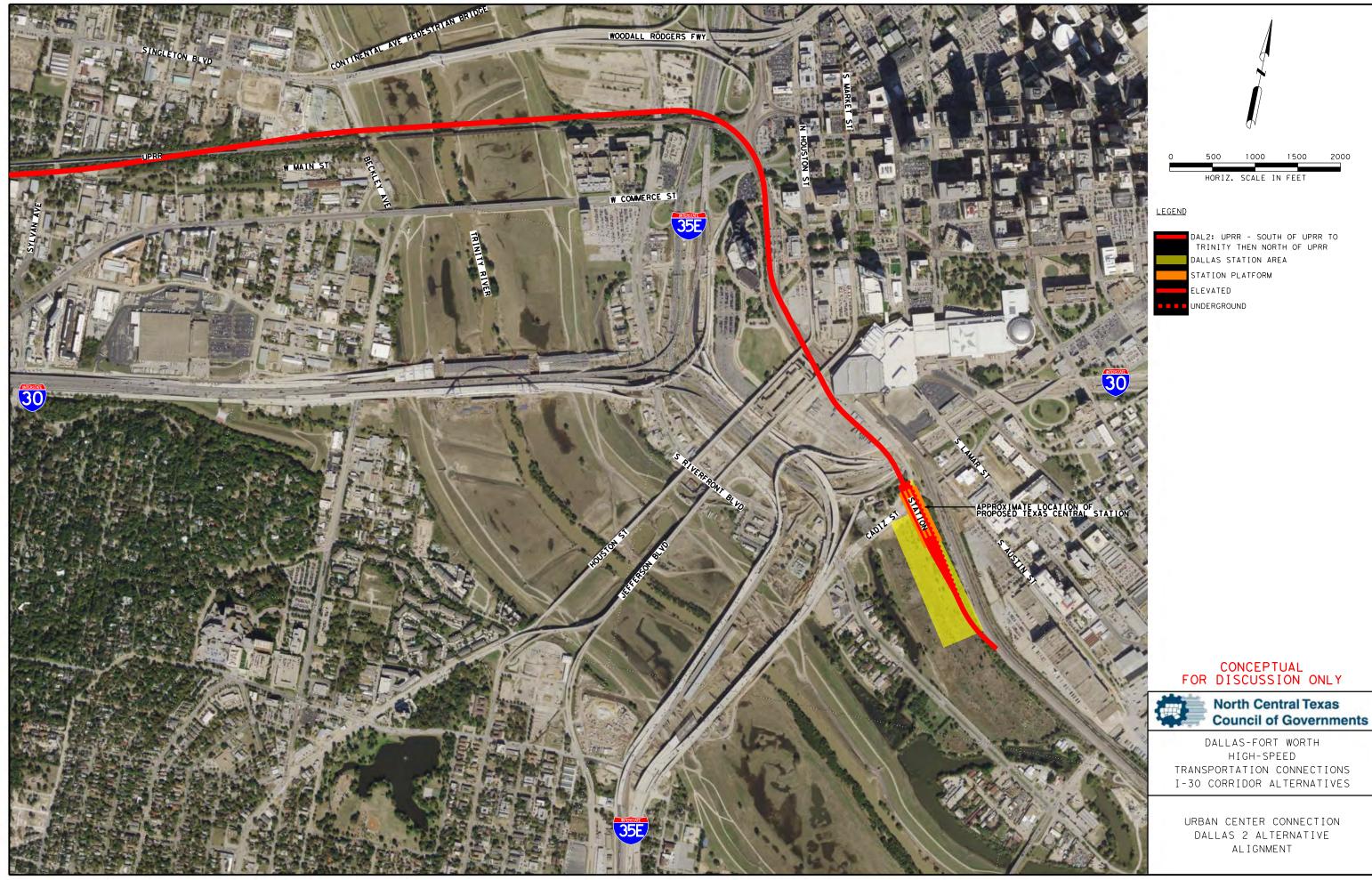




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| | CONCEPTUAL FOR DISCUSSION ONLYMorth Central Texas Council of GovernmentsDALLAS-FORT WORTH HIGH-SPEED TRANSPORTATION CONNECTIONS I-30 CORRIDOR ALTERNATIVESURBAN CENTER CONNECTION DALLAS ALTERNATIVE ALIGNMENTS |

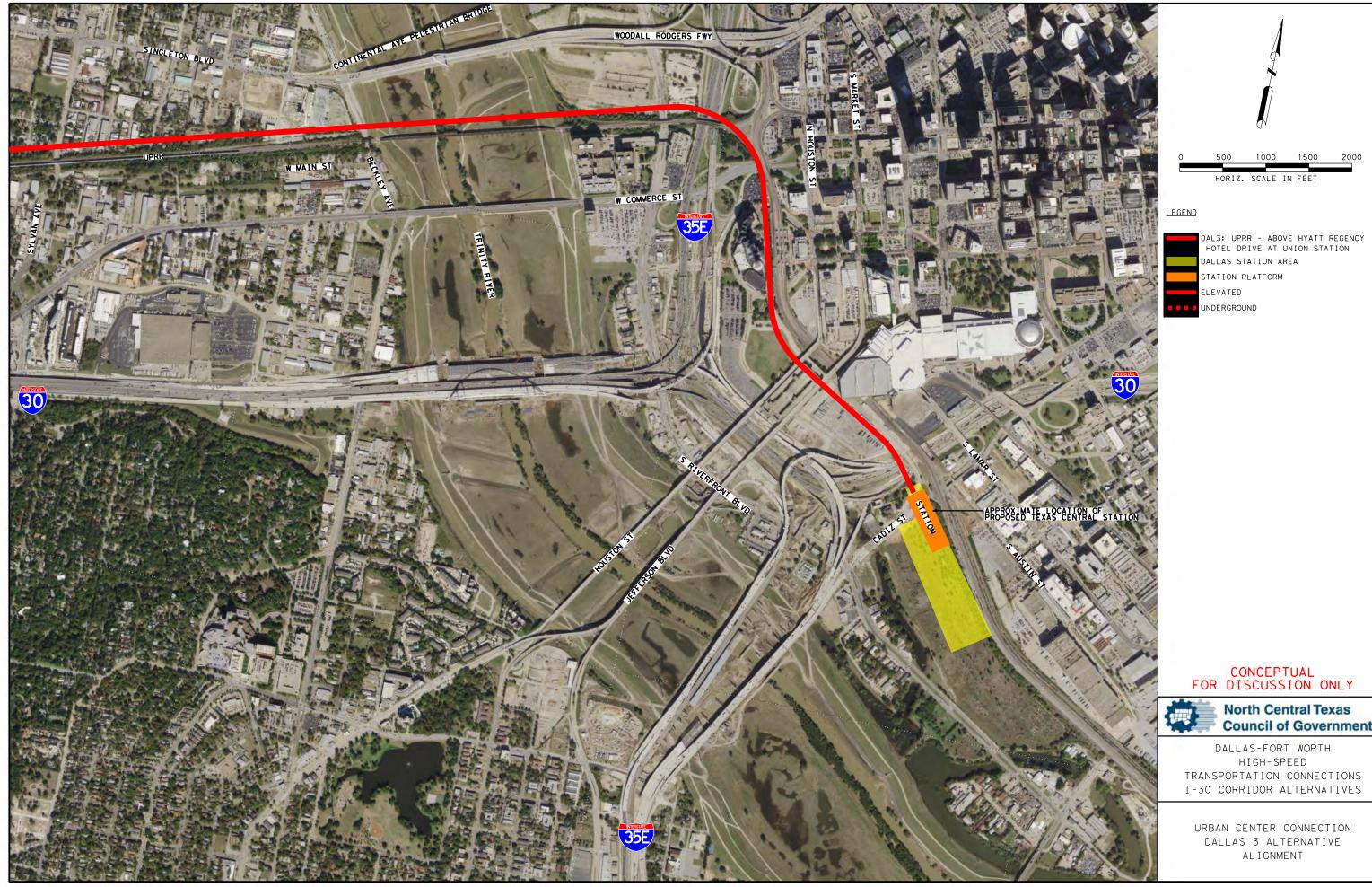




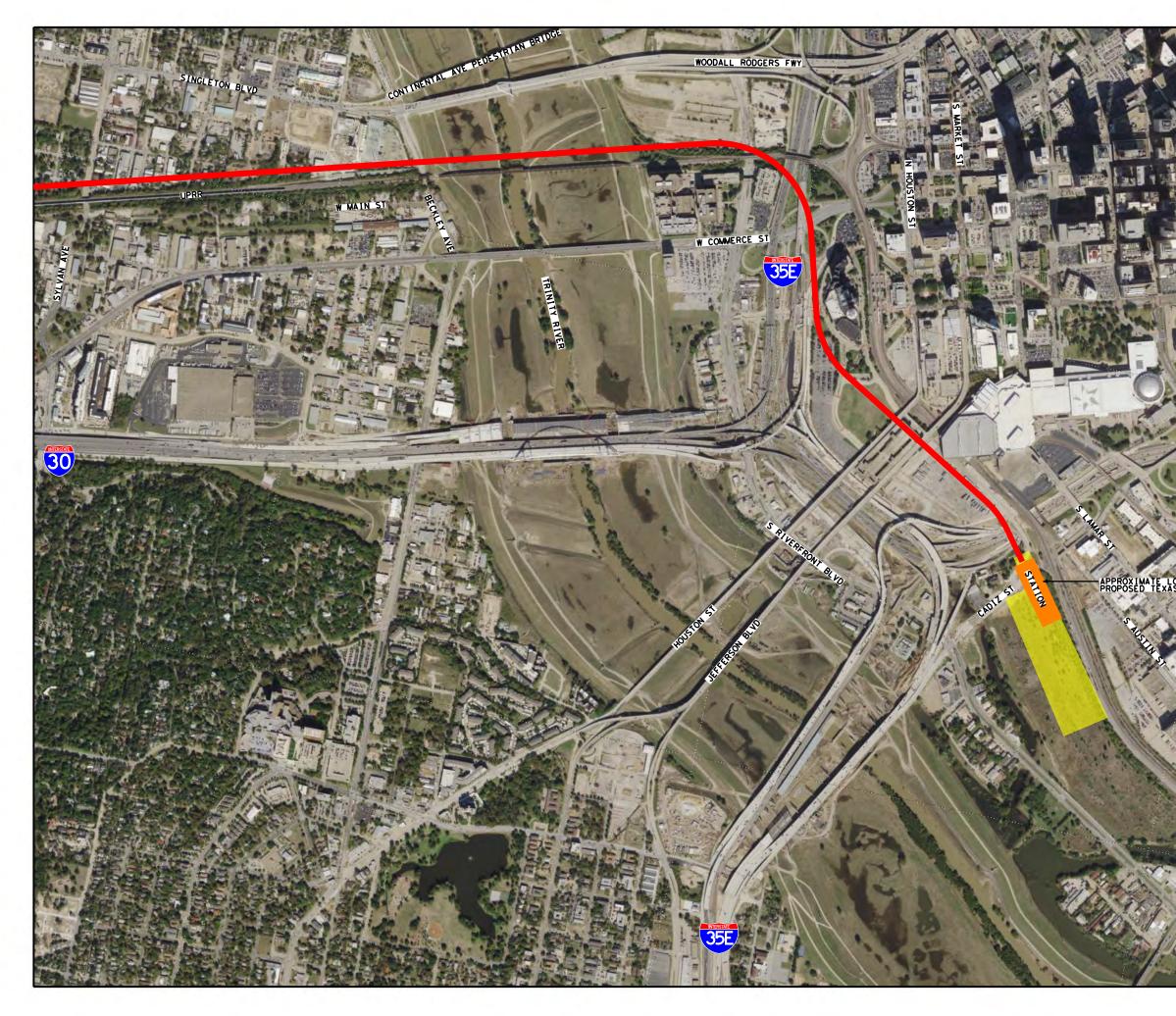


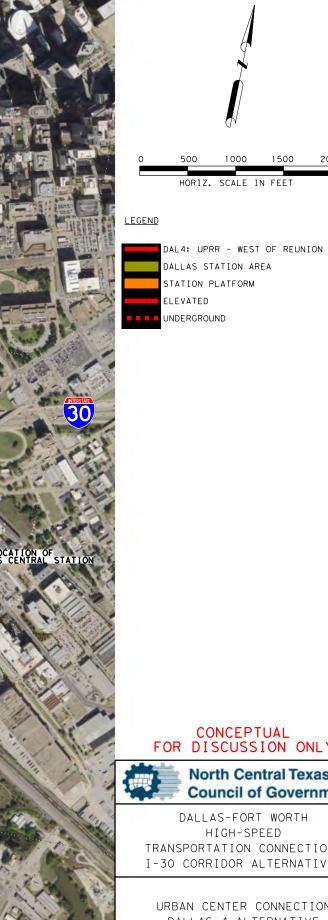
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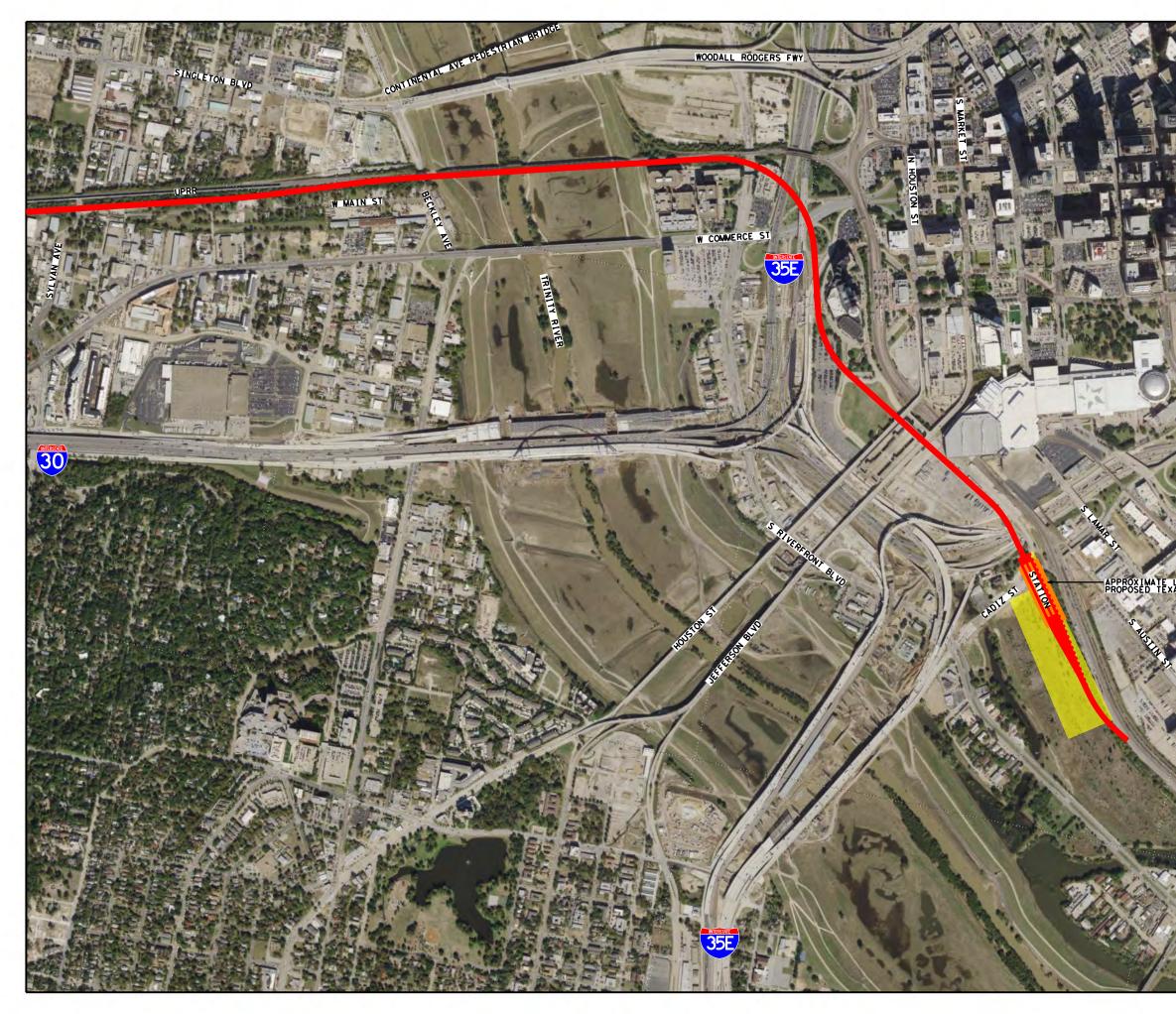
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North Central Texas Council of Governments

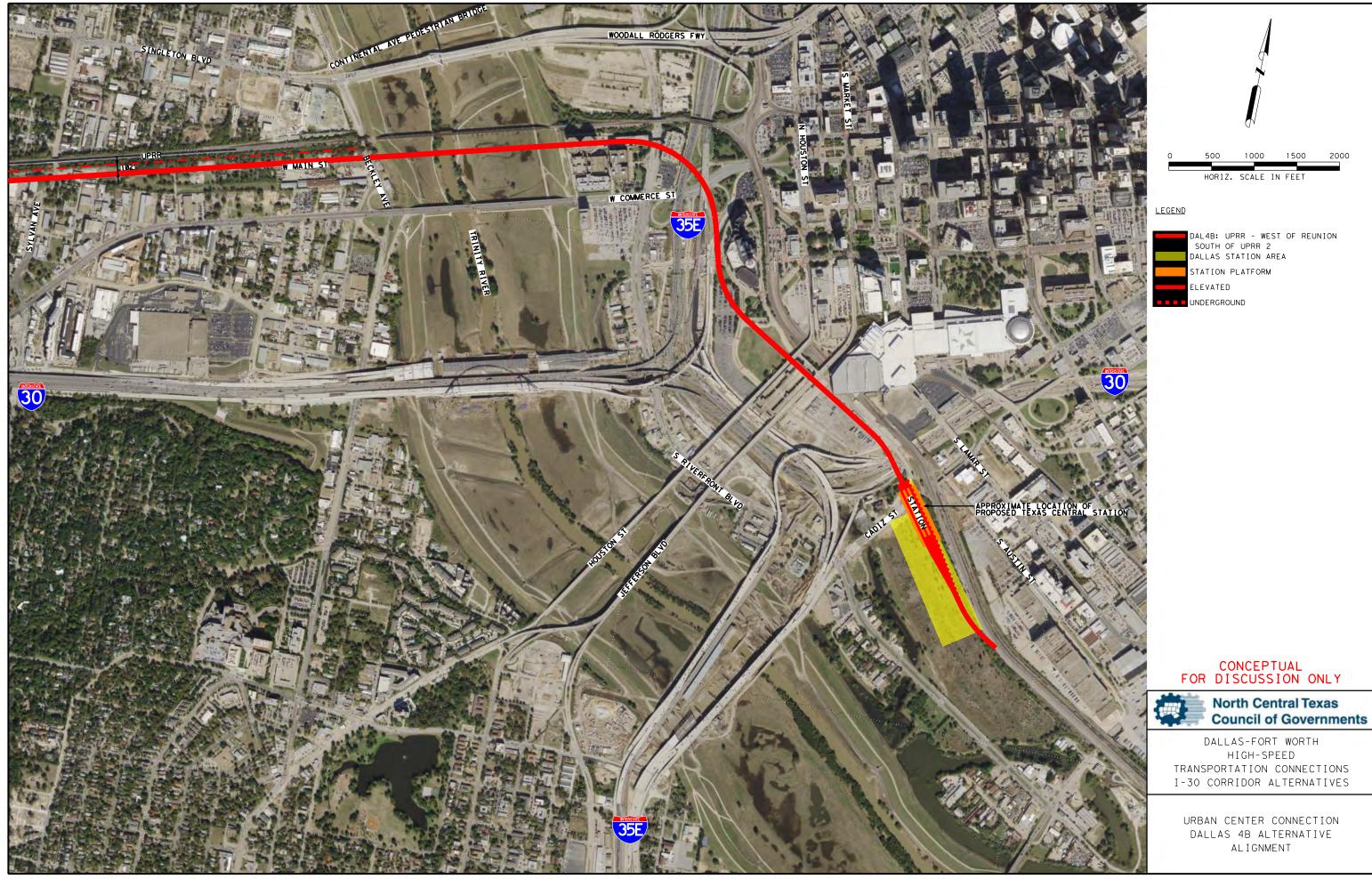
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TRANSPORTATION CONNECTIONS I-30 CORRIDOR ALTERNATIVES

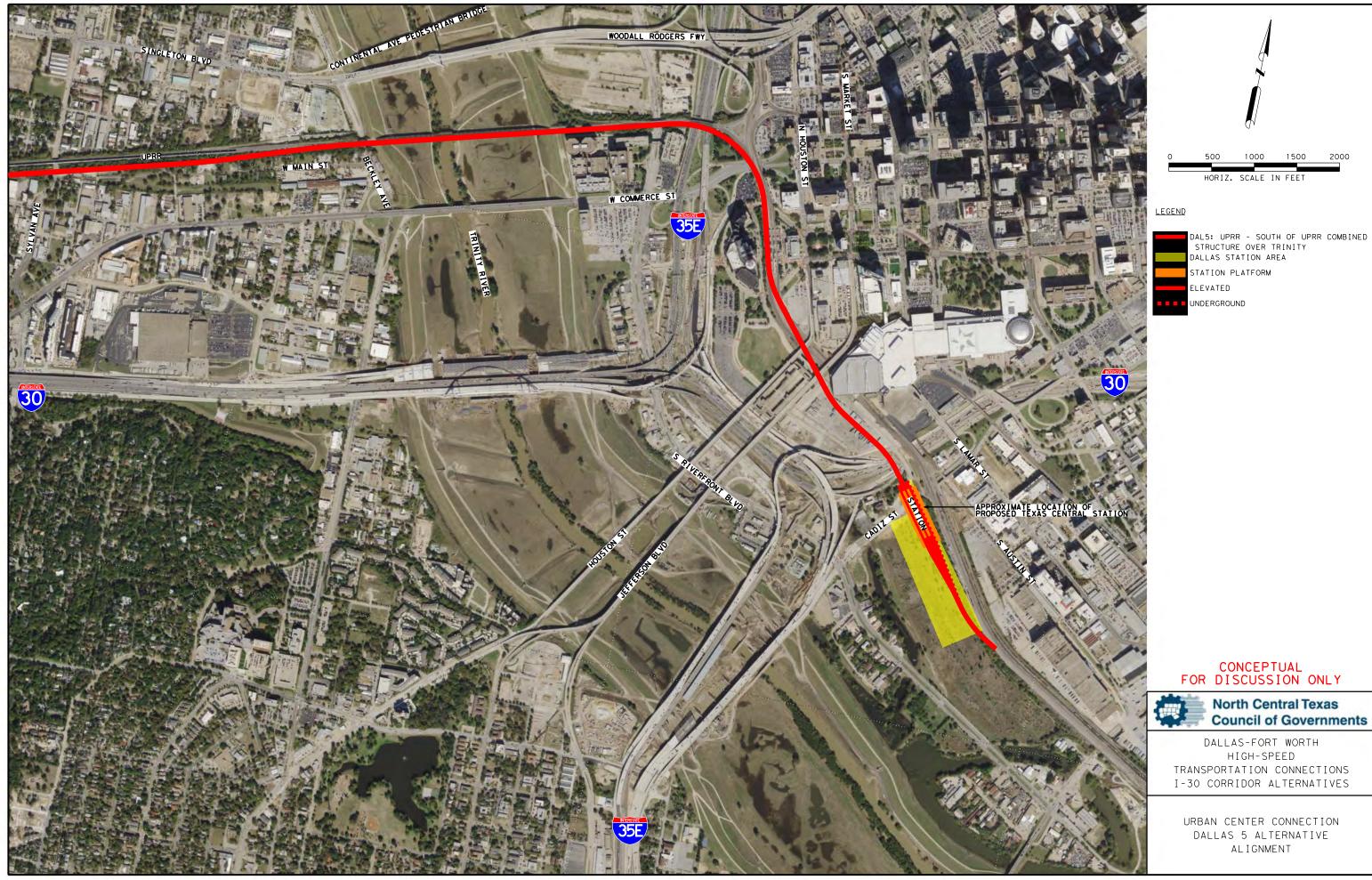
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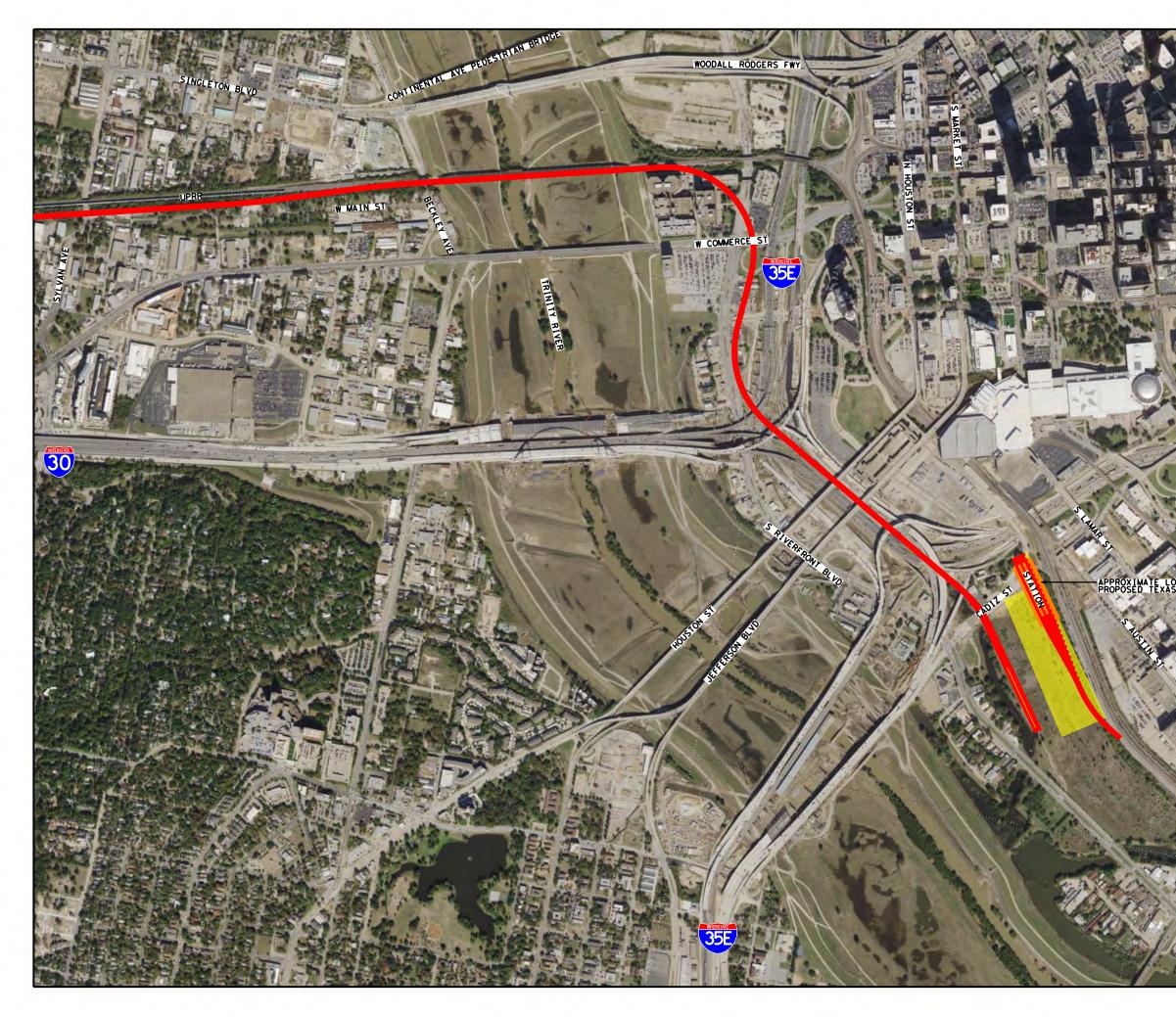




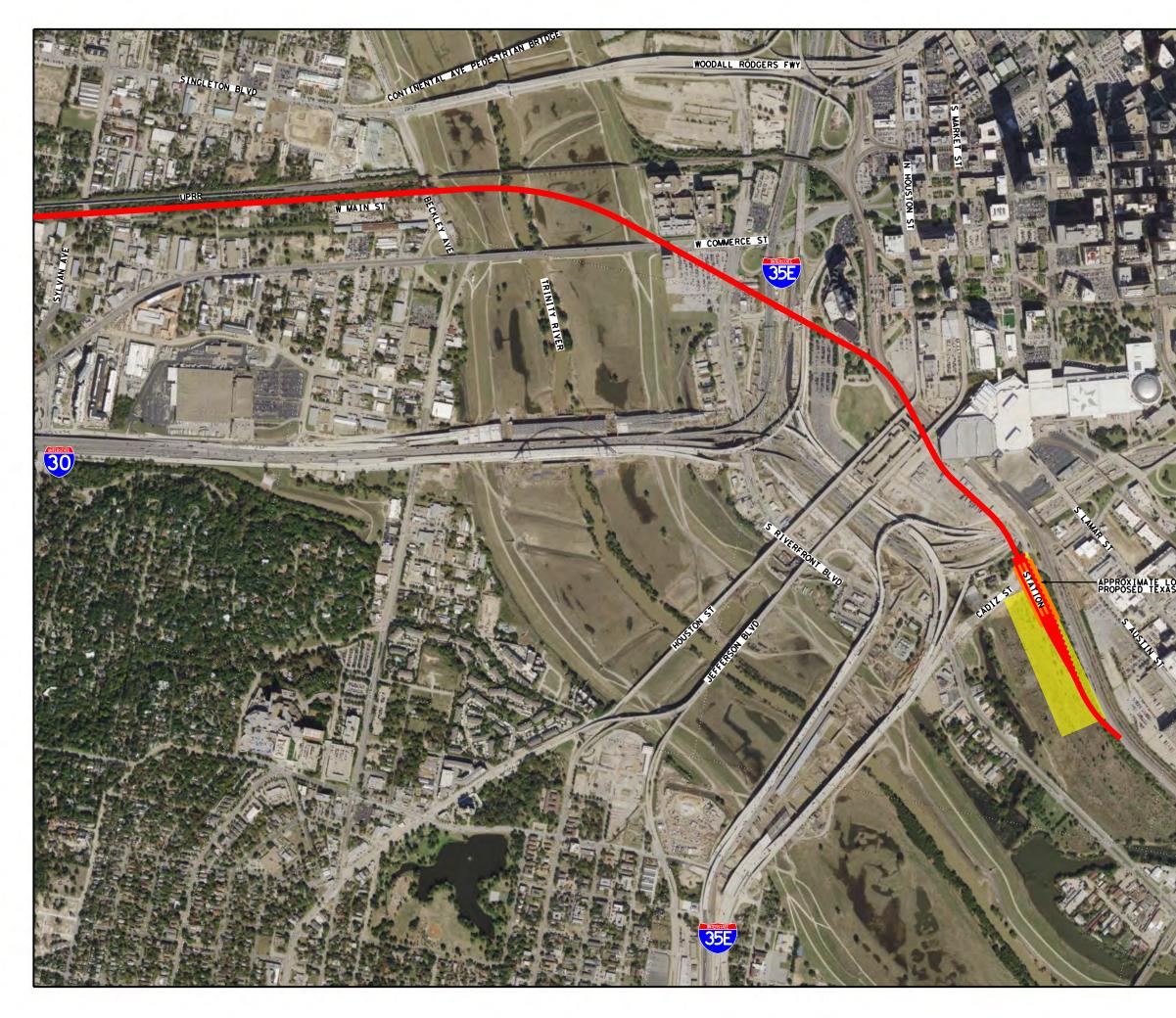


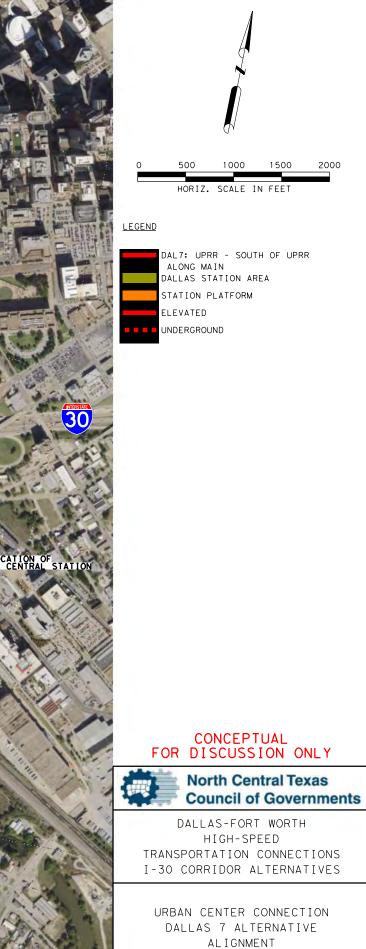
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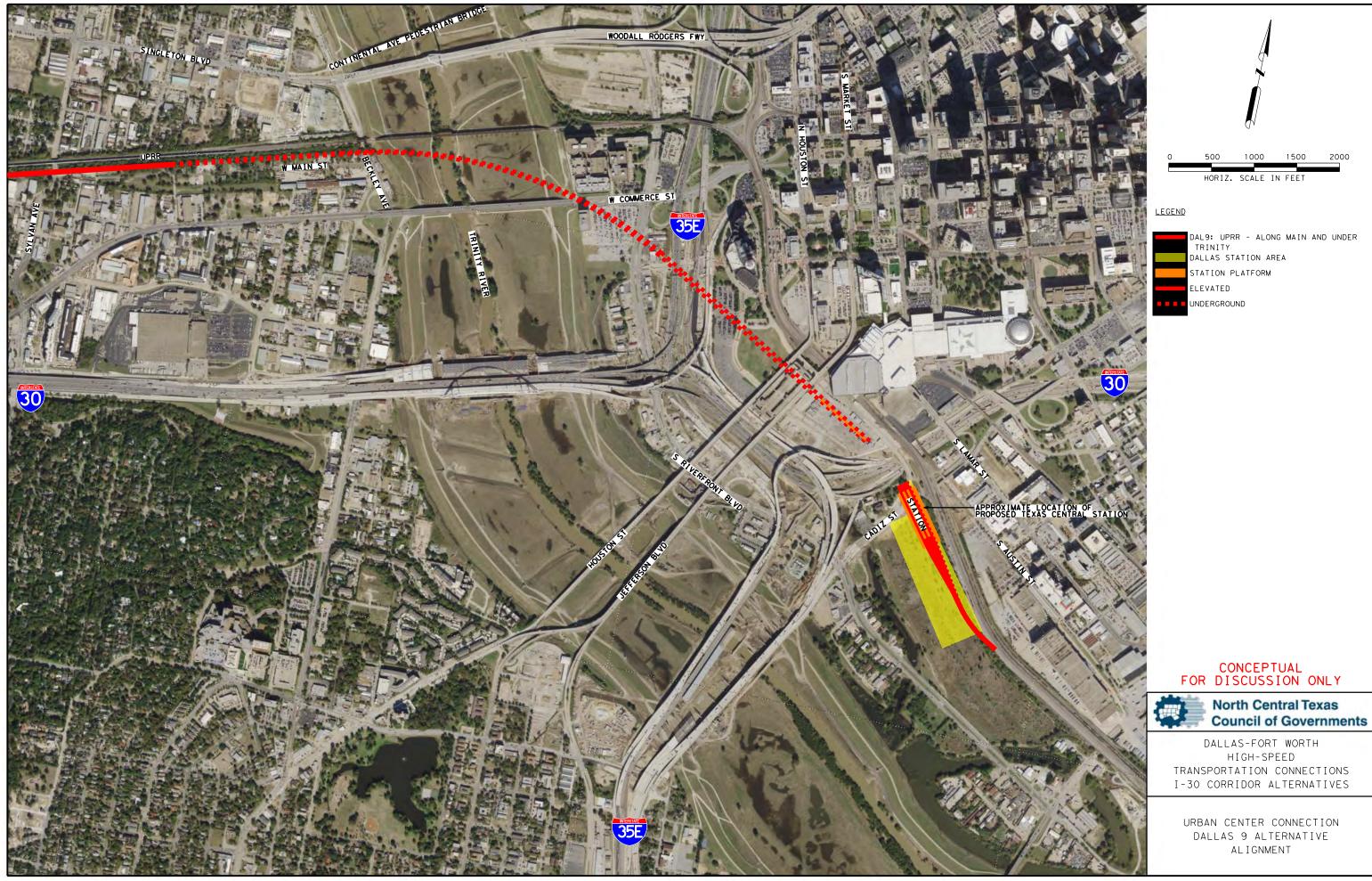


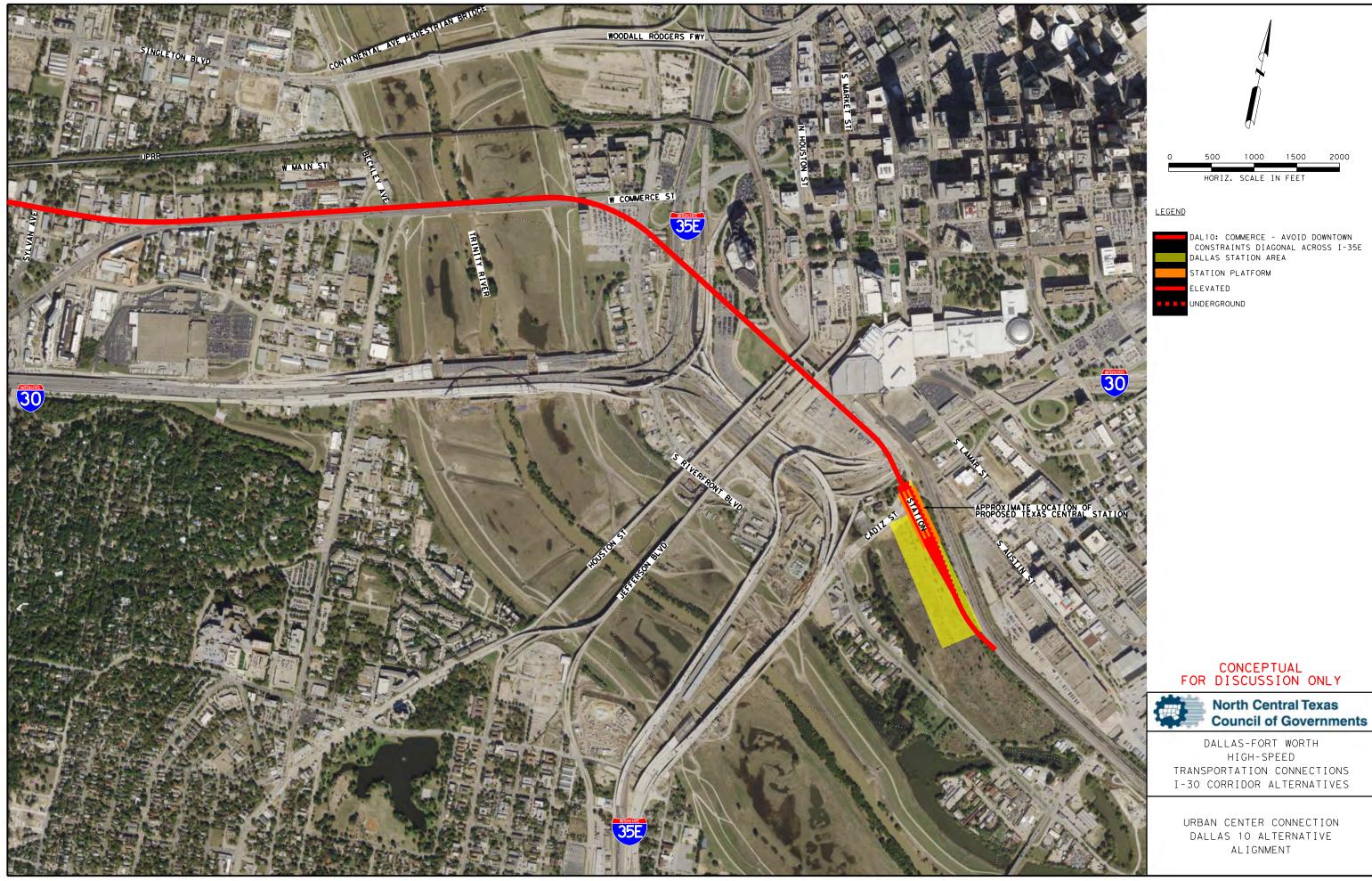


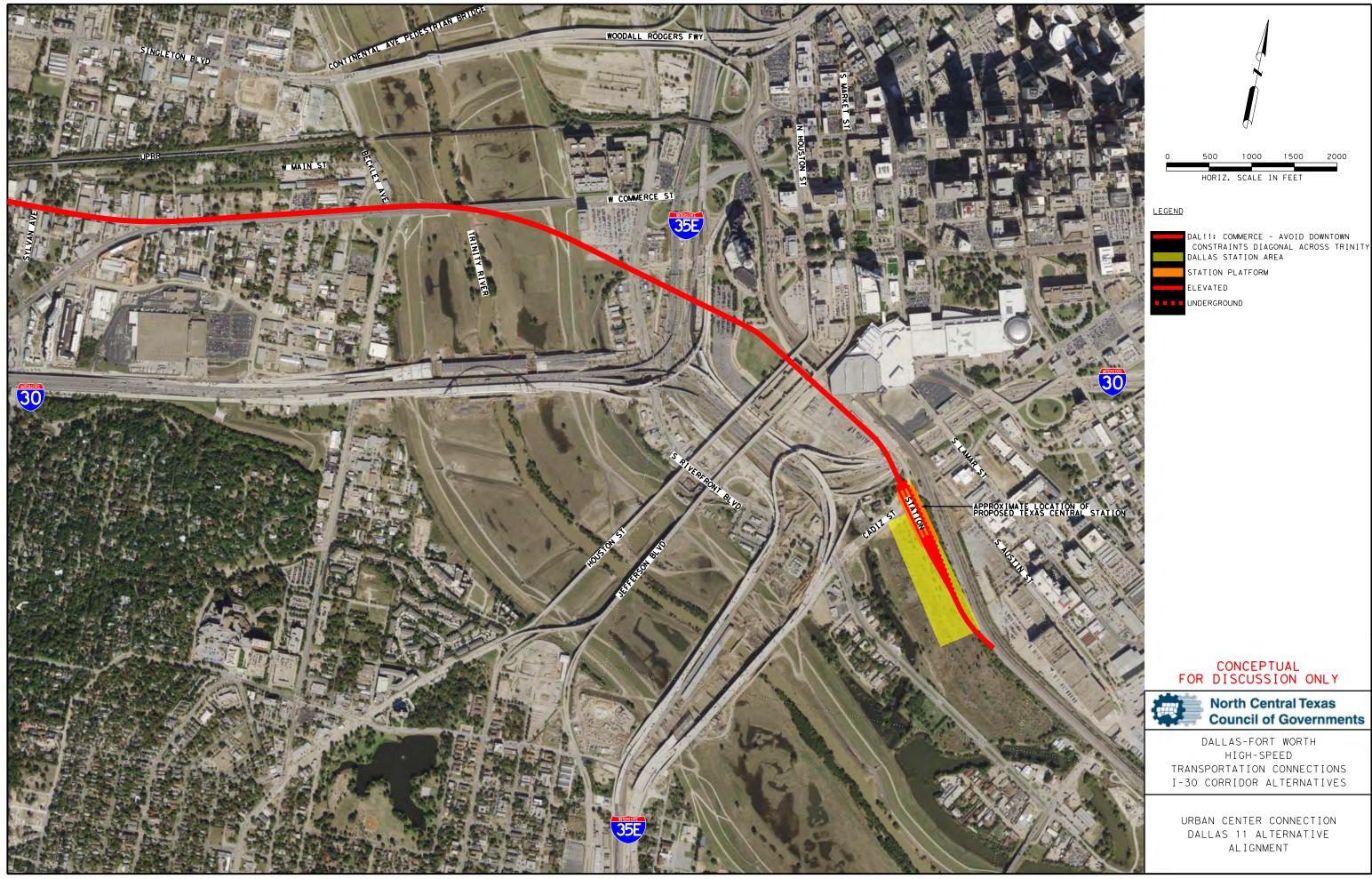


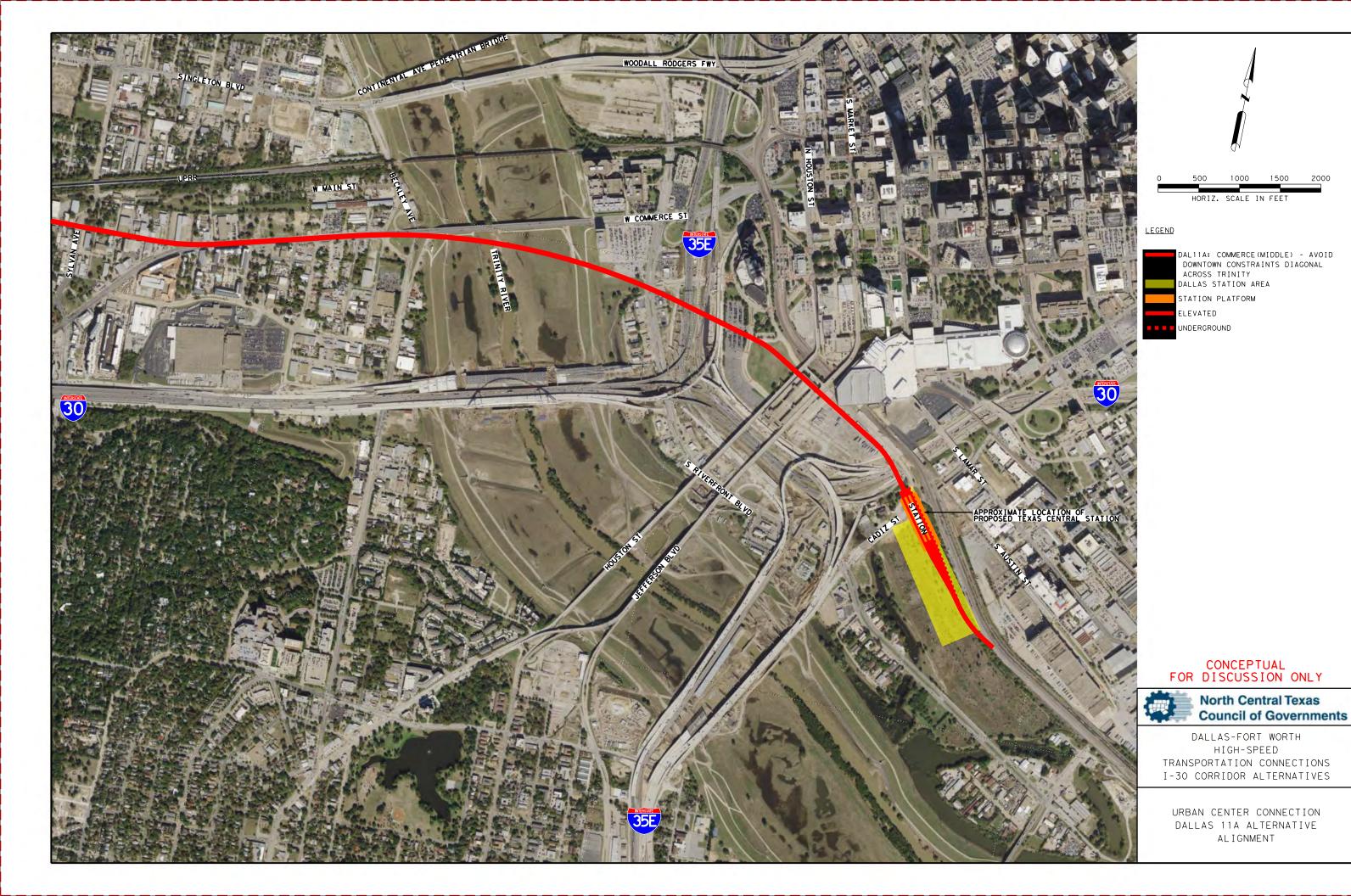


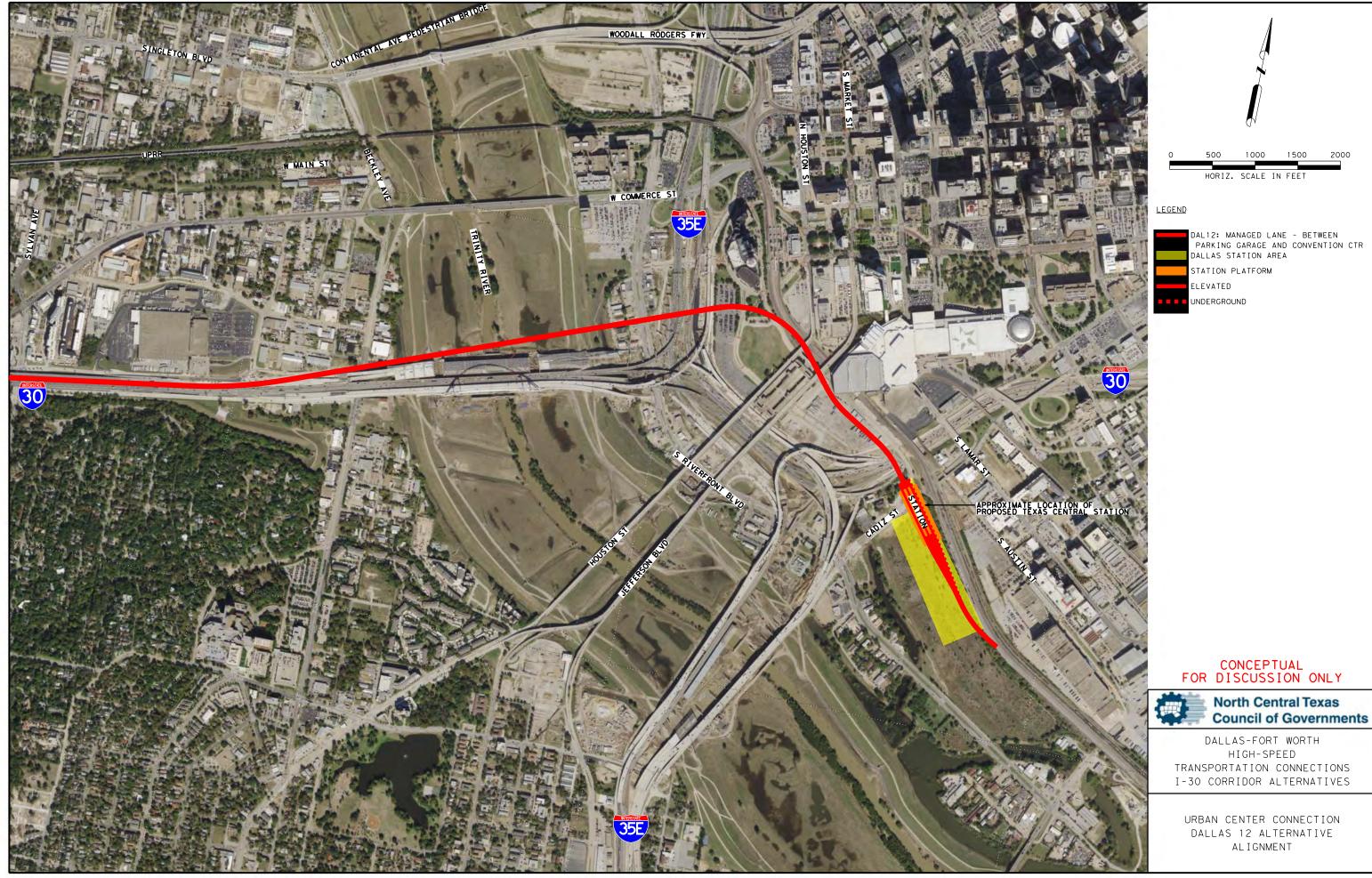


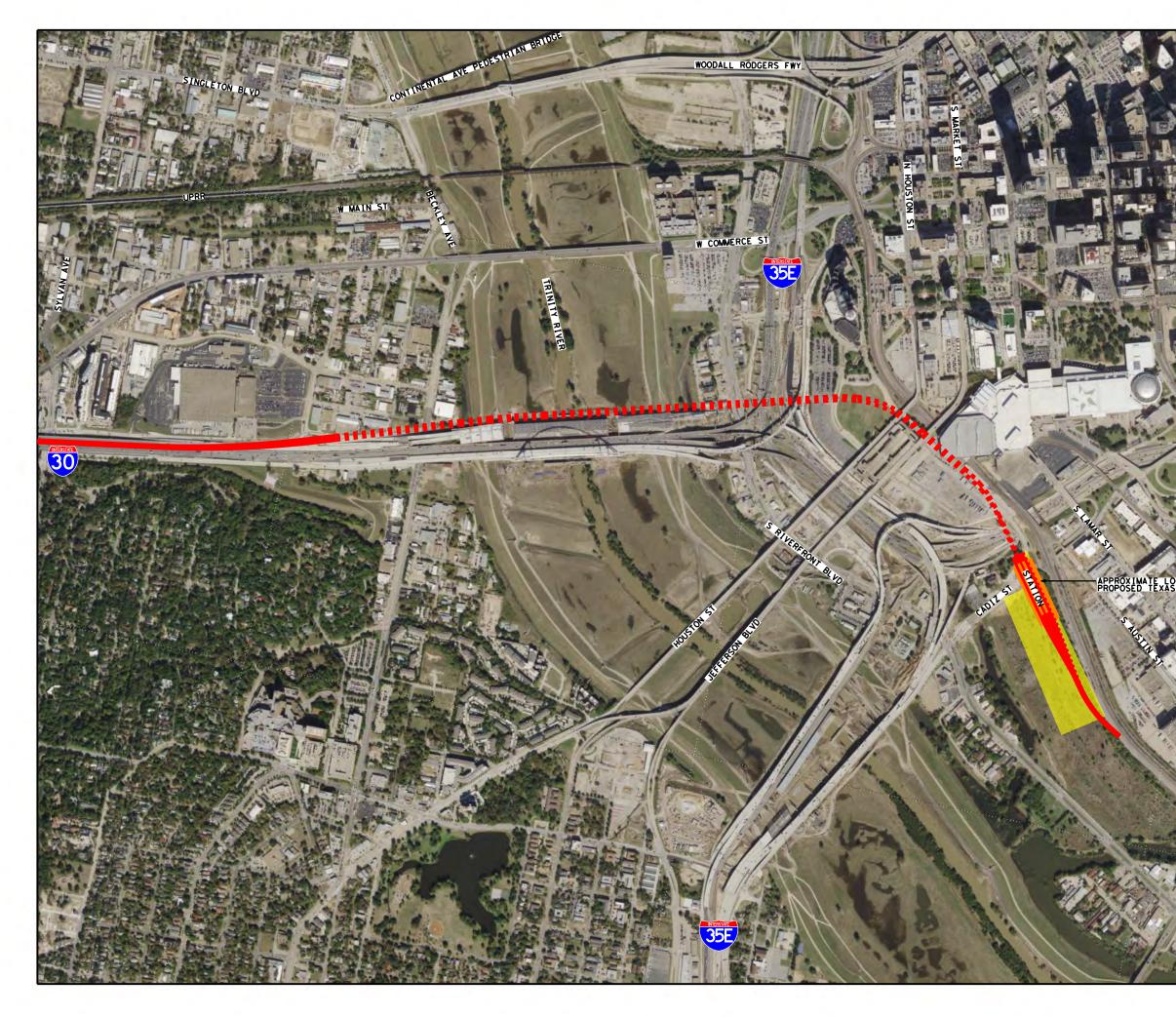




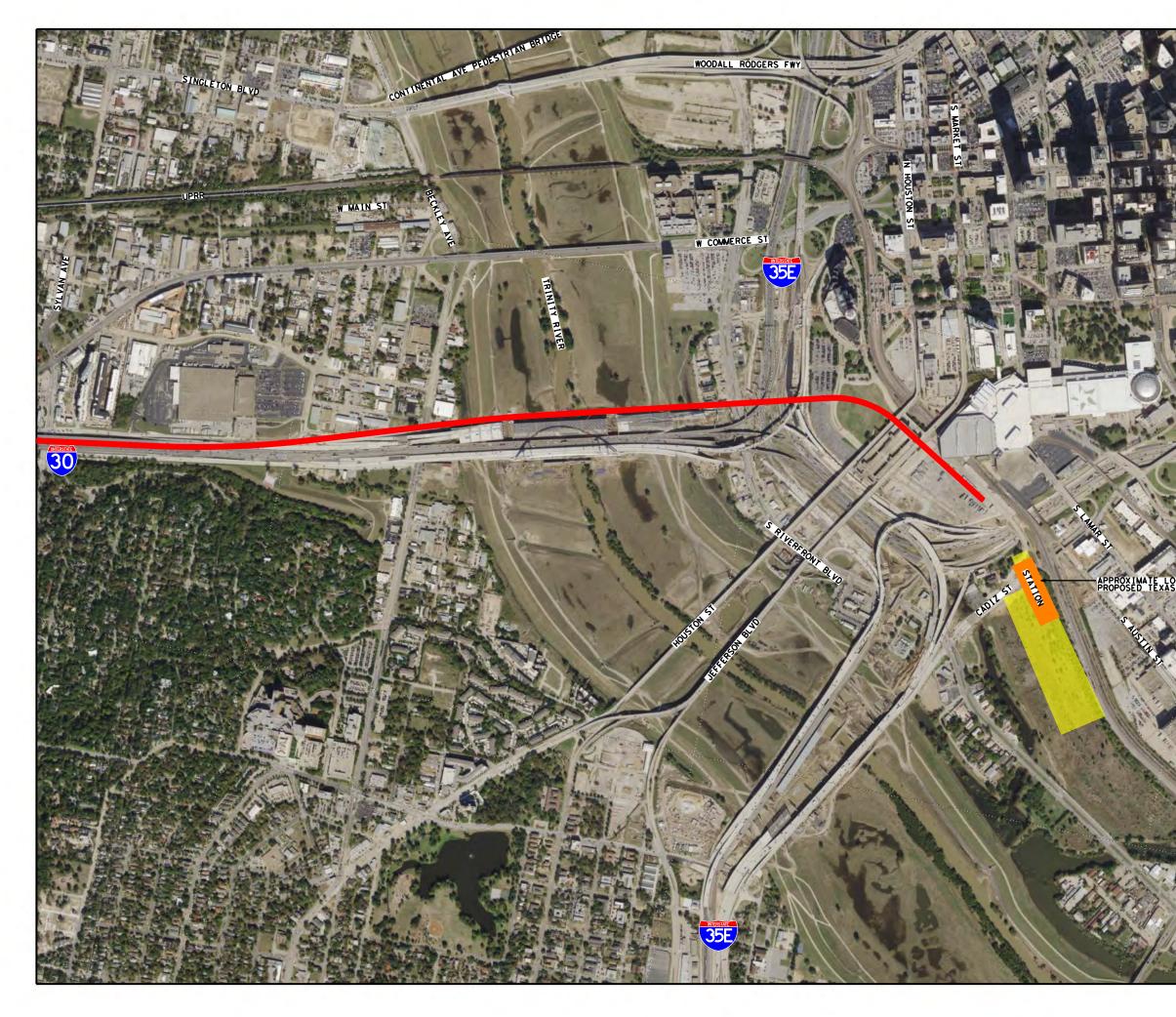






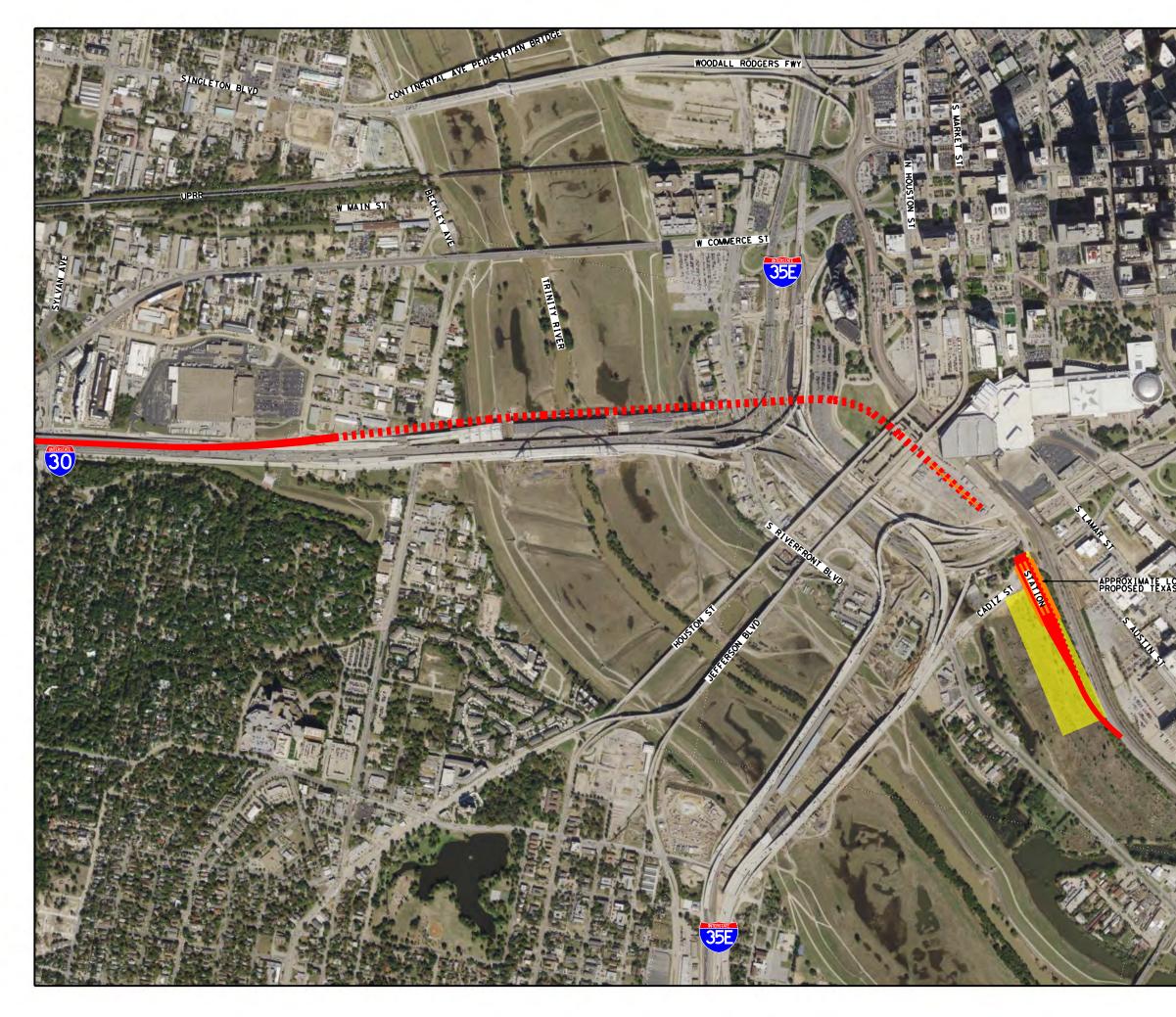




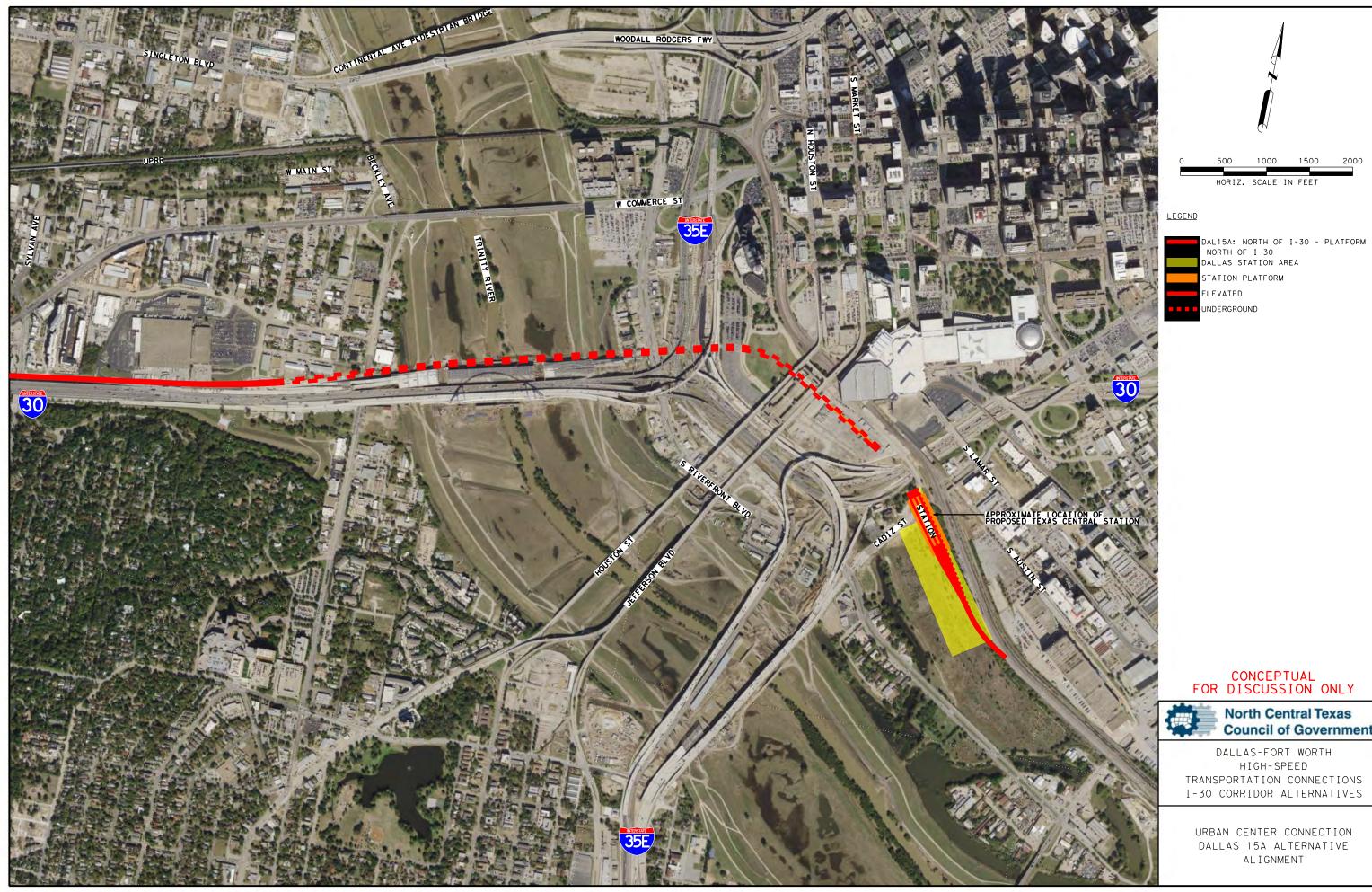




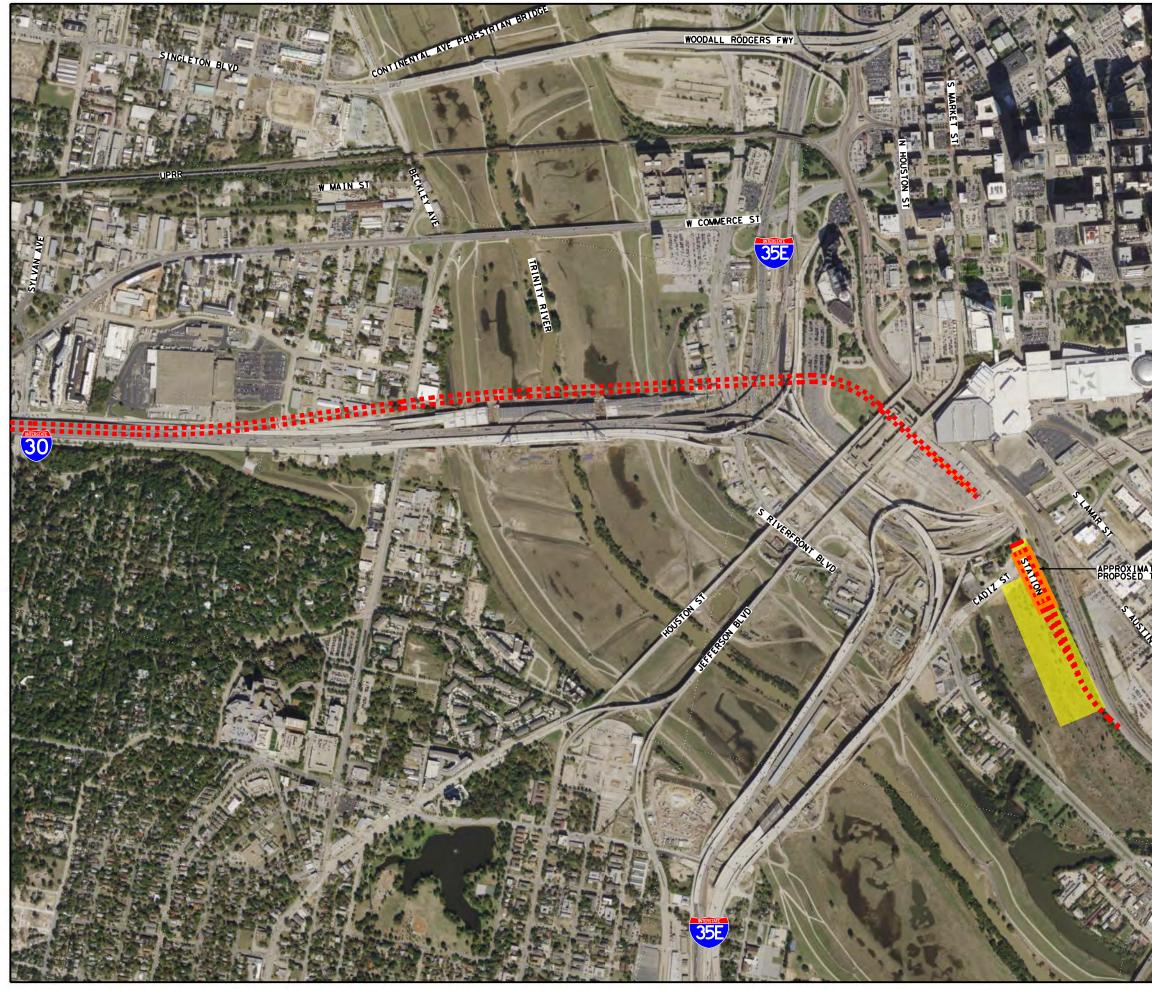
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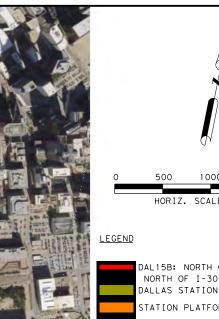


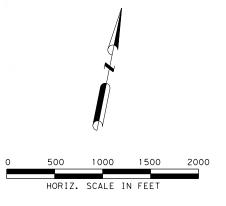




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DAL15B: NORTH OF I-30 - PLATFORM NORTH OF I-30 EXTENDED UNDERGROUND DALLAS STATION AREA STATION PLATFORM ELEVATED UNDERGROUND

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DALLAS-FORT WORTH HIGH-SPEED TRANSPORTATION CONNECTIONS I-30 CORRIDOR ALTERNATIVES

URBAN CENTER CONNECTION DALLAS 15B ALTERNATIVE ALIGNMENT

