Appendix F

Water Quality Technical Study

Texas Department of Transportation

TEXAS–OKLAHOMA PASSENGER RAIL STUDY

Water Quality

Technical Study

Texas Department of Transportation

U.S. Department of Transportation
Federal Railroad Administration

July 2016

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Acronyms and Abbreviations

°F	degrees Fahrenheit
BMP	Best Management Practice
CFR	Code of Federal Regulations
CWA	Clean Water Act
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FRA	Federal Railroad Administration
GIS	Geographic Information System
IH-35	Interstate Highway 35
KCS	Kansas City Southern
mph	miles per hour
NEPA	National Environmental Policy Act
NPDES	National Pollution Discharge Elimination System
NPS	National Park Service
NRI	Nationwide Rivers Inventory
NWSR	National Wild and Scenic Rivers
NWSRS	National Wild and Scenic Rivers System
ODEQ	Oklahoma Department of Environmental Quality
Program	Texas-Oklahoma Passenger Rail Program
SFHA	Special Flood Hazard Areas
SSURGO	Soil Survey Geographic (database)
Study	Texas-Oklahoma Passenger Rail Study
TCEQ	Texas Commission on Environmental Quality
TMDL	Total Maximum Daily Load
TRE	Trinity Railway Express
TxDOT	Texas Department of Transportation
U.S.C.	United States Code
USDOT	U.S. Department of Transportation
USGS	U.S. Geological Survey

1.0 Introduction

The Texas Department of Transportation (TxDOT), along with the Federal Railroad Administration (FRA), is preparing a service-level Environmental Impact Statement (EIS) to evaluate intercity passenger rail service alternatives for the Texas-Oklahoma Passenger Rail Program (Program). The purpose of the Program is to enhance intercity mobility by providing enhanced passenger rail service as a transportation alternative that is competitive with automobile, bus, and air travel. Preparation of the service-level EIS, in support of which this technical study has been prepared, is one of two primary objectives of the Texas-Oklahoma Passenger Rail Study (Study). In addition to the service-level EIS, TxDOT and FRA are preparing a service development plan for the corridor to guide further development and capital investment in passenger rail improvements identified in the EIS Record of Decision. The Oklahoma Department of Transportation is a partnering state agency for the Study and the EIS.

The 850-mile corridor analyzed for the Study runs north-south and roughly parallels Interstate Highway 35 (IH-35), with the northern point in Edmond, Oklahoma (i.e., northern end of the Oklahoma City portion of the corridor), and the southern end in south Texas, potentially in Corpus Christi, Brownsville, Laredo, or the Rio Grande Valley, as shown on Figure 1-1. For this service-level analysis, a preliminary alignment was developed to represent each EIS alternative, based on conceptual engineering that considered and avoided obvious physical or environmental constraints. These alignments were not refined to optimize performance, reduce cost, avoid specific properties or individual environmental resources, or for any other such considerations. If an alternative is selected at the service-level for further development, the above considerations would be assessed at the project level. A broad corridor of study with a width of 500 feet has been identified along each route (EIS Study Area). This EIS Study Area provides an envelope that could accommodate areas for associated effects, including necessary roadway shifts, grade separations, construction activities, and affiliated features such as stations and parking, traction-power substations, power lines, and maintenance-of-way facilities. The area for which data were collected is identified as the Study Vicinity. Typically, county-wide data were collected for counties partially or completely within the Study Area.

The analysis provides quantitative information about water resources within the EIS Study Area for each alternative and compares it against the No Build Alternative and other build alternatives in the same geographic region. The discussion of effects also provides qualitative differences in permanent, temporary, and direct and indirect effects that are associated with the service type (conventional rail, higher-speed rail, or high-speed rail) relative to the environmental context. However, because the 500-foot EIS Study Area does not represent the actual footprint of operation or construction phases, the analysis is primarily comparative, based on the presence of the resource within the EIS Study Area and the likelihood of effects appropriate for this service-level analysis.

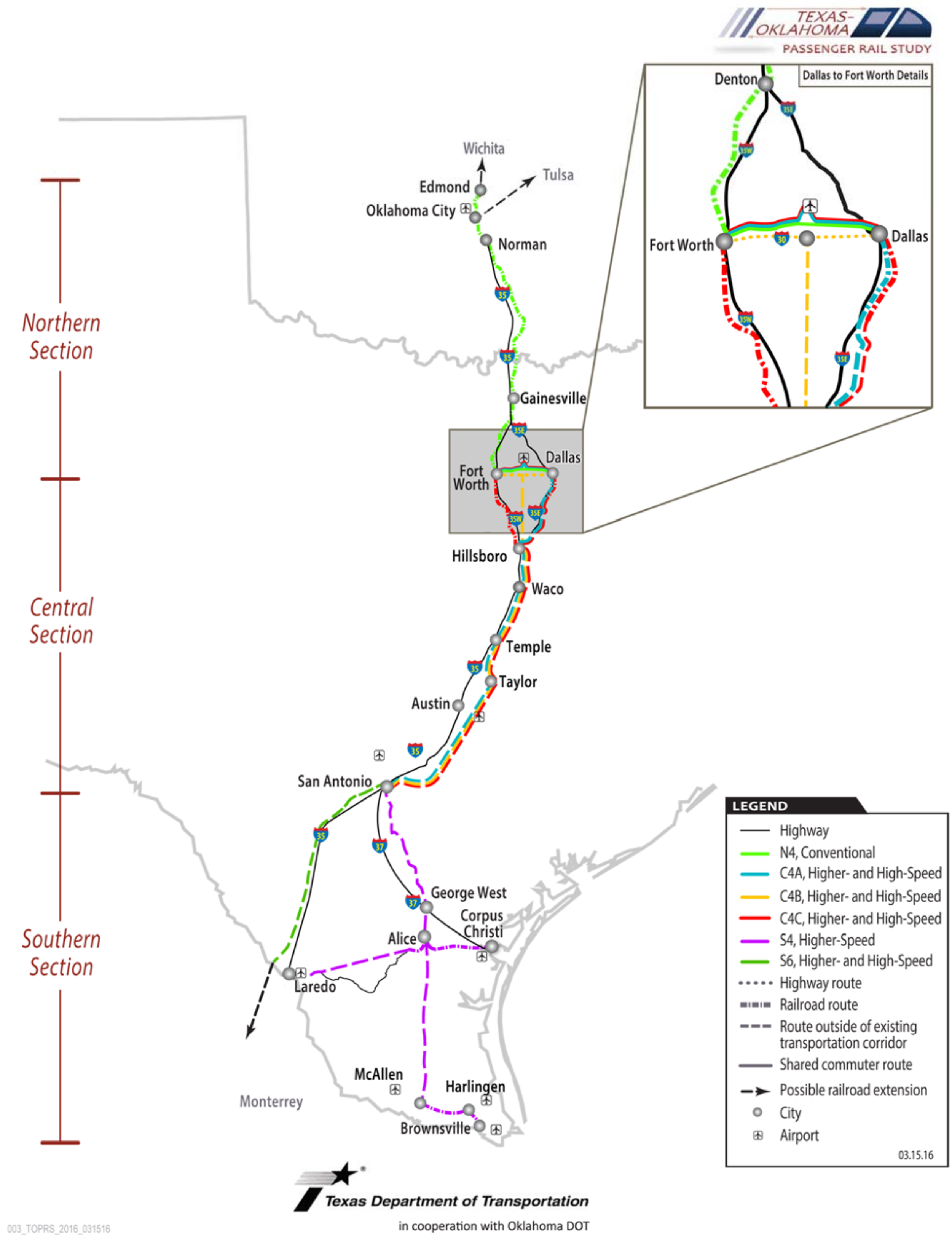


Figure 1-1: Build Alternatives

The build alternatives are divided into the following three geographic sections based on the key regional markets that could be served by passenger rail improvements:

- Northern Section: Oklahoma City to Dallas and Fort Worth
- Central Section: Dallas and Fort Worth to San Antonio
- Southern Section: San Antonio to South Texas

In addition, the alternatives consist of both a route, which refers to the specific corridor that a potential alignment follows, and a service type, which refers to the speed or category of rail transportation (conventional rail, higher-speed rail, or high-speed rail). The alternatives that have been carried forward for analysis in the EIS, including their geographic sections, routes, and service types, are listed in Table 1-1.

Table 1-1: Alternatives Carried Forward for Further Evaluation

Route	Service Type [a]
Northern Section	
N4A	CONV
Central Section	
C4A	HrSR
	HSR
C4B	HrSR
	HSR
C4C	HrSR
	HSR
Southern Section	
S4	HrSR
S6	HrSR
	HSR

[a] CONV = conventional rail (up to speeds of 79 to 90 miles per hour [mph]); HrSR = higher-speed rail (up to speeds of 110 to 125 mph); HSR = high-speed rail (up to speeds of 220 to 250 mph)

The route alternatives were based on the alignments of existing transportation networks with corridors potentially suitable for passenger rail operations (i.e., the existing railroad network and the existing interstate highway network) (the term “operations” includes maintenance of the facilities as well), or they were located on new alignments outside existing transportation corridors. Potential alignments described as “following” railway corridors share existing tracks, are located within an existing right-of-way, or are generally adjacent to existing tracks, depending on the service type. Alternatives that are outside the existing transportation corridor could have greater indirect effects than those located in the existing transportation corridor; for example, alternatives outside existing corridors could divide neighborhoods or wildlife communities or create a potential new barrier.

1.1 Service Type Descriptions

The three service types (conventional rail, higher-speed rail, and high-speed rail) considered in this EIS are described below.

1.1.1 Conventional Rail

Conventional rail typically includes diesel-powered, steel-wheeled trains operating on steel tracks. Roadway crossings may be grade-separated depending on the type of roadway and amount of traffic, and rail rights-of-way may be fenced. Conventional rail would be operated at speeds up to 79 to 90 mph and would mostly use existing railroad rights-of-way. For conventional rail alternatives, existing railroad track may be used, or in some cases, modifications such as double-tracking could be constructed within the existing right-of-way to accommodate additional trains.

1.1.2 Higher-Speed Rail

Higher-speed rail is similar to conventional rail in several respects. In many cases, higher-speed rail trains can run on the same steel tracks that support conventional rail, but higher speeds can require improvements such as upgrading wooden ties with concrete ties, improving signaling, and upgrading roadway crossings. In this case, higher-speed rail trains are assumed to be diesel-powered. Higher-speed rail would be operated at speeds up to 110 to 125 mph. Where proposed within an existing railroad right-of-way, a shared right-of-way with separate tracks for freight and passenger services would be constructed. Because of its maximum speed and because train frequency would be similar to conventional rail, higher-speed rail could operate on a single track with passing locations and would not require double-tracking. Where higher-speed rail is proposed outside an existing transportation corridor, the new alignment would be designed with curves and other features that could accommodate high-speed rail service if warranted by ridership and economically feasible in the future. However, unlike high-speed rail, the design would not include electrification or a full double track, and some grade crossings would remain.

1.1.3 High-Speed Rail

High-speed rail includes electric trains powered by an overhead power supply system. Train sets are steel wheel on steel rail, but are designed to operate at high speeds with an aerodynamic shape, and suspension and braking systems are designed for high-speed travel. High-speed rail would be operated at speeds up to 220 to 250 mph. The entire right-of-way would be fenced and fully grade-separated. The alignment would be electrified and double-tracked. This service type could only reach its maximum speeds outside existing transportation corridors because existing railroad alignments are not compatible with the speeds required and they do not have the required space for separation of freight and high-speed rail. In areas where this service type is within existing transportation corridors, it would operate at lower speeds.

1.2 Alternative Descriptions

For this service-level analysis, a preliminary alignment was developed to represent each route alternative, based on conceptual engineering that considered obvious physical or environmental constraints. They are not detailed alignments that have been refined to optimize performance, reduce cost, avoid specific properties or individual environmental resources, or similar considerations, which would be assessed at the project-level phase for alternatives carried forward for further analysis.

The alternatives evaluated in the service-level EIS, shown on Figure 1-1, have been developed to a level of detail appropriate for a service-level analysis: the route alternatives represent a potential corridor where rail improvements could be implemented but do not specify the precise location of the track alignment. When a route alternative is refined to include a service type (conventional, higher-speed, or high-speed rail), it is then referred to as an alternative. Alternatives in the Northern, Central, and Southern sections could be built as individual, stand-alone projects or in combination with alternatives in another section. In addition, more than one alternative in the Central Section and Southern Section could be built in the future because the alternatives provide different service types for independent destinations. Details on connecting the alternatives would be determined during project-level studies.

Potential alignments are described below in terms of nearby transportation corridors and cities. For example, potential alignments are described as “following” railway corridors, which could mean that they are sharing existing tracks, within an existing right-of-way or generally adjacent to existing tracks depending on the service type.

The Southern Section alternatives include a potential extension to Monterrey, Mexico. The EIS evaluates alignment corridors only within the United States; however, the potential extension to Monterrey has been included for ridership analysis purposes, and FRA and TxDOT have initiated coordination with the Mexican government about the potential extension.

1.2.1 No Build Alternative

The No Build Alternative would not fulfill the Program’s purpose and need but is carried forward as a baseline alternative against which the build alternatives are compared. The No Build Alternative would consist of the existing transportation network, including roadway, passenger rail, and air travel in the Study Vicinity and committed improvements to these systems. The No Build Alternative includes existing and planned roadway, passenger rail, and air travel in the Study Vicinity (including operation, maintenance, and expansion). Information was collected from current regional transportation plans within the Study Vicinity and websites describing services such as train schedules. These improvements and their evaluation at this service-level stage would require project-specific assessment. Conducting detailed project-specific assessments at this stage of the program development process is not feasible, except from a cumulative analysis perspective.

1.2.2 Northern Section: Oklahoma City to Dallas and Fort Worth

Based on initial ridership and cost information, only one route alternative with one service type was considered feasible in the Northern Section: Alternative N4A with conventional rail.

1.2.2.1 Alternative N4A Conventional Rail

Alternative N4A would begin in Edmond and follow the BNSF rail alignment south to Oklahoma City. The alternative would continue south along the BNSF rail alignment to Norman, Oklahoma; through Metro Junction, near Denton, Texas; and on to Fort Worth (as does the Heartland Flyer). From Fort Worth, the alternative would continue east to Dallas following the Trinity Railway Express (TRE) tracks. From Edmond, Oklahoma, to Dallas, the route would be approximately 260 miles long. Because existing freight traffic would not preclude passenger service along this section of track, the route would provide passenger rail service on the existing BNSF track, with potential improvements within the existing BNSF right-of-way.

Alternative N4A would provide several improvements over the existing Heartland Flyer service. Alternative N4A would increase the number of daily round trips along this route (the Heartland Flyer currently offers one round trip per day), and the N4A route would extend from Fort Worth to Dallas without requiring a transfer (the Heartland Flyer service currently terminates in Fort Worth). In addition, Alternative N4A would provide improvements to existing station facilities and new train equipment with more onboard amenities, including business class available for a premium price.

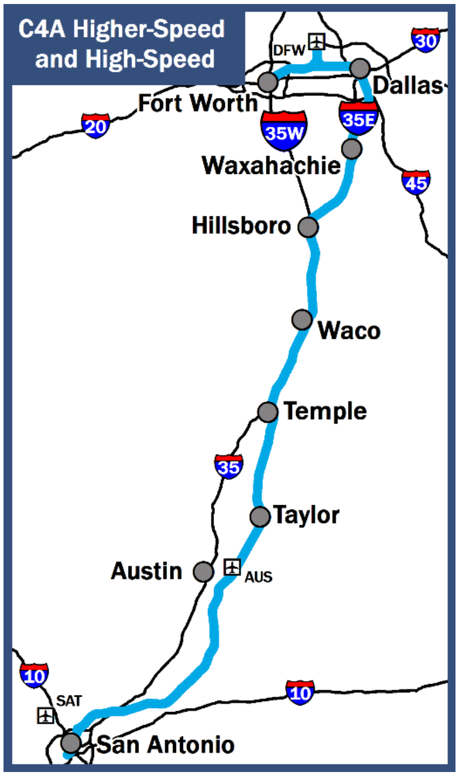
Alternative N4A assumes diesel-locomotive hauled equipment running three to six daily round trips. Two or three of the round trips would operate on an accelerated schedule, making roughly seven stops, with the remaining local trains making up to 12 stops.

1.2.3 Central Section: Dallas and Fort Worth to San Antonio

Three route alternatives, each with higher-speed and high-speed rail options, were evaluated in the Central Section: Alternatives C4A, C4B, and C4C.

The Central Section alternatives would provide several improvements over the existing Texas Eagle service in this corridor. All of the alternatives would increase the number of daily round trips along this route (the Texas Eagle currently offers one round trip per day). The high-speed rail alternatives would provide faster service between Dallas and Fort Worth and Antonio — 2 hours versus 8 hours for the Texas Eagle Service. In addition, the Central Section alternatives would provide improvements to existing station facilities and new train equipment.

1.2.3.1 Alternative C4A Higher-Speed and High-Speed Rail



Alternative C4A would begin in Fort Worth and follow the TRE tracks east to Dallas. From Dallas, it would follow the BNSF alignment south toward Waxahachie where it would enter a new alignment outside existing highway and rail corridors to accommodate maximum operating speeds. Though outside existing transportation corridors, the southern portion of Alternative C4A would generally follow the BNSF alignment for about 250 miles, traveling south from Waxahachie through Hillsboro, Waco, Temple, Taylor, and Austin to San Antonio.

Alternative C4A Higher-Speed Rail assumes new high-performance diesel-locomotive hauled equipment running six to 12 daily round trips. Express trains would likely make seven stops, and local trains would make up to 12 stops.

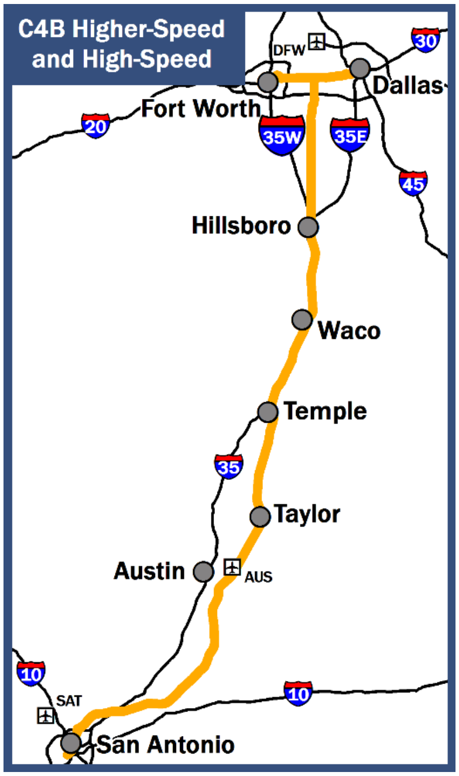
Alternative C4A High-Speed Rail assumes true electric-powered, high-speed service running 12 to 20 daily round trips. Express trains would likely make six stops, and local trains would make up to nine stops.

1.2.3.2 Alternative C4B Higher-Speed and High-Speed Rail

Alternative C4B would serve both Fort Worth and Dallas, with trains following a new elevated high-speed rail alignment over IH-30. In Arlington (between Dallas and Fort Worth), the alternative would turn south to Hillsboro on an alignment outside existing transportation corridors. The alternative would then follow the same high-speed rail alignment as Alternative C4A from Hillsboro to San Antonio.

Alternative C4B Higher-Speed Rail assumes new high-performance diesel-locomotive hauled equipment running six to 12 daily round trips. Express trains would likely make seven stops, and local trains would make up to 12 stops.

Alternative C4B High-Speed Rail assumes true electric-powered, high-speed service running 12 to 20 daily round trips. Express trains would likely make six stops, and local trains would make up to eight stops.

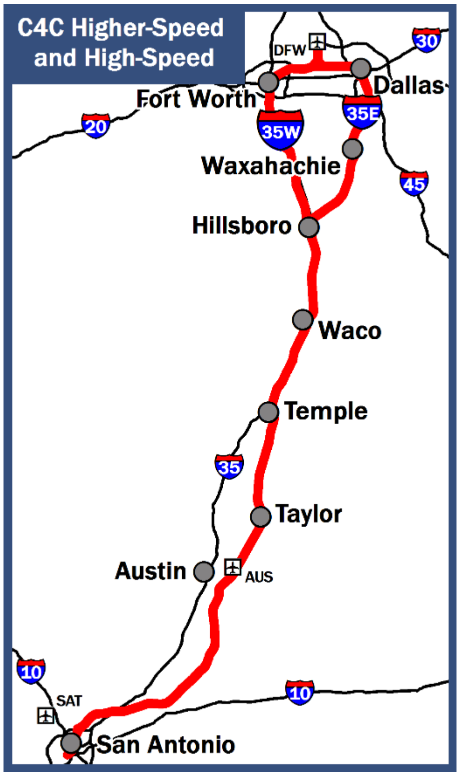


1.2.3.3 Alternative C4C Higher-Speed and High-Speed Rail

Alternative C4C would follow the same potential alignment as Alternative C4A from Fort Worth east to Dallas and south to San Antonio, but would include a link from Hillsboro directly to Fort Worth parallel to the UPRR alignment. Service on the Alternative C4C route would operate in a clockwise direction, running from Hillsboro to Fort Worth, to Dallas, back to Hillsboro, and south to San Antonio in order to serve Fort Worth directly (while also being compatible with the general service for Alternative C4A).

Alternative C4C Higher-Speed Rail assumes new high-performance diesel-locomotive hauled equipment running six to 12 daily round trips. Express trains would likely make seven stops, and local trains would make up to 12 stops.

Alternative C4C High-Speed Rail assumes true electric-powered high-speed service running 12 to 20 daily round trips. Express trains would likely make six stops, and local trains would make up to nine stops.



1.2.4 Southern Section: San Antonio to South Texas

Two route alternatives were evaluated in the Southern Section: Alternative S4, with higher-speed rail, and Alternative S6, with higher-speed and high-speed rail options.

1.2.4.1 Alternative S4 Higher-Speed Rail

Alternative S4 would begin in San Antonio and travel southeast along the UPRR alignment to George West, where it would continue outside existing transportation corridors to Alice. At Alice, the alternative would divide into three legs at a stop. The first leg would travel west along the Kansas City Southern (KCS) Railway to San Diego, Texas; it would then travel outside existing transportation corridors to east of Laredo in an alignment that would allow higher speeds and rejoin the KCS Railway to enter the highly developed Laredo area. The second leg would travel south along abandoned railroad tracks to McAllen and east to Harlingen and Brownsville. The third leg would travel east along the KCS Railway to Corpus Christi.

Alternative S4 Higher-Speed Rail assumes new high-performance diesel-locomotive hauled equipment running four to six daily round trips. Depending on corridor demand model forecasts, the primary service may be designated as Laredo-Alice-San Antonio and Corpus Christie-Alice-San Antonio, with a connecting feeder from Brownsville, Harlingen, and McAllen.

1.2.4.2 Alternative S6 Higher-Speed and High-Speed Rail

Alternative S6 would begin in San Antonio and travel south on a new alignment outside existing transportation corridors to a station near the Laredo-Columbia Solidarity Bridge, which crosses the Rio Grande north of Laredo. The alternative would then cross on a new railway bridge to join a new rail line being constructed in Mexico, which would continue to Monterrey. This study only examines the physical effects of the U.S. component of this new line, but it does consider the ridership effect of such a connection.

Alternative S6 Higher-Speed Rail assumes new high-performance diesel-locomotive hauled equipment running four to six daily round trips between San Antonio and Laredo, which would be the only U.S. stops for the alternative. If an extension from Laredo to Monterrey were to be added, the frequency of trips to Monterrey is assumed to be the same as those from San Antonio to Laredo.

Alternative S6 High-Speed Rail assumes true electric-powered, high-speed service running eight to 12 daily round trips between San Antonio and Laredo. If an extension from Laredo to Monterrey is added, the frequency of trips to Monterrey is assumed to be the same as those from San Antonio to Laredo.

1.2.5 Station Cities

The study does not evaluate specific station locations, and no conclusion about the exact location of stations will be made as part of the service-level EIS process. However, based on ridership data and transit connectivity information developed as part of the alternatives analysis (TxDOT 2014), and based on stakeholder input, the cities in which stations would most likely be located have been assumed. The size and design of stations would be appropriate for the service type and the route of the alternative. Cities that could have stations are listed in Table 1-2.

Table 1-2: Cities with Potential Stations

Oklahoma	
Edmond	Pauls Valley
Oklahoma City	Ardmore
Norman	
Texas	
Gainesville	Austin
Fort Worth	San Antonio
Arlington	Alice
Dallas	Corpus Christi
Waxahachie	Harlingen
Waco	McAllen
Temple (also serving Killeen)	Brownsville
Taylor	Laredo

2.0 Regulatory Context and Purpose

FRA's *Procedures for Considering Environmental Impacts* states: "There should be an assessment of the consistency of the alternatives with federal and state standards concerning drinking water, storm sewer drainage, sedimentation control, and non-point source discharges such as runoff from construction operations. The need for any permits under Sections 402 and 404 of the Federal Water Pollution Control Act (33 United States Code [U.S.C.] 1342, 1344) for the discharge of dredged or fill material shall be discussed" (64 Federal Register 28554).

This technical study identifies surface water and groundwater resources by using Geographic Information System (GIS) data within the EIS Study Area that could be affected by stormwater runoff, erosion, discharge of dredged or fill material, or the introduction of contaminants. This study also identifies potential effects and potential Best Management Practices (BMPs) associated with the alternatives.

3.0 Baseline/Affected Environment

3.1 Study Area

As a first step in the water quality analysis, the project GIS database in ARC/View was used to identify the various resources within the EIS Study Area. The EIS Study Area was defined by the geographic area that could be affected by stormwater runoff, erosion, or contaminants. The extent of the water quality analysis conducted for the route alternative, including the various sections and station locations, was limited to a 500-foot-wide area. These threshold limits for potential effects were used to create a potential “zone of effect” for the entire route alternative by using GIS.

3.2 Regulatory Environment

Applicable federal, state, and local legislation, regulations, and orders pertaining to water quality within the EIS Study Area are summarized below. Additional local and regional laws, regulations, and orders may be applicable and will be addressed in project-level analysis.

3.2.1 Federal Laws, Regulations, and Orders

3.2.1.1 Clean Water Act (CWA)

- **Section 401 (33 U.S.C. 1341 and 40 Code of Federal Regulations [CFR] 121).** Section 401 of the CWA requires a water quality certification from the State Water Resources Control Board or appropriate Regional Water Quality Control Boards whenever a project involves the placement of dredged or fill material into waters of the U.S.
- **Section 402 (33 U.S.C. 1342 and 40 CFR 122).** Establishes a permitting system for the discharge of all pollutants (except dredge or fill material) into waters of the U.S. A National Pollution Discharge Elimination System (NPDES) permit is required for all point source discharges of pollutants to surface waters. A point source is a discernible, confined, and discrete conveyance, such as by pipe, ditch, or channel.
- **Section 404 (33 U.S.C. 1344, 33 CFR Part 323, and 40 CFR Part 230).** Establishes a permit program administered by the U.S. Army Corps of Engineers, which regulates the discharge of dredged or fill materials into waters of the U.S. (including wetlands). Section 404(b)(1) guidelines allow the discharge of dredged or fill materials into the aquatic system only if there is no practicable alternative that would have less adverse impacts.

3.2.1.2 Wild and Scenic Rivers Act of 1968, as Amended (16 U.S.C. 1271–1287)

The purpose of the Wild and Scenic Rivers Act is to preserve and protect wild and scenic rivers and immediate environments for the benefit of present and future generations. The act is applicable to all projects that affect designated wild, scenic, and recreational rivers and immediate environment, and rivers under study for inclusion in the National Wild and Scenic Rivers System (NWSRS). The act prohibits federal agencies from undertaking activities that would adversely affect the values for which the river was designated. The act is administered by a variety of state and federal agencies.

Designated river segments flowing through federally managed lands are administered by the land-managing agency (e.g., U.S. Forest Service, Bureau of Land Management, or National Park Service [NPS]). River segments flowing through private lands are administered by the state in conjunction with local government agencies. On projects that affect designated rivers or their immediate environments, consultation will occur through the NEPA process between the state lead agency and the land-managing agencies.

The following three categories of rivers are protected by the Wild and Scenic Rivers Act:

- Designated Rivers – Rivers included in the NWSRS and their tributaries are protected under Section 7(a) of the act.
- Study Rivers – Potential additions to the NWSRS are protected under Section 7(a) of the act.
- Nationwide Rivers Inventory (NRI) – Rivers believed to possess one or more "outstandingly remarkable" natural or cultural values with more than local or regional significance are protected under Section 5 (d) of the act.

Entire rivers or river segments may be protected. An environmental review of potential impacts on protected rivers is initiated when projects occur within 1 mile from a National Wild and Scenic River (NWSR), within 20 miles upstream from an NWSR, within 10 miles downstream from an NWSR, or are located on a tributary in close proximity to an NWSR. Projects within these thresholds are required to consult with the federal agency having jurisdiction over the NWSR.

3.2.1.3 Safe Drinking Water Act of 1974, as Amended (42 U.S.C. 300[f])

The purpose of the Safe Drinking Water Act is to ensure public health and welfare through safe drinking water. The act is applicable to all public drinking water systems and reservoirs (including rest area facilities). It is also applicable to actions that may have a significant impact on an aquifer or wellhead protection area that is the sole or principal drinking water. This act requires coordination with the U.S. Environmental Protection Agency (EPA) when an area designated as a principal or Sole Source Aquifer may be affected by a proposed project.

Executive Order 11988 – Floodplain Management; USDOT Order 5650.2

Executive Order 11988 directs all federal agencies to avoid all short-term and long-term adverse impacts associated with floodplain modification and to avoid direct and indirect support of development within 100-year floodplains when there is a reasonable alternative available.

Projects that encroach upon 100-year floodplains must be supported with additional specific information. The U.S. Department of Transportation (USDOT) Order 5650.2, Floodplain Management and Protection, prescribes "policies and procedures for ensuring that proper consideration is given to the avoidance and mitigation of adverse floodplain impacts in agency actions, planning programs, and budget requests." The order requires that attention be given and findings made in environmental review documents indicating all risks, impacts, and support from the proposed transportation facility.

3.2.1.4 Flood Disaster Protection Act (42 U.S.C. 4001–4128)

The purpose of the Flood Disaster Protection Act is to identify flood-prone areas and provide increased insurance coverage. The act requires purchase of insurance for buildings in special flood-hazard areas. The act is applicable to any federally assisted acquisition or construction project in an area identified as having special flood hazards. Projects should avoid construction in, or develop a design to be consistent with, Federal Emergency Management Agency (FEMA)-identified flood-hazard areas.

3.2.2 State Regulations

3.2.2.1 1955 Oklahoma Water Pollution Control Act

The 1955 Oklahoma Water Pollution Control Act declared that it is the public policy of the state "to conserve the waters of the state and to protect, maintain and improve the quality thereof for public water supplies, for the propagation of wildlife, fish and aquatic life and for domestic, agricultural, industrial, recreational and other legitimate beneficial uses." The act made it unlawful to pollute state waters. It is further forbidden for any person to carry on certain activities that cause the discharge of waste into waters or lead to a related reduction in water quality without first securing a permit from the Oklahoma Water Resources Board.

Subsequent changes in roles and responsibilities regarding administration of the act have transferred various water quality and related programs and functions of several agencies to the Oklahoma Department of Environmental Quality (ODEQ).

3.2.2.2 Texas Commission on Environmental Quality (Civil Law from Title 28 of third Partida; Water Code §11.096. Obstruction of Navigable Streams)

According to this Texas civil law, no person may obstruct the navigation of any stream that can be navigated by steamboats, keelboats, or flatboats by cutting and felling trees or by building on or across the stream a dike, milldam, bridge, or other obstruction. Under Section 11.096, the Texas Commission on Environmental Quality (TCEQ) shall be notified prior to projects that construct bridges or dam, or that places obstructions in streams that are determined to be navigable in fact.

A historical legal decision, *Trice v. State, 712 S.W.2d 842 (Tex.App. Waco 1986, writ ref'd n.r.e.),* addressed who is allowed to bridge Texas streams under the laws then in effect. The court noted (p. 847):

> "The State, through legislative action, has also authorized certain entities to erect bridges over the navigable waters within its boundaries. [citing statutes pertaining to counties, municipalities, railroads, and toll road corporations] However, except for its tidal waters, the State has not authorized an individual to construct a bridge over its navigable waters. Furthermore, the State has not created an agency or designated any public official to regulate bridge construction over its navigable waters."

Under a change in the law in 1993, the Commissioner of the General Land Office was granted limited permitting power to allow private road crossings over public streams. See Natural Resources Code §51.291 (quoted in section on OBSTRUCTIONS) (Texas Parks and Wildlife Department 2004).

3.2.2.3 Texas Commission on Environmental Quality: Edwards Aquifer Protection Program.

Before building on the recharge, transition, or contributing zones of the Edwards Aquifer, an Edwards Aquifer Protection Plan must be reviewed and approved by the TCEQ Edwards Aquifer Protection Program. Once a plan is approved, the site is monitored for compliance throughout construction and operation. The Edward Aquifer Protection Plan should outline the BMPs that will be implemented and maintained — both during and after construction activities — to prevent contaminants found in stormwater from reaching the Edwards Aquifer.

All projects must be consistent with the state Nonpoint Source Pollution Management Program (Section 319).

3.2.3 Other Permitting Agencies

3.2.3.1 County Agencies

The current alternatives cross up to 7 county jurisdictions in Oklahoma and 29 county jurisdictions in Texas. Potential exists for each county to regulate construction activities within the county as it pertains to water quality or water conservation. Divisions of county public works departments or county districts that focus on land development, protection of natural resources, flood control, water conservation, or construction stormwater could require permits. The types of permits may include floodplain protection, grading, waterway crossing, construction stormwater, building, or encroachment permits. County permit requirements and regulations would need to be investigated, meetings held with each county, and a permitting strategy developed for each county that would address all conditions and permits consistent with county programs.

3.2.3.2 Individual Cities

Under the CWA (and regulations promulgated pursuant to the CWA), communities with a population greater than 100,000 are required to apply for a municipal permit under the NPDES program. In some cases, individual cities join with counties, water districts, and flood control districts to apply for joint permits. Cities that are joint permittees with counties are required to implement programs to make sure that city-permitted projects adhere to the conditions of NPDES permits; this may include programs to ensure that BMPs and other stormwater quality protection measures are incorporated into grading and building permits, and that regulatory and site inspection programs are developed. Individual water quality protection measures, including BMPs, are developed at the county level; hence the counties and cities are jointly responsible for compliance.

3.3 Regional Climate

The EIS Study Area spans approximately 850 miles in a general north to south orientation, from central Oklahoma to southern Texas. The route alternatives are spread across a broad geographic area with generally semi-arid, humid subtropical, and modified subtropical conditions with mild winters and hot summers. The area generally lies along low-elevation basins and valleys associated with the rolling terrain in the Great Plains and the Coastal Plains in the most southern extent of the EIS Study Area. The areas are either developed or vegetated with open grasslands, agricultural land, shrub land, or forests. The climate is characterized by a regime of moderate to hot summer drought and winter rain. Winter rains occurs as a result of low-pressure depressions associated with Pacific and Arctic fronts (University of Oklahoma 2014; Texas Climate Data 2014). Precipitation in the Northern Section averages about 48 inches per year near Oklahoma City and 37 inches per year near the Dallas and Fort Worth area. In the Central Section, precipitation averages 36 inches in Waco to 34 inches in Austin, and in the Southern Section it ranges from 32 inches in San Antonio to 20 inches in Laredo. Precipitation is generally rain except during winter in the Northern Section, from Dallas and Fort Worth to Oklahoma, where snowfall is possible. The daily high temperature ranges on average from 50 to 94 degrees Fahrenheit (°F) in the Northern Section to 67 to 100°F in the Southern Section; however, temperatures of over 100°F are common in summer throughout the entire EIS Study Area (U.S. Climate Data 2014).

3.4 Surface Waters

Surface waters and associated channels are sensitive resource areas because (1) they convey floodwaters and may enhance adjacent flooding or may attenuate downstream flooding risk by storing floodwater, (2) they typically provide important native species habitat and may support wetland and riparian habitats, (3) they provide direct pathways of contamination to downstream ecological or human resources, and (4) they provide locations for groundwater recharge.

For the purpose of this technical study, surface waters include lakes, rivers, and streams identified using U.S. Geological Survey (USGS) 1:24,000 scale digital line graphs. Blue-line streams and bodies of water on the digital line graphs are generally under jurisdiction of the U.S. Army Corps of Engineers. Most surface waters within the EIS Study Area are associated with significant drainage channels or are within coastal areas. These include improved flood control drainage channels, intermittent river and stream channels, perennial river and stream channels, ponds, lakes, reservoirs, coastal estuaries lagoons, and intertidal sloughs. Table 3-1 identifies surface waters crossed by the EIS Study Area for each alternative. Figures 3-1, 3-2, and 3-3 show the location of surface waters, boundaries of hydrologic units, and extent of floodplains within the vicinity of the EIS Study Area.

Table 3-1: Surface Waters Crossed with the EIS Study Area

Water Body Classification	Number Crossed
Northern Section	
Alternative N4A (Conventional Rail)	
Perennial Stream	43
Intermittent Stream	300
Open Water – Lake/Pond	163
Open Water – Reservoir	31
Total	**537**
Central Section	
Alternative C4A (Higher- and High-Speed Rail)	
Perennial Stream	75
Intermittent Stream	362
Open Water – Lake/Pond	246
Open Water – Reservoir	17
Total	**700**
Alternative C4B (Higher- and High-Speed Rail)	
Perennial Stream	42
Intermittent Stream	374
Open Water – Lake/Pond	222
Open Water – Reservoir	12
Total	**650**
Alternative C4C (Higher- and High-Speed Rail)	
Perennial Stream	82
Intermittent Stream	459
Open Water – Lake/Pond	291
Open Water – Reservoir	18
Total	**850**
Southern Section	
Alternative S4 (Higher-Speed Rail)	
Perennial Stream	4
Intermittent Stream	310
Open Water – Lake/Pond	113
Open Water – Reservoir	16
Total	**443**
Alternative S6 (Higher- and High-Speed Rail)	
Perennial Stream	2
Intermittent Stream	196
Open Water – Lake/Pond	53
Open Water- Reservoir	4
Total	**255**
Source: USGS (2014).	

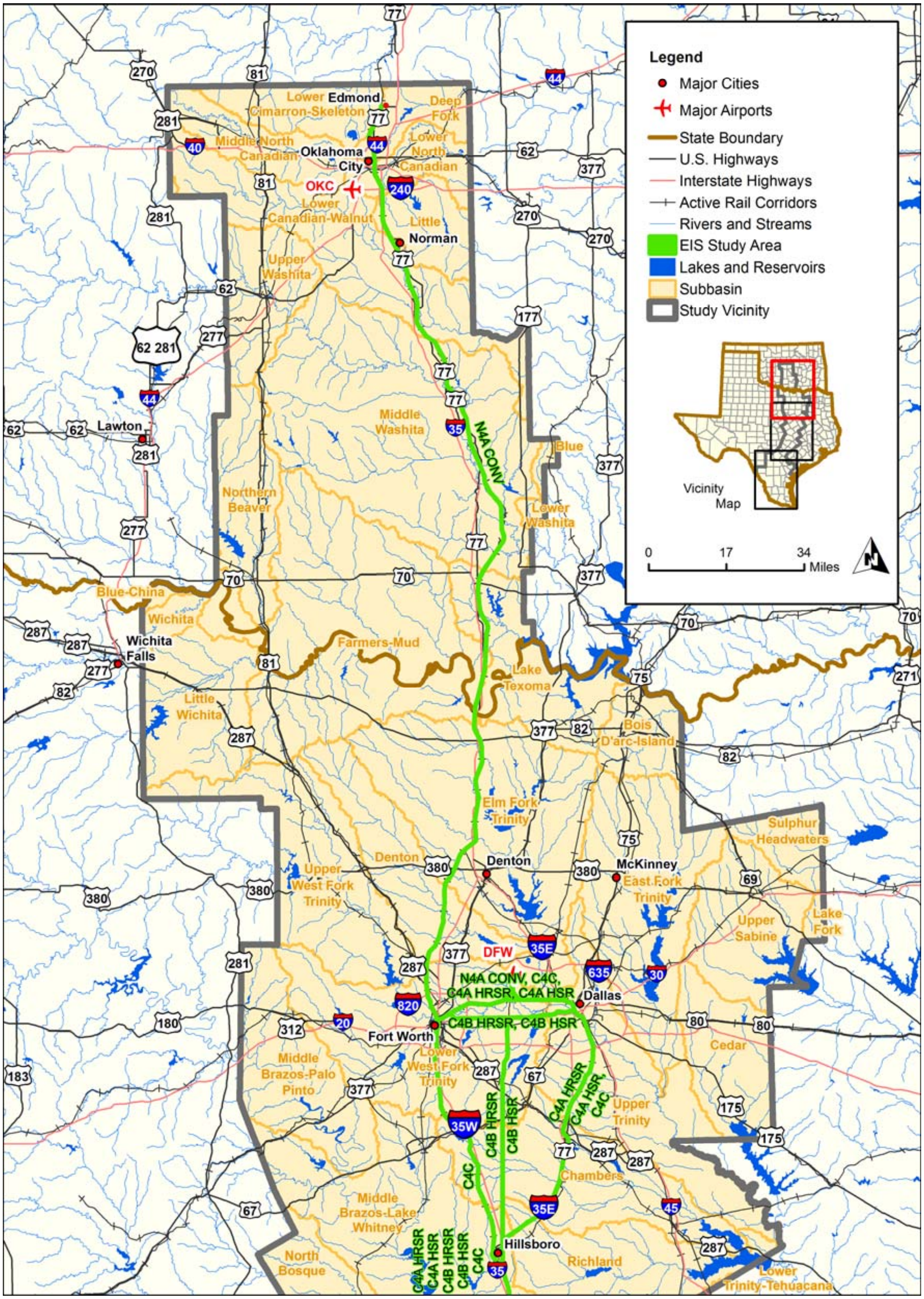


Figure 3-1: Surface Waters, Hydrologic Units Sub-basins, and Floodplains within the Vicinity of the Northern Section EIS Study Area

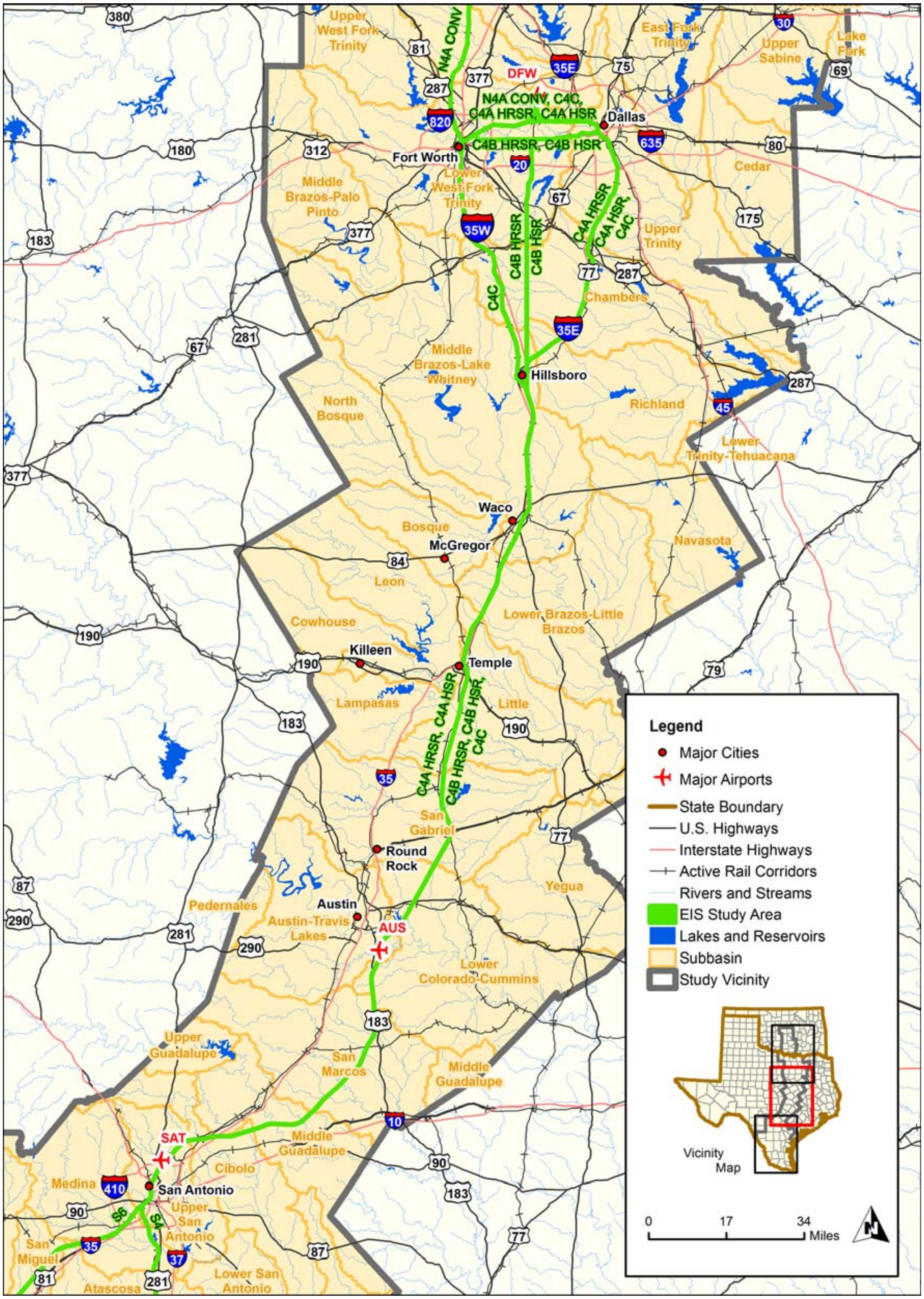


Figure 3-2: Surface Waters, Hydrologic Units Sub-basins, and Floodplains within the Vicinity of the Central Section EIS Study Area

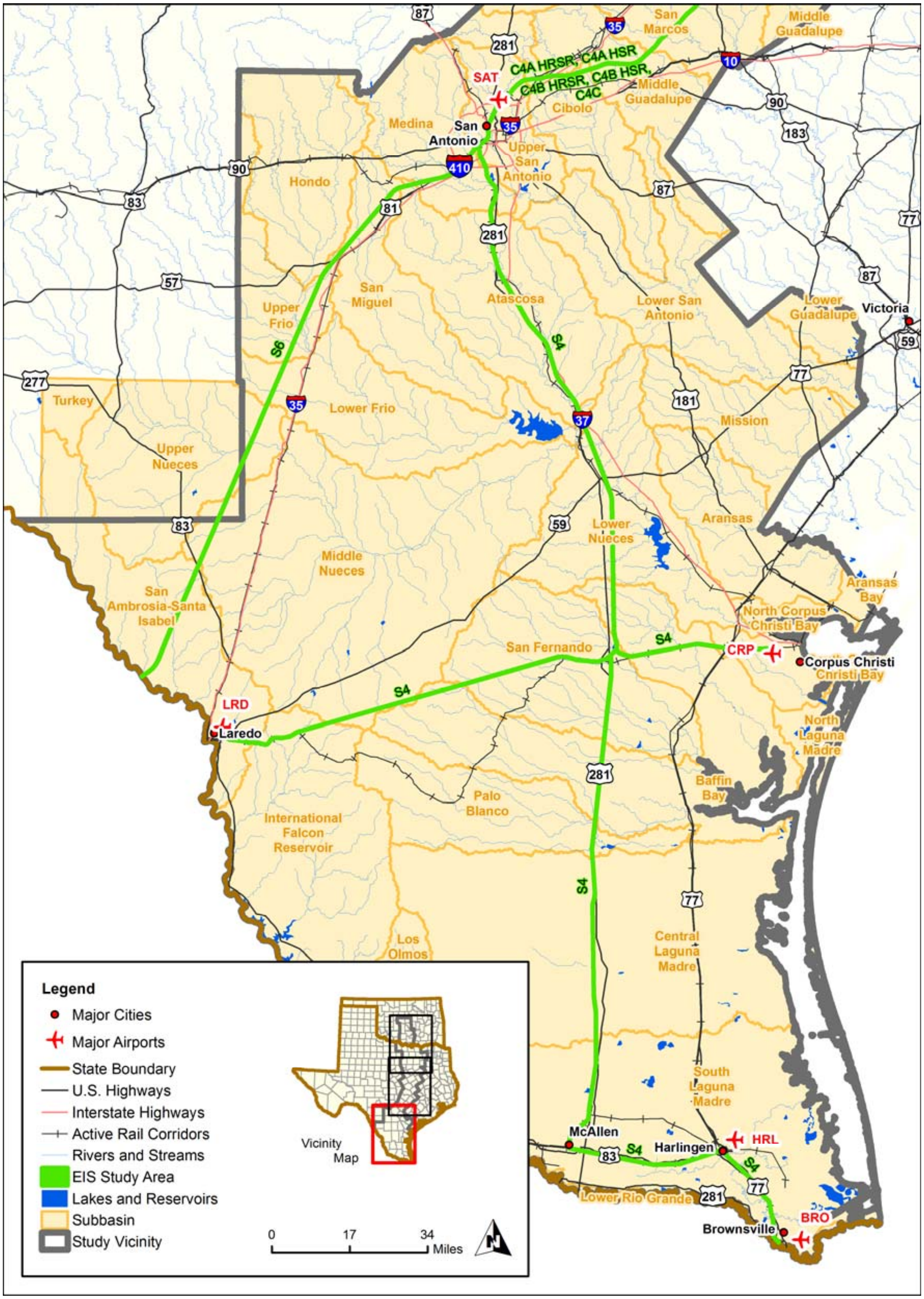


Figure 3-3: Surface Waters, Hydrologic Units Sub-basins, and Floodplains within the Vicinity of the Southern Section EIS Study Area

3.4.1 Hydrologic Units

The EIS Study Area crosses portions of Oklahoma and Texas. Within these states, the study area includes 43 hydrologic unit sub-basins. Each unit generally consists of individual watersheds or sub-watersheds and in some cases contains more than one watershed. Table 3-2 lists these hydrologic units by state. Figures 3-1, 3-2, and 3-3 show the boundaries of the hydrologic units within the vicinity of the EIS Study Area.

Table 3-2: Hydrologic Units Crossed within the EIS Study Area

Hydrologic Unit	State	Hydrologic Unit	State
Deep Fork	Oklahoma	Lower Frio	Texas
Farmers-Mud	Oklahoma	Lower Nueces	Texas
Little	Oklahoma	Lower West Fork Trinity	Texas
Lower Canadian-Walnut	Oklahoma	Medina	Texas
Lower Cimarron-Skeleton	Oklahoma	Middle Brazos-Lake Whitney	Texas
Lower North Canadian	Oklahoma	Middle Guadalupe	Texas
Middle Washita	Oklahoma	Middle Nueces	Texas
Lake Texoma	Oklahoma and Texas	Palo Blanco-Richland	Texas
Atascosa	Texas	San Fernando	Texas
Austin-Travis Lakes	Texas	San Gabriel	Texas
Baffin Bay	Texas	San Marcos	Texas
Central Laguna Madre	Texas	San Miguel	Texas
Chambers	Texas	South Corpus Christi Bay	Texas
Cibolo	Texas	South Laguna Madre	Texas
Denton	Texas	Upper Frio	Texas
Elm Fork Trinity	Texas	Upper Nueces	Texas
Hondo	Texas	Upper San Antonio	Texas
Leon	Texas	Upper Trinity	Texas
Little	Texas	International Falcon Reservoir	Texas
Lower Brazos-Little Brazos	Texas	San Ambrosia-Santa Isabel	Texas
Lower Colorado-Cummins	Texas		
Source: USGS (2014).			

3.4.2 Floodplains

For the purpose of this document, floodplains are Special Flood Hazard Areas (SFHA), as defined by FEMA Flood Insurance Rate Maps, with the following zone designations:

- Zone A: Areas of 100-year flood; base flood elevations and flood hazard factors not determined.
- Zone AO: Areas of 100-year shallow flooding where depths are between 1 and 3 feet; average depths of inundation are known, but no flood hazard factors are determined.
- Zone AH: Areas of 100-year shallow flooding where depths are between 1 and 3 feet; base flood elevations are known, but no flood hazard factors are determined.
- Zone A1-A30: Areas of 100-year flood; base flood elevations known and flood hazard factors determined.
- Zone V: Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors not determined.
- Zone V1-V30: Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined.

Areas with the following designations are not considered floodplains for the purposes of this analysis:

- Zone B: Generally includes areas above the 100-year flood but below the 500-year flood, except small drainages where areas below the 100-year flood may be included.
- Zone C: Areas of minimal flooding.
- Zone D: Areas of undetermined, but possible flood hazard.
- Zone X: Areas of unknown flood hazard.

Floodplains are important because (1) they provide floodwater storage and attenuation of downstream flooding risk, (2) they typically provide important native species habitat, (3) they provide water quality improvement through deposition of sediments and other contaminants and natural treatment, and (4) they may provide locations for groundwater recharge.

Most floodplains within the EIS Study Area are associated with significant drainage channels or riparian areas or are within coastal areas. Figures 3-1, 3-2, and 3-3 show the locations of floodplains associated with surface waters within the vicinity of the EIS Study Area.

3.4.3 Listed Section 303(d) Impaired Waters

Section 303(d) of the CWA (33 U.S.C. 1250, et seq., at 1313[d]), requires states to identify waters that do not meet water quality standards after applying certain required technology-based effluent limits (“impaired” bodies of water). States are required to compile this information in a list and submit the list to EPA for review and approval. This list is known as the Section 303(d) list of impaired waters. As part of the listing process, states are required to prioritize waters and watersheds for future development of Total Maximum Daily Loads (TMDLs). In Oklahoma, the ODEQ has ongoing efforts to monitor and assess water quality to prepare the Section 303(d) list and subsequently to develop TMDLs. The most recent Section 303(d) list was approved in 2013 and contains 4,203 bodies of water; many are listed as being impaired for multiple pollutants.

In Texas, the TCEQ has the responsibility to monitor and assess the water quality, prepare the Section 303(d) list, and develop TMDLs. The most recent Section 303(d) list in Texas was approved in 2013 and contains 1,214 bodies of water under evaluation; of those, 568 are listed as impaired. The 303(d) list can identify areas where there already is a significant degradation of water quality, providing an indication of where additional contaminants resulting from the Program would have the most impact.

Table 3-3 identifies the number of perennial and intermittent streams and the Section 303(d) impaired waters within the EIS Study Area. Figures 3-4, 3-5, and 3-6 show Section 303(d) waters crossed within the EIS Study Area, based on review of the Texas and Oklahoma 303(d) lists.

Table 3-3: Surface Waters Classified as Impaired Crossed by the EIS Study Area

Water Body Classification	Number Crossed
Northern Section	
Alternative N4A (Conventional Rail)	
Perennial Stream	43
Intermittent Stream	300
Impaired Streams	14
Percent	**4.0%**
Central Section	
Alternative C4A (Higher- and High-Speed Rail)	
Perennial Stream	75
Intermittent Stream	362
Impaired Streams	17
Percent	**3.9%**
Alternative C4B (Higher- and High-Speed Rail)	
Perennial Stream	42
Intermittent Stream	374
Impaired Streams	21
Percent	**5.0%**

Water Body Classification	Number Crossed
Alternative C4C (Higher- and High-Speed Rail)	
Perennial Stream	82
Intermittent Stream	459
Impaired Streams	18
Percent	3.3%
Southern Section	
Alternative S4 (Higher-Speed Rail)	
Perennial Stream	4
Intermittent Stream	310
Impaired Streams	7
Percent	2.2%
Alternative S6 (Higher- and High-Speed Rail)	
Perennial Stream	2
Intermittent Stream	196
Impaired Streams	5
Percent	2.5%
Source: USGS (2014).	

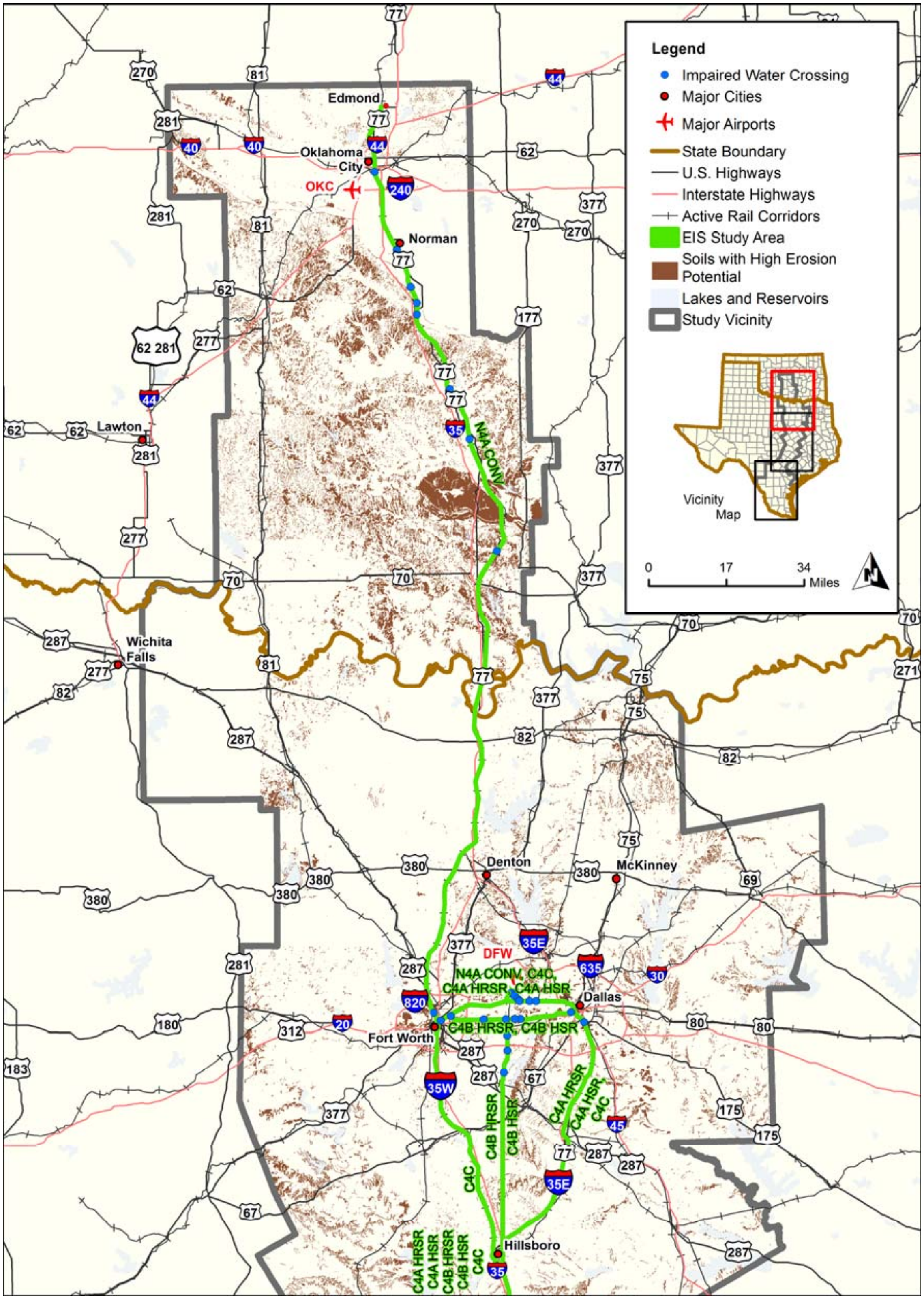


Figure 3-4: Impaired Waters Crossed and Soils with High (Severe and Very Severe) Erosion Potential within the Vicinity of the Northern EIS Study Area

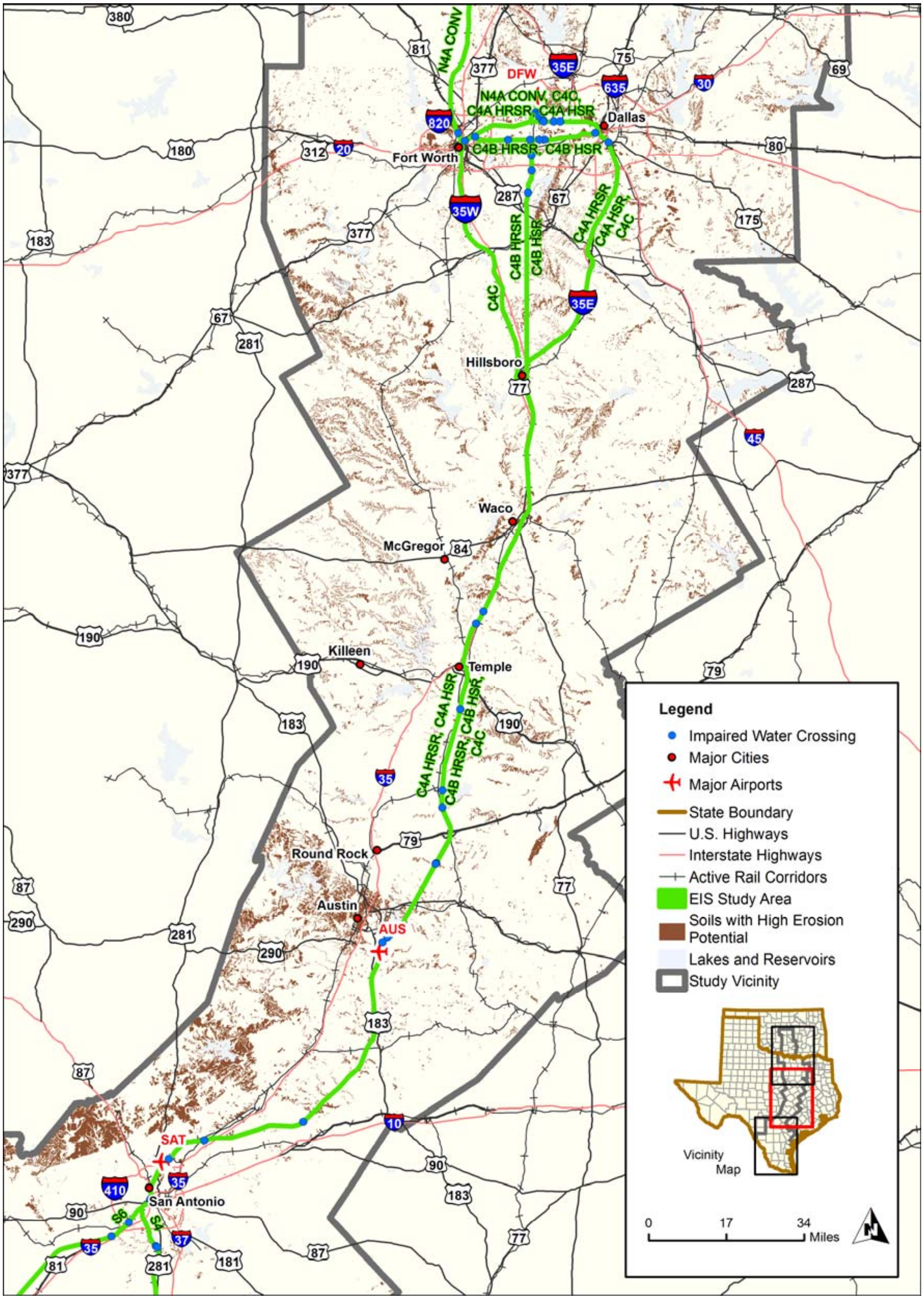


Figure 3-5: Impaired Waters Crossed and Soils with High (Severe and Very Severe) Erosion Potential within the Vicinity of the Central Section EIS Study Area

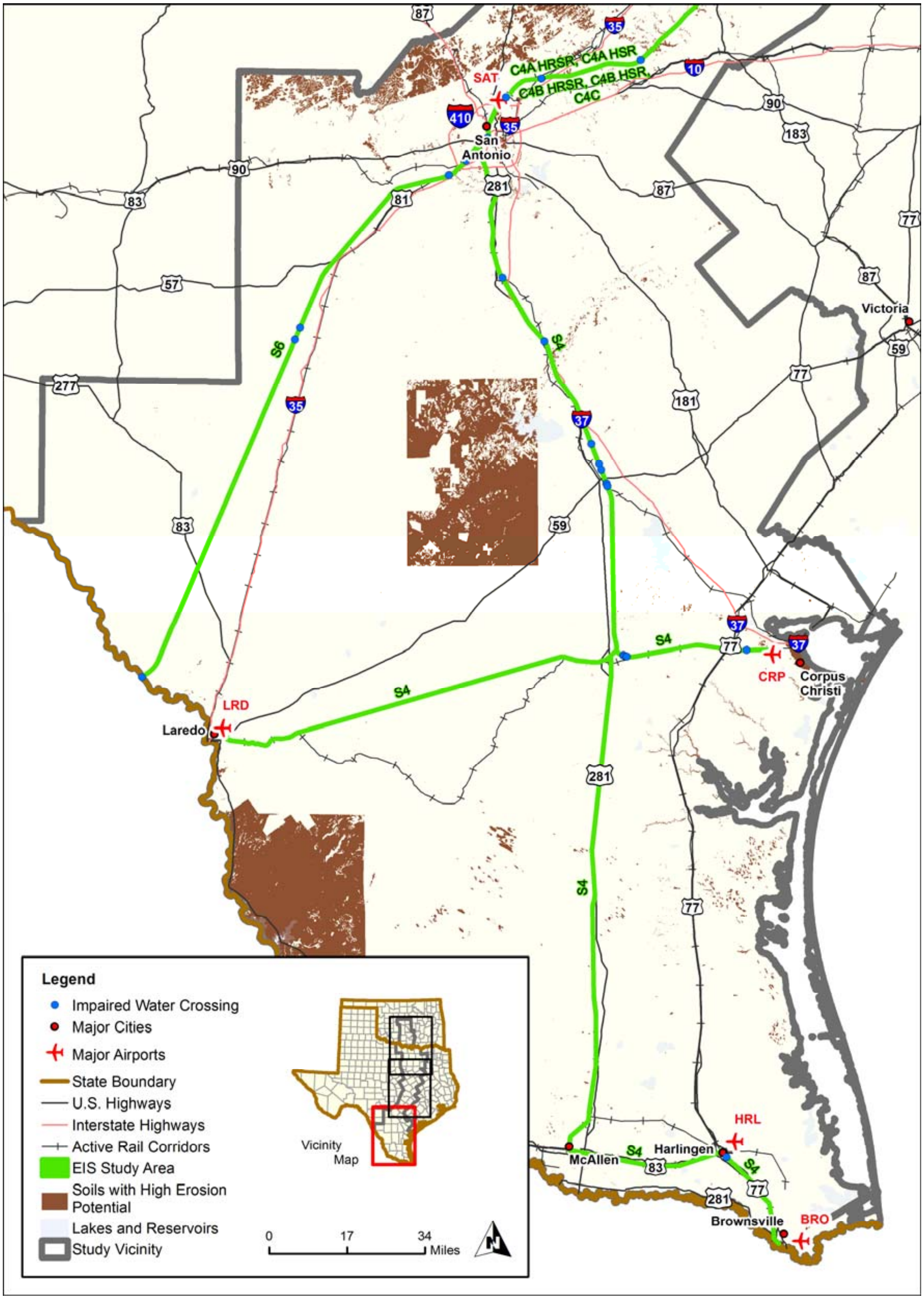


Figure 3-6: Impaired Waters Crossed and Soils with High (Severe and Very Severe) Erosion Potential within the Vicinity of the Southern Section EIS Study Area

3.4.4 Designated Waters

No surface waters designated as NWSR or Study Rivers within the NWSRS occur within Oklahoma. However, eight rivers and river segments included in the NRI occur within Oklahoma. The only NRI river or river segment that is within the Northern Section EIS Study Area is a 20-mile segment of the Washita River in Carter and Murray counties (NPS 2014). This segment of the river is listed in the NRI for the outstanding, remarkable values it possesses including scenery, recreation, geology, fish populations, and fish and wildlife habitat. The segment of the river is within the migration route of the federal endangered whooping crane and contains important fish and wildlife habitat. It has been identified as a potential State Scenic River passing through the Arbuckle Mountains, with numerous observable geologic processes. Recreational activities on the river include floating, camping, and fishing (NPS 2014).

There are no Study Rivers within the NWSRS within Texas (NWSRS 2014). Nineteen rivers and river segments that are included in the NRI occur within Texas. No designated waters in Texas occur within the EIS Study Area.

3.5 Erosion

Soils susceptible to erosion within the EIS Study Area may include soils with a high erodibility factor and steep slopes with few rock fragment inclusions, which may result in suspension and transport of materials, slumping, or landslides, and consequent erosion. Regional soil data in the Soil Survey Geographic (SSURGO) database provide information on susceptibility to erosion. Soil erosion is influenced by several factors including soil texture, slope, climate, and vegetative cover. The SSURGO database includes an Erosion Hazard of Forest Roads and Trails – Dominant Component category that is calculated using erodibility factor (*kfact*), slope (*slope*h) and content of rock fragments for each individual soil map unit. For the purpose of this analysis, susceptibility of soils to erosion is evaluated based on the Erosion Hazard of Forest Roads and Trails – Dominant Component index. Table 3-4 summarizes SSURGO soil types crossed by the alternatives and identifies potential severe and very severe soil erosion potential conditions. Figures 3-4, 3-5, and 3-6 show areas within the vicinity of the EIS Study Area with severe and very severe soil erosion potential. Erosive soil data for the area within the vicinity of the Southern Section EIS Study Area is limited and available data were used for tabular summaries and graphical depictions.

Table 3-4: Soils Crossed within the EIS Study Area

Erosion Hazard Classification	Number Crossed
Northern Section	
Alternative N4A (Conventional Rail)	
Not Rated	31
Slight	651
Moderate	420
Severe	77
Very Severe	20
Total	1,199

Erosion Hazard Classification	Number Crossed
Central Section	
Alternative C4A (Higher- and High-Speed Rail)	
Not Rated	29
Slight	874
Moderate	439
Severe	68
Very Severe	33
Total	**1,443**
Alternative C4B (Higher- and High-Speed Rail)	
Not Rated	32
Slight	836
Moderate	428
Severe	85
Very Severe	31
Total	1,412
Alternative C4C (Higher- and High-Speed Rail)	
Not Rated	33
Slight	1044
Moderate	531
Severe	82
Very Severe	41
Total	**1,731**
Southern Section[a]	
Alternative S4 (Higher-Speed Rail)	
Not Rated	29
Slight	1102
Moderate	190
Severe	3
Very Severe	19
Total	**1,340**
Alternative S6 (Higher- and High-Speed Rail)	
Not Rated	5
Slight	349
Moderate	81
Severe	0
Very Severe	4
Total	**439**

[a] Availability of erosive soil data for the area within the vicinity of the Southern Section EIS Study Area is limited.
Source: SSURGO (2014).

3.6 Groundwater

Groundwater is a significant resource for freshwater across the EIS Study Area in Texas and Oklahoma because it is a major source of potable and irrigation water in the region. Eleven major and six minor groundwater aquifers occur within the EIS Study Area. Oklahoma aquifers within the EIS Study Area are listed in Table 3-5. Aquifers in Oklahoma contain an estimated 320 million acre-feet of fresh water, of which about half is considered recoverable for use. The aquifers supply more than 60 percent of the water used in the state, particularly where less surface water is available. Aquifers in Oklahoma include six in bedrock and six in Quaternary-age alluvium and terrace deposits. Bedrock aquifers typically consist of sandstone, sand, limestone, dolomite, gypsum, or fractured novaculite and chert. These aquifers range in thickness from 100 feet to several thousand feet. The depth to fresh water typically ranges from several feet to greater than 1,000 feet. Alluvium and terrace aquifers typically consist of unconsolidated sand, silt, clay, and gravel deposited by rivers and streams. The thickness of these aquifers ranges from 10 to 100 feet (Oklahoma Historical Society 2014). Major aquifers crossed by the EIS Study Area in Oklahoma include Garber-Wellington, Canadian River, Washita River, Antlers, Red River, Arbuckle-Simpson, North Canadian River, and Trinity aquifers. The entire area of the Arbuckle-Simpson Aquifer is considered a recharge area. These aquifers include alluvial terrace (unconfined) and bedrock types (confined). The Pennsylvanian (unconfined) is the only minor aquifer crossed in Oklahoma by the EIS Study Area.

Table 3-5: Aquifers Crossed within the EIS Study Area

Aquifer Name	Type
Oklahoma – Major Aquifers	
Garber-Wellington	Confined
Canadian River	Unconfined
Washita River	Unconfined
Antlers	Confined
Red River	Unconfined
Arbuckle-Simpson[a]	Confined
North Canadian River	Unconfined
Oklahoma – Minor Aquifers	
Pennsylvanian	Unconfined
Texas – Major Aquifers	
Carrizo	Confined, unconfined, not defined
Brazos River Alluvium	Unconfined
Edwards[a]	Confined
Gulf Coast	Unconfined
Trinity	Confined

Aquifer Name	Type
Texas – Minor Aquifers	
Woodbine	Confined, unconfined
Yegua Jackson	Unconfined
Sparta	Confined, unconfined
Queen City	Confined, unconfined

[a] Designated Sole Source Aquifer

Source: Texas Water Development Board (2014a).

The eastern portion of the Arbuckle-Simpson Aquifer is the only EPA-designated Sole Source Aquifer in Oklahoma within the EIS Study Area.The Arbuckle-Simpson Aquifer underlies approximately 500 square miles in southern Oklahoma and is the principle water source for 39,000 people within the region. The aquifer is a source for several rivers including the Blue River and Delaware Creek, which are tributaries of the Washita River, and nearly 100 springs including Byrds Mill Spring, which is the primary drinking water source for the city of Ada (Oklahoma Historical Society 2014). The entire aerial extent of the aquifer is considered a recharge area (Oklahoma Geologic Society 1983).

Within Oklahoma, the EIS Study Area crosses over seven major aquifers including the confined areas of the Garber-Wellington, unconfined areas of the Canadian River, unconfined areas of the Washita River, confined areas of the Antlers, unconfined areas of the Red River, unconfined areas of the otherwise confined Arbuckle-Simpson, and unconfined areas of the North Canadian River. One minor aquifer, the unconfined area of the Pennsylvanian, underlies the EIS Study Area in Oklahoma.

Aquifers in Texas provide about 60 percent of the 16.1 million acre-feet of water available within the state. Nine major and 21 minor aquifers are recognized and monitored for water quality in Texas (Texas Water Development Board 2014b). The aquifers include alluvial aquifers in sediments deposited by rivers and streams in the Cenozoic, coastal aquifers composed of layers of sand, gravel, and clay deposited in the Cenozoic, and bedrock aquifers in Cretaceous rocks such as sandstone and limestone found across the middle of the state. The alluvial and coastal aquifers are typically shallow and intensively used for irrigation. The bedrock aquifers can be as deep as 3,000 feet and may have complex connections to adjacent aquifers via caves and fractures (University of Texas 2004).

The Edwards Aquifer (designated Edwards 1 and Edwards 2) is the only designated Sole Source Aquifer in Texas. The aquifer underlies approximately 3,600 square miles within Kinney, Uvalde, Medina, Bexar, Comal, and Hayes counties. The aquifer has three primary zones: the contributing zone, the recharge zone, and the artesian zone. The contributing zone collects rainfall as source water for the aquifer and occurs north of the other zones on the Edwards Plateau. The aquifer is considered one of the most prolific artesian aquifers in the world and serves approximately 2 million people with water (San Antonio Water System 2014). The recharge area (unconfined) for the aquifer underlies approximately 1,250 square miles and follows the Balcones Fault escarpment from Bracketville through San Antonio and north to Austin (TCEQ 2014). Across much of the aquifer, the recharge and artesian zones (confined) are interspersed, except on the western end where the artesian areas extend approximately 10 to 20 miles south and on the eastern end where the artesian areas extend only a few miles to the south (San Antonio Water System 2014). Major springs produced by the Edwards Aquifer include San Pedro, San Antonio, Comal, San Marcos, and Hueco Springs (Edwards Aquifer Website 2014).

Within Texas, the EIS Study Area crosses over five unconfined and confined areas of the Carrizo, unconfined areas of the Brazos River alluvium, confined areas of the Trinity, confined areas of the Edwards, and unconfined areas of the Gulf Coast aquifers. Four minor aquifers underlie the EIS Study Area in Texas including unconfined areas of the Yegua Jackson and unconfined and confined areas of the Sparta, the Queen City, and the Woodbine aquifers.

Aquifers crossed within the EIS Study Area are listed in Table 3-5. Major and minor aquifers within the vicinity of the EIS Study Area are shown on Figure 3-7 through Figure 3-12.

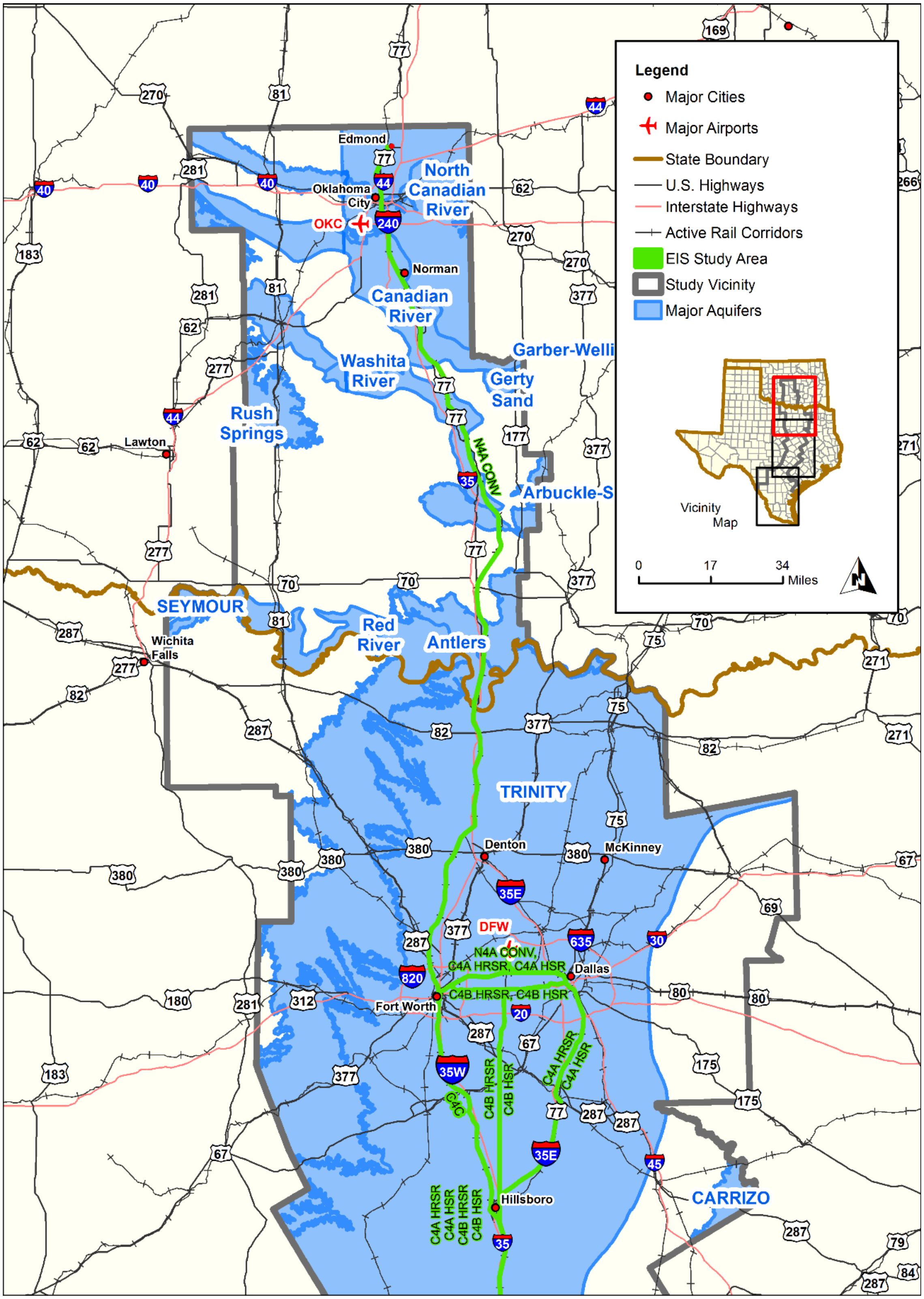


Figure 3-7: Major Aquifers within the Vicinity of the Northern Section EIS Study Area

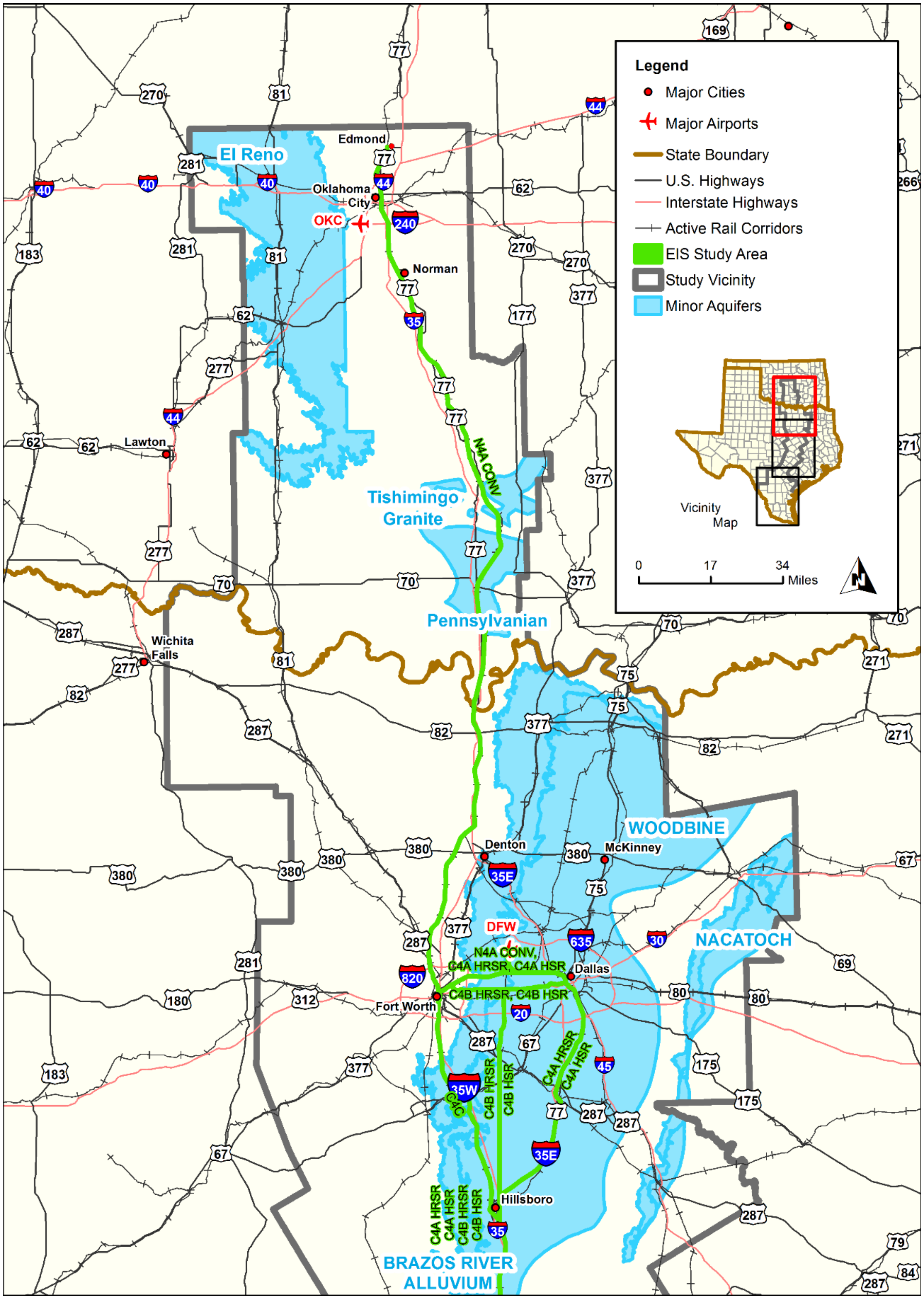


Figure 3-8: Minor Aquifers within the Vicinity of the Northern Section EIS Study Area

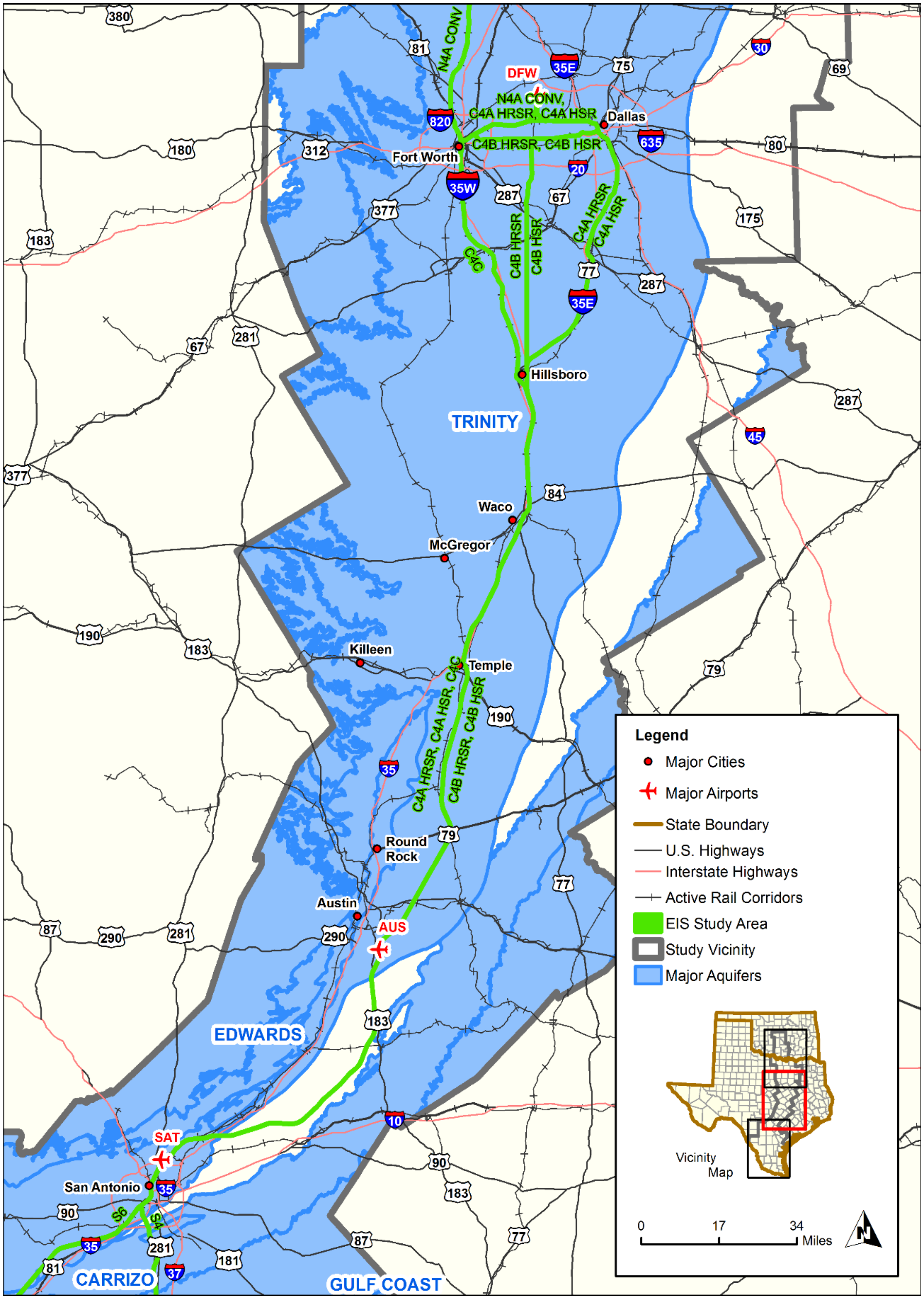


Figure 3-9: Major Aquifers within the Vicinity of the Central Section EIS Study Area

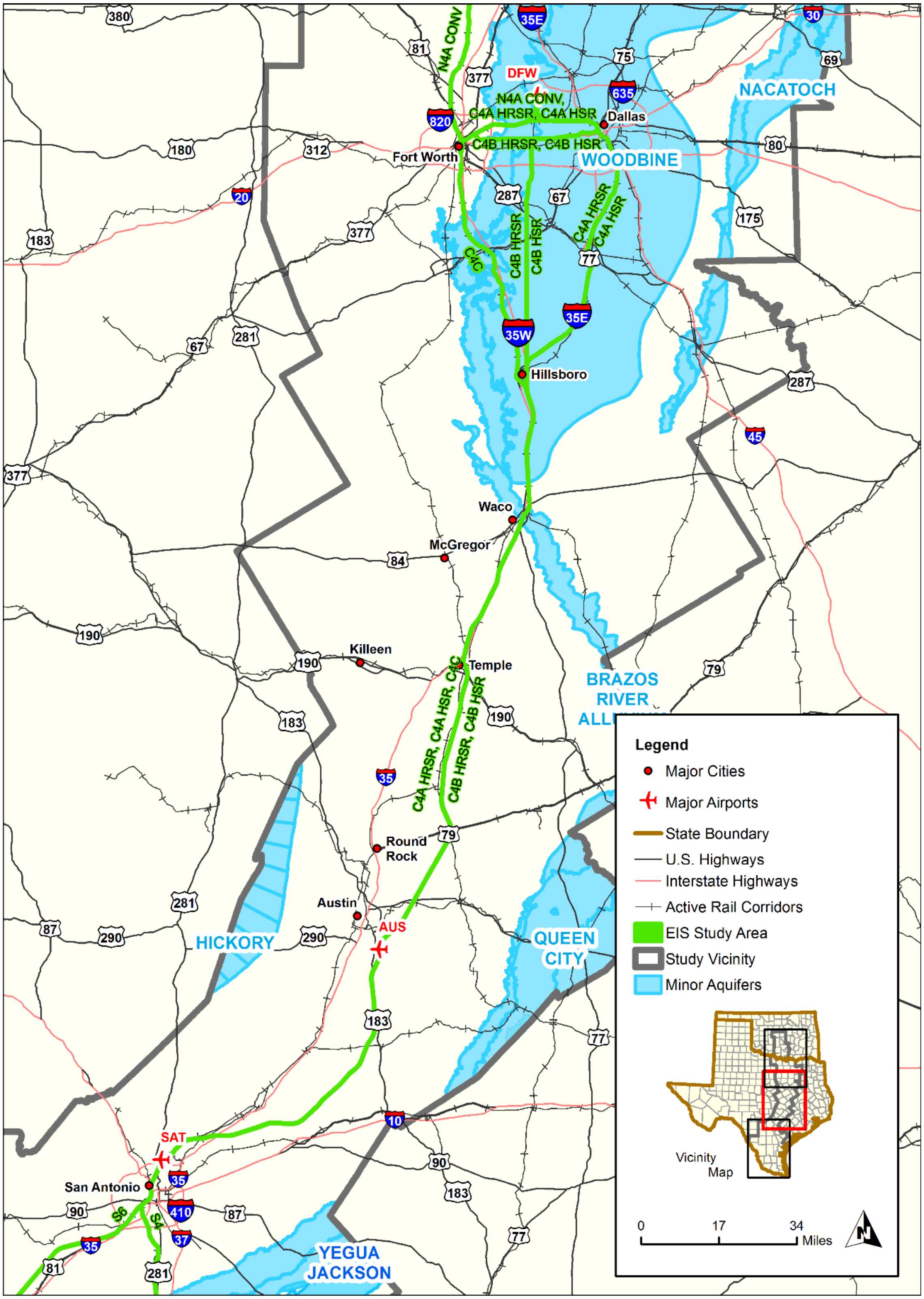


Figure 3-10: Minor Aquifers within the Vicinity of the Central Section EIS Study Area

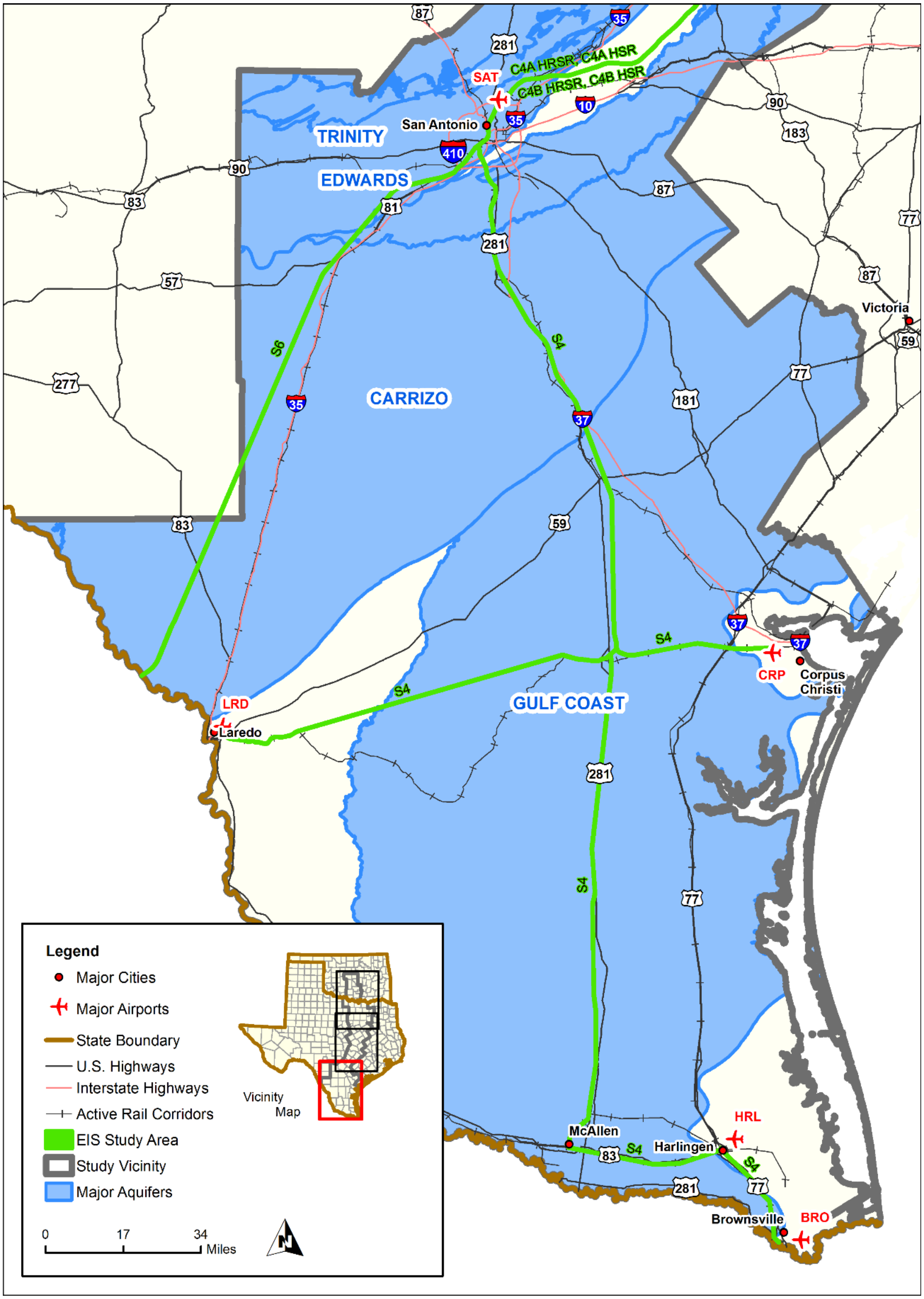


Figure 3-11: Major Aquifers within the Vicinity of the Southern Section EIS Study Area

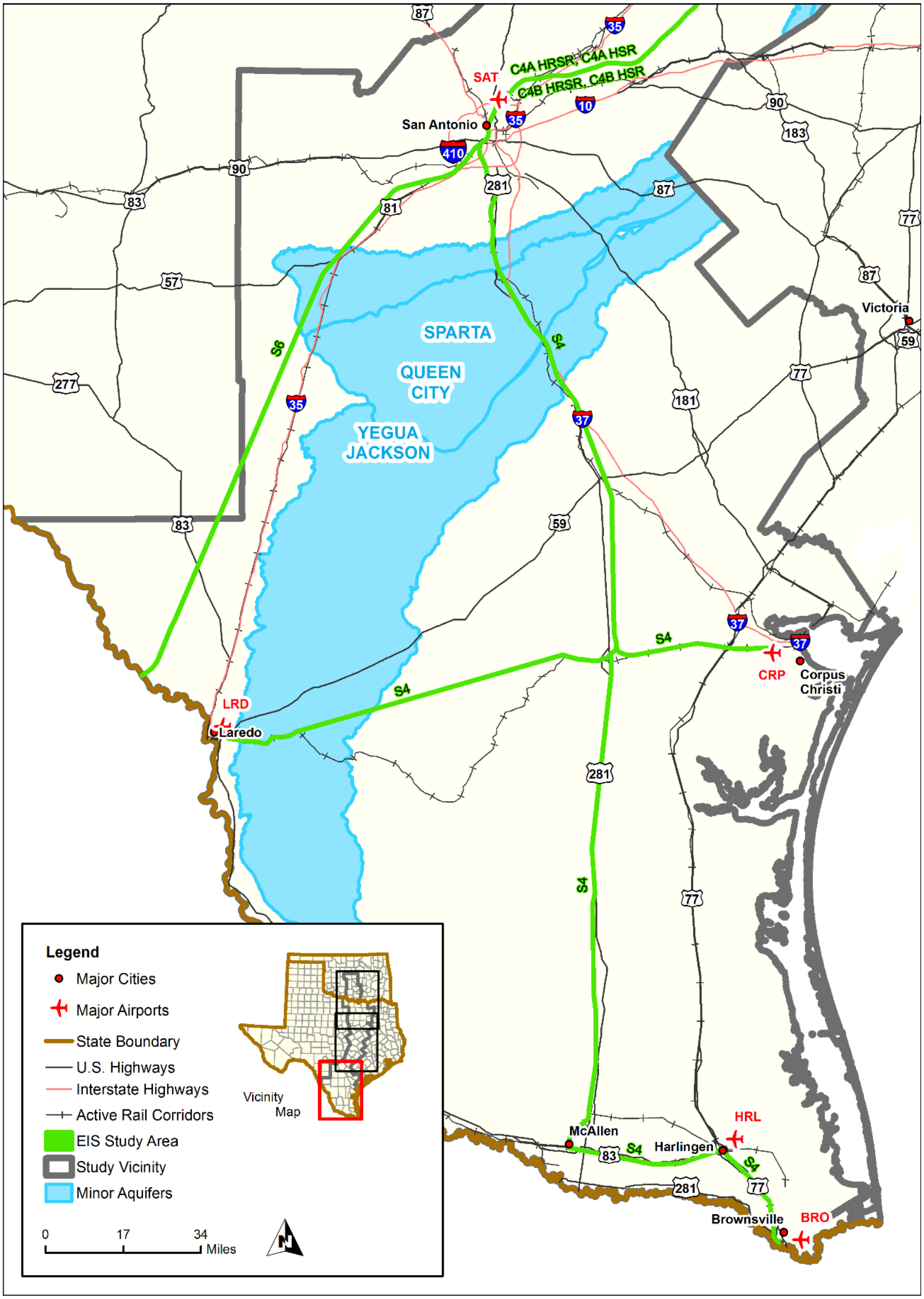


Figure 3-12: Minor Aquifers within the Vicinity of the Southern Section EIS Study Area

4.0 Evaluation Methods

The methodology employed for effect evaluation consists of a combination of qualitative and quantitative assessments. A qualitative assessment was used for general comparisons of the alternatives when discussing issues such as sedimentation and groundwater resources, which required a more detailed approach than warranted for this technical study.

The general conclusions for the qualitative effects support the relative change in effects among the alternatives. The effects assessment and conclusions are focused on surface water, runoff, erosion, and groundwater and are detailed in Section 3.2.4, Environmental Consequences. Effects related to runoff were strictly qualitative while those for groundwater included a combination of both qualitative and quantitative assessments. Effects related to surface water and erosion were quantitative. All quantitative assessments were based on the number of features (e.g., Section 303[d] waters and erosive soils) potentially crossed and the size of the features. The quantitative effects conclusions were determined based on a comparison of the magnitude of potential effects. The No Build Alternative is the primary basis of comparison.

The effects as a result of the route alternatives are characterized as negligible, moderate, or substantial compared to the No Build Alternative. A threshold or value for which an effect is determined to be negligible, moderate, or substantial is not feasible or appropriate for this service-level analysis. A threshold would not provide an accurate means of comparison as the alternatives have varying lengths both between and within the geographical sections (Northern, Central, and Southern). Additionally, alternatives within any given geographical section cannot be compared with those in other sections as the Program will require that alternatives be selected from each of the three sections. Effects determinations considered the service-type and route construction requirements (e.g., use of existing tracks), as well as minimization, avoidance, and mitigation strategies. These terms are defined as follows:

- Negligible intensity effects from construction and operation of an alternative are those that would have a slight change in water quality and surface water and groundwater hydrology, but are very close to the existing conditions.
- Moderate intensity effects from construction and operation of an alternative are those with a noticeable change in water quality and surface water and groundwater hydrology, but would not have an adverse residual effect on water resources, such as streams, rivers, lakes, and reservoirs.
- Substantial intensity effects from construction and operation of an alternative are those that would have a noticeable change in water quality and surface water and groundwater hydrology and would be highly likely to have an adverse residual effect on water resources, such as streams, rivers, lakes, and reservoirs.

Additional potential effects on hydrology and water quality could include increased or decreased runoff and stormwater discharge caused by changes in the area of paved surfaces, increased or decreased contribution of automotive-based nonpoint source contamination, and impacts on areas of groundwater discharge or infiltration.

For the quantitative assessment, readily available information, such as stream locations, effects on areas with existing water quality problems, and soil information, was used to assess the magnitude of potential effect. Water resources within the vicinity of the EIS Study Area are also discussed to provide context for the effect evaluations. To evaluate the quantitative effects on water quality caused by the alternatives, the following activities were conducted:

- The acreage of lakes and the linear feet of rivers and streams within the EIS Study Area were determined. For this analysis, surface waters are defined as lakes, rivers, and streams identified using USGS 1:24,000 scale digital line graphs. Surface water linear feet were calculated as the flow-path length of rivers and streams within the EIS Study Area. Lake surface areas represent the impoundment at maximum capacity.
- The locations of surface waters designated by the Wild and Scenic Rivers Act (Public Law 90-542; 16 U.S.C. §1271 et seq.), which includes specific designated river segments (Designated Rivers), Study Rivers, and NRI segments within the EIS Study Area, were determined.
- The locations of impaired waters, which are defined as waters on the CWA Section 303(d) list (USGS 2014), within the EIS Study Area were determined.
- The locations of potential erodible conditions were identified as those areas with a combination of erodible soils and high slopes, evaluated as the product of *kfact* (an erodibility factor that is adjusted for the effect of rock fragments) and *slopeh* (the maximum value for the range of slope of a soil component within a map unit). The SSURGO includes an Erosion Hazard of Forest Roads and Trails - Dominant Component category that is calculated using erodibility factor (kfact), slope (slopeh), and content of rock fragments for each individual soil map unit (Natural Resources Conservation Service 2014). For this analysis, susceptibility of soils to erosion is evaluated based the Erosion Hazard of Forest Roads and Trails - Dominant Component index.

5.0 Water Quality Effects

5.1 No Build Alternative

The No Build Alternative, as described in Section 1.2.1 of this document and in the introduction to Chapter 3 of the Draft EIS, is used as the baseline for comparison. The No Build Alternative would not implement the Program of rail improvements associated with this service-level evaluation and would not meet the purpose and need of the Program; therefore, the No Build Alternative would not affect water quality and hydrology. The No Build Alternative assumes that city and county stormwater systems are in place and that standards are met.

5.2 Potential Effects

5.2.1 Northern Section: Oklahoma City to Dallas and Fort Worth

5.2.1.1 Surface Waters

Table 5-1 identifies potential effects on surface waters (lakes, rivers, streams) within the EIS Study Area for Alternative N4A (conventional rail); this includes acreage of surface waters (lakes and ponds) or linear feet (rivers and streams) crossed within the EIS Study Area. Although a relatively high number of potential crossings of surface waters are possible with Alternative N4A, overall effects would be negligible as compared to the No Build Alternative because Alternative N4A would use existing railway infrastructure and corridors. Additionally, project design and BMPs would protect or improve water quality and reduce negative hydrology impacts on surface waters.

Table 5-1: Surface Waters, Listed 303(d) Impaired Waters, and NWSR Designated Waters Crossed within the Northern Section EIS Study Area

Water Body Classification	Number Crossed	Linear Feet	Acres
Alternative N4A CONV			
Streams and Rivers	343	317,365	-
Lakes and Reservoirs	194	-	103
303(d) Waters	14	15,368	-
Designated Waters	1	-	-
Source: USGS (2014).			

5.2.1.1.1 Floodplains

Table 5-2 identifies potential effects on SFHAs (100-year floodplain) within the EIS Study Area for Alternative N4A. This includes the acreage of 100-year floodplains within the EIS Study Area. As indicated in Table 5-2, 195 areas, representing 2,349 acres of SFHAs, could be affected by

Alternative N4A. Actual impacts on SFHAs would depend on construction techniques and crossing methods (e.g., bridges and culverts) used at each individual crossing.

Table 5-2: Special Flood Hazard Areas (100-year Floodplain) Crossed within the Northern Section EIS Study Area

Alternative	Number of SFHAs Crossed	Acres
Alternative N4A (Conventional Rail)	195	2,349
Source: FEMA (2011).		

5.2.1.1.2 Designated Waters

As described in Section 3.4.4, the Washita River is the only designated water in Oklahoma. A 20-mile stretch of the river in Carter and Murray counties is designated as an NRI river segment (NPS 2014). Alternative N4A would operate completely within the existing BNSF right-of-way from Edmond, Oklahoma, to Fort Worth and completely within the TRE right-of-way from Fort Worth to the Northern Section terminus at Dallas Union Station. Where feasible, existing railroad track would be used. Modifications within the existing BNSF and TRE rights-of-way, such as double-tracking, would accommodate additional trains in areas where shared track is not feasible. Alternative N4A would potentially include improvements to the existing crossings of the Washita River and may also include up to 20 new river crossings, depending on the improvements and their proximity to the river. The types and construction of the spans will be defined for project-level NEPA documentation. Effects from improvements on existing or new crossings of rivers may include long term effects such as clearing of the riparian buffer, grading, and fill. These effects could alter the Washita River, resulting in increased nutrient and sediment inputs and changes in channel flow characteristics and water temperature. However, the effects would likely be localized in the area of new crossings over the river and would be avoided or minimized through implementation of measures listed in Section 5.3, Subsequent Analysis and Avoidance, Minimization, and Mitigation Strategies. The potential discharge of construction materials to the river would be negligible because effects would be minimized during the design process and implementation of BMPs during construction. Although a relatively high number of potential crossings of an NRI river (Washita River) is possible with Alternative N4A, overall effects would be negligible because the alternative would use existing railway infrastructure and corridors. Additionally, project design and BMPs would reduce water quality and hydrology impacts related to designated waters.

No surface waters designated as NWSR, Study Rivers, or NRI occur within the Texas portion of the EIS Study Area for Alternative N4A.

5.2.1.1.3 Section 303(d) Impaired Waters

Table 5-1 identifies potential effects on linear feet of surface waters for listed Section 303(d) waters in the Northern Section EIS Study Area. Alternative N4A could involve the construction of improvements, including new river crossings or sidings, in the vicinity of 303(d) impaired water bodies. Overall effects on 303(d) waters from Alternative N4A would be negligible because of the relatively low magnitude (number and length) of 303(d) impaired water bodies crossed within the EIS Study Area and the use of existing railway infrastructure and corridors. Potential effects would be avoided or minimized through implementation of measures listed in Section 5.3, Subsequent Analysis and Avoidance, Minimization, and Mitigation Measures.

5.2.1.2 Runoff

Under Alternative N4A (conventional rail), additional impervious surface associated with the stations would be constructed. However, most rail construction would use permeable material; therefore, Alternative N4A would not be expected to contribute significantly to runoff. In many cases, the improvements would occur in existing urbanized areas, resulting in the addition of less impervious surface than the suburban and rural areas. However, where railway segments or facilities are constructed in undeveloped areas, increased runoff could result. The quantity of increased runoff has not been determined but, if substantial, would result in increased surface flows downstream and potentially greater flooding risk. This potential increase may be offset by reduced automobile use and a correlating reduction in impervious surfaces associated with parking lots and roadways throughout the region, potentially resulting in a net beneficial effect on runoff. To further reduce the potential for an adverse effect on runoff from Alternative N4A, facility designs would include measures to reduce impervious surfaces or provide on-site retention and treatment. Increases in runoff from the construction of new impervious surfaces would be reduced through the implementation of structural stormwater management practices and construction BMPs (Section 5.3, Subsequent Analysis and Avoidance, Minimization, and Mitigation Measures). The project-level NEPA process will evaluate the effects on runoff from impervious surfaces associated with the project design, assess potential effects on existing stormwater structures, and propose specific measures to address those potential effects.

5.2.1.3 Erosion

Table 5-3 lists the acreage of potentially erodible areas within the EIS Study Area for Alternative N4A (conventional rail). This table shows areas of potential effects on surface water quality. Because the erodible index is slope-sensitive, only areas that exceed slope thresholds (slope steepness at which a given soil will begin to erode) within the indicated acreage meet criteria for erodible areas. Overall potential increases in erosion from Alternative N4A would be moderate due to the low acreage of erosive soils crossed. The construction of new stations would potentially increase erosion and sedimentation of surface waters during construction. However, these effects would likely be mitigated by implementing BMPs during construction (Section 5.3, Subsequent

Analysis and Avoidance, Minimization, and Mitigation Measures). Operation of new stations would not likely increase localized erosion of sediments into surface waters.

Table 5-3: Areas with High Erosion Potential that are Crossed by the Northern Section EIS Study Area

Erosion Classification	Number Crossed	Acres
Alternative N4A CONV		
Severe	77	800
Very Severe	20	505
Approximate Total	**97**	**1,305**
Source: SSURGO (2014).		

5.2.1.4 Groundwater

The EIS Study Area for Alternative N4A crosses eight major and three minor aquifers systems in Oklahoma and Texas (see Table 5-4). The largest major aquifer crossed is the Trinity Aquifer, which is primarily confined. The Arbuckle-Simpson Aquifer is a Sole Source Aquifer that also underlies the EIS Study Area. Effects from construction and operational activities would most likely affect unconfined and Sole Source Aquifer systems because they have a direct connection to the ground surface and are the primary source of water for adjacent populations. Long-term effects may include groundwater contamination caused by runoff from created impervious surfaces and spills of construction materials such as hydraulic fluid, fuel, paint, and solvents. These impacts on groundwater resources would be negligible compared to the No Build Alternative because the alternative would use existing railway infrastructure and corridors and because the stormwater treatment measures and BMPs that would be implemented during construction and operation would reduce the potential for contaminants associated with impervious surfaces and spills to affect groundwater (Section 5.3, Subsequent Analysis and Avoidance, Minimization, and Mitigation Measures).

Table 5-4: Aquifers Crossed within the Northern Section EIS Study Area

Aquifer Name	Type	Alternative N4A CONV (acres)
Alternative N4A CONV		
Oklahoma – Major Aquifers		
Garber-Wellington	Confined	2,540
Canadian River	Unconfined	2,080

Aquifer Name	Type	Alternative N4A CONV (acres)
Washita River	Unconfined	1,940
Antlers	Confined	1,305
Red River	Unconfined	700
Arbuckle-Simpson[a]	Confined	165
North Canadian River	Unconfined	145
Texas – Major Aquifers		
Trinity	Confined	6,435
Approximate Total		**15,310**
Oklahoma – Minor Aquifers		
Pennsylvanian	Unconfined	1,760
Texas – Minor Aquifers		
Woodbine	Confined	955
Woodbine	Unconfined	385
Approximate Total		**3,100**

[a] Designated Sole Source Aquifer

Source: Texas Water Development Board (2014a).

5.2.2 Central Section: Dallas and Fort Worth to San Antonio

5.2.2.1 Surface Waters

Table 5-5 identifies potential effects on surface waters (lakes, rivers, and streams) within the EIS Study Area for Alternative C4A (higher- and high-speed rail), Alternative C4B (higher- and high-speed rail), and Alternative C4C (higher- and high-speed rail). This includes the acreage (lakes and ponds) and linear feet (rivers and streams) of surface waters crossed within the EIS Study Area. Potential effects would be avoided or minimized through implementation of measures listed in Section 5.3, Subsequent Analysis and Avoidance, Minimization, and Mitigation Strategies. Potential effects on surface waters from each of the three alternatives (both service types) would be moderate compared with the No Build Alternative because of the total linear feet and acreage of surface waters crossed by the alternative.

Table 5-5: Surface Waters, Listed 303(d) Impaired Waters, and NWSR Designated Waters Crossed within the Central Section EIS Study Area

Water Body Classification	Number Crossed	Linear Feet	Acres
Alternative C4A (Higher- and High-Speed Rail)			
Streams and Rivers	437	316,909	-
Lakes and Reservoirs	263	-	153
303(d) Waters	17	24,187	-
Designated Waters	0	-	-
Alternative C4B (Higher- and High-Speed Rail)			
Streams and Rivers	416	293,669	-
Lakes and Reservoirs	234	-	99
303(d) Waters	21	18,870	-
Designated Waters	0	-	-
Alternative C4C (Higher- and High-Speed Rail)			
Streams and Rivers	541	400,363	-
Lakes and Reservoirs	309	-	164
303(d) Waters	18	23,084	-
Designated Waters	0	-	-

5.2.2.1.1 Floodplains

Table 5-6 identifies potential impacts on SFHAs (100-year floodplain) crossed within the EIS Study Area for Alternative C4A (both service types), Alternative C4B (both service types), and Alternative C4C (both service types).

Table 5-6: Special Flood Hazard Areas (100-year Floodplain) Crossed within the Central Section EIS Study Area

Alternative	Number of SFHAs Crossed	Acres
Alternative C4A (Higher- and High-Speed Rail)	219	2,038
Alternative C4B (Higher- and High-Speed Rail)	217	1,980
Alternative C4C (Higher- and High-Speed Rail)	551	3,812
Source: FEMA (2011).		

The actual effects on SFHAs would depend on construction techniques and crossing methods (e.g., bridges and culverts) used at each individual crossing.

5.2.2.1.2 Designated Waters

There are no designated waters in the EIS Study Area for the Central Section (Table 5-5). Therefore, no effects on designated waters are anticipated from the Central Section alternatives.

5.2.2.1.3 Section 303(d) Impaired Waters

Table 5-5 identifies potential effects on the linear feet of Section 303(d) waters in the Central Section EIS Study Area. Potential impacts on 303(d) waters from each of the Central Section alternatives (both service types) would be negligible compared to the No Build Alternative because of the low amount of linear feet of surface waters crossed within the EIS Study Area. Potential effects would be avoided or minimized through implementation of measures listed in Section 5.3, Subsequent Analysis and Avoidance, Minimization, and Mitigation Measures.

5.2.2.2 Runoff

Under Alternative C4A (higher- and high-speed rail), Alternative C4B (higher- and high-speed rail), and Alternative C4C (higher- and high- speed rail), additional impervious surface associated with the stations would be constructed. Most rail construction would use permeable material, so the alignments would not be expected to contribute significantly to runoff. In many cases, the improvements would occur in existing urbanized areas, resulting in the addition of less impervious surface than the suburban and rural areas. However, where segments or facilities are constructed in undeveloped areas, increased runoff will result. The amount of increased runoff has not been determined but, if substantial, would result in increased surface flows downstream and potentially greater flooding risk. This potential increase may be offset by reduced automobile use and a correlating reduction in impervious surfaces associated with parking lots and roadways throughout the region, resulting in a net beneficial effect on runoff. To further reduce the potential for adverse effects on runoff from the Central Section alternatives (both service types), facility designs would include measures to reduce impervious surfaces or provide on-site retention and treatment. Increases in runoff from the construction of new impervious surfaces would be reduced through the implementation of structural stormwater management practices and construction BMPs (Section 5.3, Subsequent Analysis and Avoidance, Minimization, and Mitigation Measures). The project-level NEPA process will evaluate effects on runoff from impervious surfaces associated with the project design, assess potential effects on existing stormwater structures, and propose specific measures to address those potential effects. Therefore, overall potential increases in runoff from Alternative C4A Higher-Speed Rail would be negligible through implementation of avoidance and minimization measures.

5.2.2.3 Erosion

Table 5-7 lists the acreage of potentially erosive areas within the EIS Study Area for Alternative C4A (higher- and high-speed rail), Alternative C4B (higher- and high-speed rail), and Alternative C4C (higher- and high-speed rail); this represents areas of potential effects on surface waters. Because the erodible index is slope-sensitive, only areas that exceed slope thresholds within the indicated acreage meet criteria for erodible areas. Potential effects on water quality from erodible soils crossed (number and acres) within Alternative C4A Higher-Speed Rail are similar to Alternative C4B (both service types) and less than Alternative C4C (both service types). Overall potential effects from crossing erodible soils are similar in magnitude among the Central Section alternatives (both service types). The potential effects from increases in erosion from the Central Section alternatives would be moderate. Construction of the alternative and stations would potentially increase erosion and sedimentation in surface waters during construction. However, some of these effects would likely be reduced by implementing BMPs during construction (Section 5.3, Subsequent Analysis and Avoidance, Minimization, and Mitigation Measures). Operation of the alternative and stations would not likely increase localized erosion of sediments into surface waters.

Table 5-7: Areas with High Erosion Potential that are Crossed by the Central Section EIS Study Area Central

Erosion Classification	Number Crossed	Acres
Alternative C4A (Higher- and High-Speed Rail)		
Severe	68	573
Very Severe	33	851
Approximate Total	**101**	**1,424**
Alternative C4B (Higher- and High-Speed Rail)		
Severe	85	828
Very Severe	31	567
Approximate Total	**116**	**1,395**
Alternative C4C (Higher- and High-Speed Rail)		
Severe	82	654
Very Severe	41	1,052
Approximate Total	**123**	**1,706**

5.2.2.4 Groundwater

The Central Section EIS Study Area crosses over Trinity and Edwards aquifers, which are confined major aquifers (see Table 5-8). Minor aquifers that underlie the Central Section EIS Study Area include the Woodbine (confined and unconfined) and Brazos River aquifers. The EIS Study Area for Alternative C4C crosses the greatest areal extent of aquifers, followed by the Alternative C4A and Alternative C4B study areas. All three alternatives overlay the same areal extent of the Edwards Aquifer (designated Edwards 1 and Edwards 2), which is designated as a Sole Source Aquifer; however, none of the alternatives cross the recharge zone where groundwater would be more susceptible to surface disturbances and potential impacts from construction activities. The EIS Study Area for Alternative C4A crosses the greatest areal extent of unconfined minor aquifers, followed by the Alternative C4B and Alternative C4C study areas. Effects from construction and operations activities would potentially most affect unconfined aquifers because they have a direct connection to the ground surface. Effects on Sole Source Aquifers would be negligible compared to the No Build Alternative because the Central Section alternatives do not cross recharge areas. Long-term effects may include groundwater contamination caused by runoff from created impervious surfaces and spills of construction materials such as hydraulic fluid, fuel, paint, and solvents. The effects on groundwater resources from each of the Central Section alternatives would be negligible because stormwater treatment measures and BMPs would be implemented during construction and operation (Section 5.3, Subsequent Analysis and Avoidance, Minimization, and Mitigation Measures). Short-term effects on groundwater resources caused by construction and operation activities would be negligible compared to the No Build Alternative.

Table 5-8: Aquifers Crossed within the Central Section EIS Study Area

Aquifer Name	Type	Alternative C4A Area (acres)	Alternative C4B Area (acres)	Alternative C4C Area (acres)
Texas – Major Aquifers				
Trinity	Confined	16,770	15,315	20,355
Edwards[a]	Confined	1,540	1,540	1,540
Approximate Total		**18,310**	**16,860**	**21,895**
Texas – Minor Aquifers				
Woodbine	Unconfined	6,830	5,540	1,505
Woodbine	Confined	465	590	8,390
Brazos River Alluvium	Unconfined	170	170	170
Approximate Total		**7,465**	**6,300**	**10,065**

[a] Designated Sole Source Aquifer

Source: Texas Water Development Board (2014a).

5.2.3 Southern Section: San Antonio to South Texas

5.2.3.1 *Surface Waters*

Table 5-9 identifies potential effects on surface waters (lakes, rivers, and streams) within the EIS Study Area for Alternative S4 (higher-speed rail) and Alternative S6 (higher- and high-speed rail). This includes the acreage of surface waters (lakes and ponds) and linear feet (rivers and streams) crossed within the EIS Study Area. Potential impacts on surface waters from Alternative S4 and Alternative S6 (both service types) would be moderate compared to the No Build Alternative because the total linear feet and acreage of surface waters crossed by the alternative.

Table 5-9: Surface Waters, Listed 303(d) Impaired Waters, and NWSR Designated Waters Crossed within the Southern Section EIS Study Area

Water Body Classification	Number Crossed	Linear Feet	Acres
Alternative S4 (Higher-Speed Rail)			
Streams and Rivers	314	247,448	-
Lakes and Reservoirs	129	-	74
303(d) Waters	7	13,928	-
Designated Waters	0	-	-
Alternative S6 (Higher- and High-Speed Rail)			
Streams and Rivers	198	120,488	-
Lakes and Reservoirs	57	-	29
303(d) Waters	5	2,921	-
Designated Waters	0	-	-

5.2.3.1.1 Floodplains

Table 5-10 identifies potential impacts on SFHAs (100-year floodplain) within the EIS Study Area for Alternative S4 and Alternative S6 (both service types).

Table 5-10: Special Flood Hazard Areas (100-year Floodplain) crossed within the Southern Section EIS Study Area

Alternative	Number of SFHAs Crossed	Acres
Alternative S4 (Higher-Speed Rail)	118	3,046
Alternative S6 (Higher- and High-Speed Rail)	14	431
Source: FEMA (2011).		

The actual impacts on SFHAs would depend on construction techniques and crossing methods (e.g., bridges and culverts) used at each individual crossing.

5.2.3.1.2 Designated Waters

There are no designated waters in the EIS Study Area for the Southern Section (Table 5-9). Therefore, no effects on designated waters are anticipated from any of the Southern Section alternatives.

5.2.3.1.3 Section 303(d) Impaired Waters

Table 5-9 identifies potential effects on the linear feet of Section 303(d) waters for the Southern Section EIS Study Area. Potential effects on 303(d) waters from each of the Southern Section alternatives (both service types) would be negligible compared to the No Build Alternative because of the low amount of linear feet of surface waters crossed within the EIS Study Area.

5.2.3.2 Runoff

Under Alternative S4 (higher-speed rail) and Alternative S6 (higher- and high-speed rail), additional impervious surface associated with the stations would be constructed. Most rail construction would use permeable material, so the alignments would not be expected to contribute significantly to runoff. In many cases, the improvements would occur in existing urbanized areas, resulting in no increase in impervious surfaces. However, where segments or facilities are constructed in undeveloped areas, increased runoff would result. The quantity of increased runoff has not been determined but, if substantial, could result in increased surface flows downstream and potentially greater flooding risk. This potential increase may be offset by reduced automobile use and related improvements. It is anticipated that reductions in automobile use would have a correlating reduction in impervious surfaces associated with parking lots and roadways throughout the region, potentially resulting in a net beneficial effect on runoff. To further reduce the potential for adverse effects on runoff from the EIS Study Area for Alternative S4 and Alternative S6 (both service types), facility designs would include measures to reduce impervious surfaces or provide on-site retention. Potential effects from increases in runoff from the Southern Section alternatives would be negligible because increases in runoff from the construction of new impervious surfaces would be minimized through the implementation of structural stormwater management practices and construction BMPs (Section 5.3, Subsequent Analysis and Avoidance, Minimization, and Mitigation Measures). The project-level NEPA process will evaluate the impacts on runoff from impervious surfaces associated with the project design, assess potential impacts on existing stormwater structures, and propose specific measures to address those potential impacts.

5.2.3.3 Erosion

Table 5-11 lists the acreage of potentially erodible areas crossed within the EIS Study Area for Alternative S4 (higher-speed rail) and Alternative S6 (higher- and high-speed rail), which represents areas of potential effects on surface waters. Because the erodible index is slope-sensitive, only areas that exceed slope thresholds within the indicated acreage meet criteria for erodible areas. Soil erosion data for the area within the vicinity of the Southern Section EIS Study Area are limited, and available data were used for tabular summaries and graphical depictions. Potential effects on water quality from erodible soils crossed (number and acres) within Alternative S4 would be similar to Alternative S6 (both service types). The potential effects from increases in erosion from the Southern Section alternatives would be negligible. Construction of the alternatives and stations would potentially increase erosion and sedimentation in surface waters during construction. However, some of these effects would likely be reduced by implementing BMPs during construction (Section 5.3, Subsequent Analysis and Avoidance, Minimization, and Mitigation Measures). Operation of the alternative and stations would not likely increase localized erosion of sediments into surface waters.

Table 5-11: Areas with High Erosion Potential that are Crossed by the Southern Section EIS Study Area

Erosion Classification	Number Crossed[a]	Acres[a]
Alternative S4 (Higher-Speed Rail)		
Severe	3	62
Very Severe	19	616
Approximate Total	**22**	**678**
Alternative S64 (Higher- and High-Speed Rail)		
Severe	0	678
Very Severe	4	13
Approximate Total	**4**	**691**
[a] Availability of soil erosion data for the area within the vicinity of the Southern Section EIS Study Area is limited.		

5.2.3.4 Groundwater

The EIS Study Area for Alternative S4 crosses the greatest areal extent of aquifers, followed by the Alternative S6 Study Area (see Table 5-12). Both study areas cross the Edwards Aquifer; however, neither of them crosses the recharge zone where groundwater would be more susceptible to surface disturbances and potential effects from construction activities. The EIS Study area for Alternative S4 crosses the greatest areal extent of unconfined minor aquifers followed by the Alternative S6 Study Area. Effects from construction and operational activities would most likely affect unconfined aquifers because they have a direct connection to the ground surface. Effects on Sole Source Aquifers would be negligible compared to the No Build Alternative because the alternatives do not cross recharge areas. Long-term effects may include groundwater contamination caused by runoff from created impervious surfaces and spills of construction materials such as hydraulic fluid, fuel, paint, and solvents. The effects on groundwater resources would be negligible compared to the No Build Alternative because stormwater treatment measures and BMPs would be implemented during construction and operation (Section 5.3, Subsequent Analysis and Avoidance, Minimization, and Mitigation Measures). Short-term effects on groundwater resources caused by construction and operation activities would be negligible compared to the No Build Alternative.

Table 5-12: Aquifers Crossed within the Southern Section EIS Study Area

Aquifer Name	Type	Alternative S4 Area (acres)	Alternative S6 Area (acres)
Texas – Major Aquifers			
Gulf Coast	Unconfined	17,570	-
Carrizo	Unconfined	130	1,645
Carrizo	Not defined	780	-
Carrizo	Confined	2,950	5,595
Trinity	Confined	205	2,005
Edwards[a]	Confined	210	2,000
Approximate Total		**21,845**	**11,245**
Texas – Minor Aquifers			
Yegua Jackson	Unconfined	3,245	-
Sparta	Unconfined	110	-
Sparta	Confined	925	-
Queen City	Confined	1,105	-
Queen City	Unconfined	380	1,205
Approximate Total		**5,765**	**1,205**

[a] Designated Sole Source Aquifer
Source: Texas Water Development Board (2014a).

5.2.4 Summary of Potential Effects

Table 5-13 includes a summary of effects and a qualitative assessment (negligible, moderate, or substantial) for the alternatives and sections. As previously stated, it is important to note that the acreages listed in Table 5-13 are not the actual areas of effects associated with construction and operation of any of the alternatives. The construction of a passenger rail alignment can reasonably occur within a 100-foot-wide boundary, which would leave an extra 400-foot-wide corridor for the alternatives. The purpose of this service-level analysis is to use the EIS Study Area, or “corridor,” to determine the types of resources that may be affected, and more importantly, the relative magnitude of impacts on resources that may be affected. It is also important to note that some routes (Northern, Central, or Southern sections) could be built alone, combined with other section routes; more than one alternative in the Central or Southern sections could be built in the future because the alternatives provide different service types for the independent destinations. Details about how alternatives might connect would be analyzed at the project-level EIS phase.

Table 5-13: Summary of Potential Effects and Qualitative Assessment

Potential Effects	No Build	Northern Section	Central Section			Southern Section	
		N4A (CONV)	C4A (HrSR and HSR)	C4B (HrSR and HSR)	C4C (HrSR and HSR)	S4 (HrSR)	S6 (HrSR and HSR)
Surface Waters							
Total Number of Surface Waters Crossed	0	537	700	650	850	443	255
Streams and Rivers (linear feet)	0	317,365	316,909	293,669	400,363	247,448	120,488
Lakes and Reservoirs (acres)	0	103	153	99	164	74	29
Qualitative Analysis	None	Negligible	Moderate	Moderate	Moderate	Moderate	Moderate
303(d) Waters (linear feet)	0	15,368	24,187	18,870	23,084	13,928	2,921
Qualitative Analysis	None	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Designated Waters	0	1	0	0	0	0	0
Qualitative Analysis	None	Negligible	None	None	None	None	None
Runoff							
Qualitative Analysis	None	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Erosion[a]							
Highly Erodible Soils Crossed (number)	0	97	101	116	123	22	4
Highly Erodible Soils Crossed (acres)	0	1,305	1,424	1,395	1,706	678	691
Qualitative Analysis	None	Moderate	Moderate	Moderate	Moderate	Negligible	Negligible

Potential Effects	No Build	Northern Section	Central Section			Southern Section	
		N4A (CONV)	C4A (HrSR and HSR)	C4B (HrSR and HSR)	C4C (HrSR and HSR)	S4 (HrSR)	S6 (HrSR and HSR)
Groundwater							
Aquifers Crossed (acres)	0	18,410	25,775	23,160	31,965	27,610	12,450
Qualitative Analysis	None	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
[a] Availability of soil erosion data for the area within the vicinity of the Southern Section EIS Study Area is limited.							

5.3 *Subsequent Analysis and Avoidance, Minimization, and Mitigation Measures*

Once a Preferred Alternative is selected, field investigations or surveys would be conducted to determine during subsequent analysis the likelihood of effects on water quality and floodplains within the EIS Study Area. A project-level NEPA study should identify each stream and floodplain crossing, evaluate water quality and floodplain effects, and analyze the expected effects on any existing impaired stream segments. The project-level analysis will focus on stream crossings located or associated with areas of high runoff and soils that have a high potential for erosion because these areas could be a significant source of potential water quality impacts during construction activities. These areas would represent the most risk to maintaining state and federal water quality standards and compliance with NPDES construction stormwater permits. Avoidance and minimization of effects will be incorporated when feasible. If effects cannot be avoided or minimized, mitigation strategies will be implemented. Sediment and erosion control BMPs during construction would need to be assessed as part of the project-level analysis. Potential impacts may also result where new rail facilities intercept and are constructed within surface water areas. Impacts may include the following:

- Loss of flood conveyance potential and alteration of flood elevations
- Short- and long-term alteration in coastal hydrology and hydraulics in tidal lagoons where facilities are constructed within coastal surface waters; may include short-term construction dewatering and long-term effects resulting from permanent placement of structures
- Short- or long-term loss of native riparian habitats caused by construction and/or permanent installation of facilities within surface waters, resulting in loss of water quality remediation and water storage potential of native habitats

Potential impacts on water quality may also result from the alternatives, including and based on the following:

- Short-term increases in sediment and reductions in water quality may result during construction activities, where material is transported to surface water channels or coastal lagoons. At a program-level analysis, the extent of potential effects is currently not known, but all identified effects would require site specific measures to address the potential effects, including the potential need for temporary and permanent mitigation measures.
- Assuming an alternative results in a general reduction in motor vehicle use compared to what would occur under the No Build Alternative, there would be a potential beneficial effect on water quality in downstream watercourses. This benefit would be due to less impervious parking and roadways and a general reduction in the amount of automobile-generated nonpoint source contamination, including petroleum products and brake linings. This would be a net effect potentially realized over the entire region because construction of station facilities associated with the alternatives, including supporting parking lots, would result in some local increase in impervious surfaces.

For this service-level EIS, the extent of effects has not been discretely defined. The intensity of a potential effect has been classified as negligible, moderate, or substantial, along with the potential for beneficial effects under select circumstances. The ability to analyze, determine, and mitigate for future project-level impacts should include the incorporation of construction and operational BMPs that would provide structural remedies to potential water quality effects. Construction BMPs would include the following:

- Erosion:
  - Phasing and construction sequencing
  - Temporary seeding of cleared areas
  - Mulching
  - Erosion control blankets
  - Reinforced matting
- Sedimentation:
  - Hay bales, silt fences, dikes, and baffles
  - Stabilized construction access
  - Controlled temporary stock pile areas
- Runoff:
  - Runoff diversion measures
  - Level spreaders
  - Subsurface drains

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