Schedule AB-2

Public

GRAIN BELT EXPRESS LLC TIGER CONNECTOR 345 KV TRANSMISSION LINE

DRAFT ROUTE SELECTION STUDY

August 2022

Prepared By

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ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
ACEP	Agricultural Conservation Easement Program
CCN	Certificate of Convenience and Necessity
CRP	Conservation Reserve Program
DC	Direct Current
ESRI	Environmental Systems Research Institute
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
HVDC	High-voltage Direct Current
IBA	Important Bird Area
IPaC	Information of Planning and Consultation
kV	Kilovolt
MDC	Missouri Department of Conservation
MDNR	Missouri Department of Natural Resources
MONHP	Missouri Natural Heritage Program
MPSC	Missouri Public Service Commission
NAIP	National Agriculture Imagery Program
NASS	National Agricultural Statistics Service
NEPA	National Environmental Policy Act
NRHP	National Register of Historic Places
NRCS	Natural Resources Conservation Service
Project	Invenergy Tiger Connector Project
ROW	Right-of-Way
SHPO	State Historic Preservation Office (Officer)
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
WRE	Wetland Reserve Easement
WREP	The Wetland Reserve Enhancement Partnership

KEY TERMINOLOGY

Alternative Routes	Routes assembled from links that were refined after the public meetings. One Alternative Route is ultimately selected as the Proposed Route.
Conceptual Routes	Initial routes developed to consider a range of reasonable alignments in the Study Area. They are the first step in identifying routes based on large-scale opportunities and constraints and are aligned more generally than Potential Routes or Alternative Routes.
Constraint	Areas that should be avoided to the extent feasible and reasonable during the Route Selection Study process. The constraints were divided into two groups based on the size of the geographic area encompassed by the constraint. The first group includes constraints covering large areas of land in the Study Area. The second group of constraints encompasses other features covering smaller geographic areas or point-specific locations.
Converter station	A major component of a HVDC transmission system where conversions from alternating current (AC) to direct current (DC) and from DC to AC are performed.
Corridor Screening Study	The study resulted in the identification of a Study Area that included all reasonable potential corridors that could provide the new 345 kV transmission source between a point along the approved Grain Belt HVDC Route and the existing McCredie Substation
General routing guidelines	A set of principles that guides the development of alignments with respect to area land uses, sensitive features, and considerations of economic reasonableness.
Link	The section of a Potential Route located between two nodes.
Node	A common point of intersection between two or more Potential Routes.
Opportunities	Areas where the transmission line would have less disruption to land uses and the natural and cultural environment. Opportunities typically include other linear infrastructure and utility corridors, such as the existing electric and gas transmission network, rail lines, and roads but may also include reclaimed lands or unused portions of industrial or commercial areas.

Potential Routes	Conceptual Routes are refined into Potential Routes as additional information from agency coordination, public outreach, and ongoing route revisions are considered. Potential Routes ultimately become Alternative Routes after further refinement following Public Meetings.
Proposed Route	Route identified by the Route Selection Study that is ultimately filed with the Missouri Public Service Commission for construction. The Proposed Route (1) reasonably minimizes adverse impacts on area land uses and the natural and cultural environment; (2) minimizes special design requirements and unreasonable costs; and (3) can be constructed and operated in a timely, safe, and reliable manner.
Public Meeting	An open-house format public meeting held in the Study Area in compliance with regulatory requirements.
Refined Potential Route Network	As the Potential Route Network is refined, links are modified, removed, or added to create the Refined Potential Route Network.
Routing Team	A multidisciplinary team of experts in transmission line routing, impact assessment for a wide variety of natural resources and the human environment, impact mitigation, engineering, and construction management.
Study Area	The territory in which line Route Alternatives can be sited to feasibly meet the Project's functional requirements and simultaneously minimize environmental impacts and Project costs in Missouri. The Study Area includes the converter station location in Monroe County, Missouri, the existing McCredie Substation, and a future interconnection substation in Callaway County, Missouri.
Technical guidelines	Technical limitations for the Routing Team to follow related to the physical limitations, design, right-of-way requirements, or reliability concerns of the Project infrastructure
Virtual Public Meeting	Due to Center of Disease Control (CDC) Coronavirus guidelines and restrictions, Grain Belt reformatted in-person public open house meetings into virtual public open house meetings using the Company website.

EXECUTIVE SUMMARY

Grain Belt Express LLC ("Grain Belt") proposes to construct a new 345 kV transmission line between the proposed converter station location in Monroe County, Missouri along the existing Grain Belt high voltage direct current ("HVDC") transmission line route, the existing McCredie Substation located off County Road 231 in Callaway County, and a future interconnection substation that is expected to be located adjacent to Highway FF in Callaway County, Missouri. The proposed 345 kV transmission line ("Tiger Connector" or the "Project") will operate at 345 kV on double-circuit steel monopole structures within a 150-foot-wide right-of-way (ROW). The Grain Belt transmission line will deliver more affordable, reliable power to homes and businesses across Missouri and the Midwest. In linking Grain Belt to existing infrastructure, the Tiger Connector will bring the economic and energy benefits of Grain Belt to more Missouri homes, businesses, and communities. WSP was retained by Grain Belt to support the Route Selection Study (the Study) process for the Project.

A multi-disciplinary Routing Team (see **Appendix A**), consisting of members of Invenergy LLC (an affiliate of Grain Belt) and WSP, conducted a comprehensive Route Selection Study to establish a Proposed Route for the Project. This process started with the completion of a Corridor Screening Study. The Corridor Screening Study identified a Study Area that included all reasonable potential corridors that could provide the new 345 kV transmission source between a point along the approved Grain Belt HVDC Route and the existing McCredie Substation. The potential corridors identified during the Corridor Screening Study were used to assist in identifying a parcel for the proposed converter station along the Grain Belt HVDC Route. Once the parcel was identified, the Routing Team developed Potential Routes for review and comparison in this Route Selection Study.

The goal in selecting a suitable route for the Project is to minimize impacts on the natural, cultural, and human environment while avoiding circuitous routes, extreme costs, and non-standard design requirements. The Routing Team evaluated the advantages and disadvantages of the Potential Routes based on the established routing criteria, an inventory of land use, environmental, and cultural factors along each of the routes, and additional local knowledge and past experience. Less favorable Potential Routes were eliminated, and three Alternative Routes (A, B, and C) were retained for further consideration. Alternative Route A is approximately 34.4 miles long and would be constructed to parallel an existing 69 kV transmission line for 28% of its route. Alternative Route B is approximately 35.8 miles long and would be constructed as a combined greenfield and parallel route option. Alternative Route C is approximately 34.8 miles long and would be constructed to parallel an existing 345 kV transmission line for 22% of its route. Each Alternative Route presents certain advantages and challenges when compared to the other routes. Likewise, all routes carry with them certain risks related to land use and property issues (e.g., proximity to residences within 300 feet of their respective centerline).

This iterative assessment of the advantages and disadvantages of the three Alternative Routes resulted in the Routing Team's selection of **Alternative Route B** as the Proposed Route. The selection was based on the following Alternative Route B advantages:

- Crosses the fewest total parcels and has the fewest number of residences within 250, 300, and 500 feet of its centerline.
- Utilizes the greatest length of parcel boundary parallel, thereby minimizing impacts to agricultural activities (e.g., cropland cultivation, pivot irrigation).
- Requires the least impact to water resources by spanning the fewest number of streams and crossing less wetlands and Federal Emergency Management Agency (FEMA) floodplain.
- Substantially minimizes the overall tree clearing acreage of all routes.

The Routing Team believes that the cumulative social, environmental, and financial impacts associated with constructing Alternative Route B will be less than any other Alternative Route.

1 INTRODUCTION

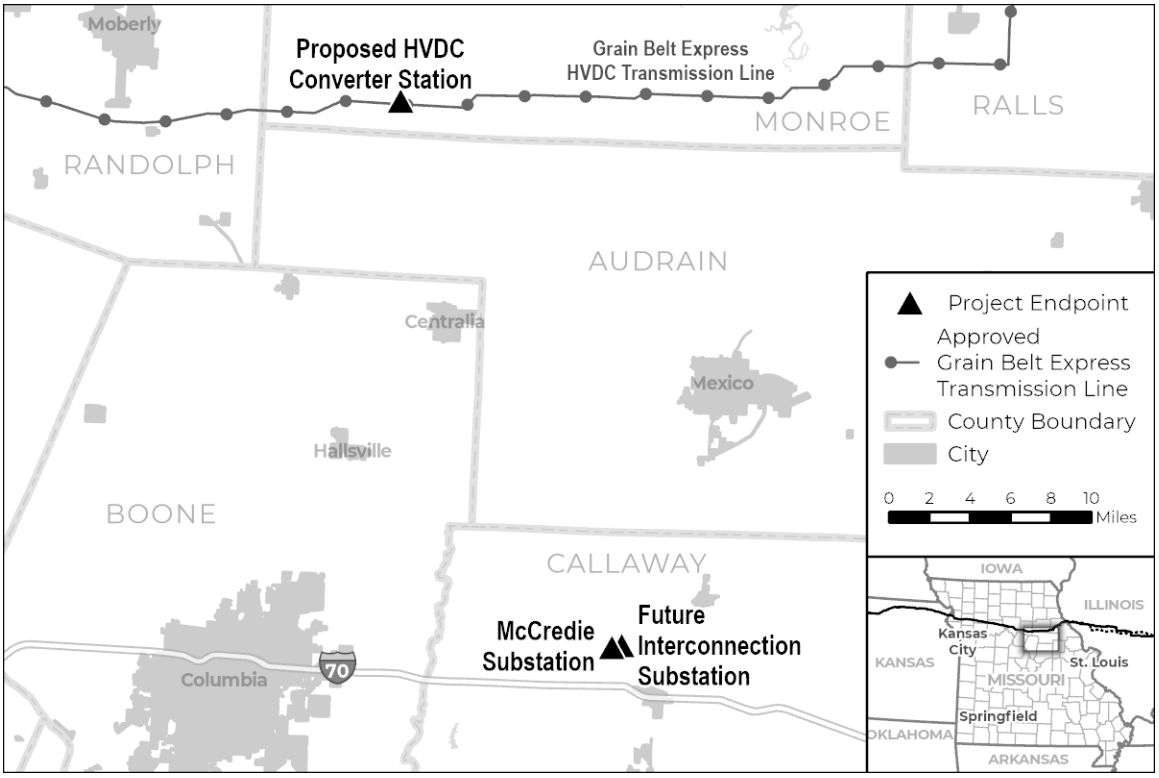
1.1 PROJECT OVERVIEW

Grain Belt is proposing to construct the Project between a proposed converter station in Monroe County, Missouri to the existing McCredie Substation and a future interconnection substation in Callaway County (**Figure 1**). The Project will be approximately 35 miles long and, in linking Grain Belt to existing infrastructure, it will bring the economic and energy benefits of Grain Belt to more Missouri homes, businesses and communities.

Invenergy LLC and WSP staff, along with other subject matter experts, combined to form "the Routing Team" that considered and evaluated routes for the Project (see **Appendix A**). The Route Selection Study assumed the following:

- The Project line will be constructed and operated at 345 kV using double-circuit steel monopoles structures.
- The steel monopoles will be approximately 120 to 160 feet above ground level.
- Width of a new ROW (i.e., not paralleling or sharing another ROW) will be 150 feet (75 feet either side of centerline).

Figure 1. Project Location



The Route Selection Study is intended to identify transmission line routes that minimize effects on land use, ecological, and cultural features, while considering economic and technical feasibility. This Study draws upon the latest available land use and ecological data collected from multiple public sources and commercial providers, as well as an initial corridor screening study that was conducted by WSP to identify potential centerline corridors and help determine an approximate location for the proposed converter station. This was supplemented through field evaluations by the Routing Team, including representatives from siting, engineering, and construction. The field evaluation also provided an opportunity to qualitatively assess the various routes. The result of this process was a comprehensive assessment of the Project Area and route alternatives that is compiled and summarized in the Route Selection Study.

1.2 OVERVIEW OF REGULATORY PROCESS

Grain Belt is seeking approval to own, construct, and operate the Project. In Missouri, the regulatory process for approval to construct the Project will require applying with the Missouri Public Service Commission ("MPSC") for an amendment to Grain Belt's existing Certificate of Convenience and Necessity ("CCN"). The application will include a description of the Proposed Route and will request a buffer area that will allow for micro-siting efforts during engineering and landowner negotiations. This Route Selection Study will be presented as part of the CCN amendment application process.

Once approvals for the Project are received, site-specific permitting and consultation efforts concerning wetlands, cultural resources, highway crossings, and other activities will be pursued with the appropriate local, state, and federal agencies.

1.3 PROJECT TIMELINE AND ROUTING PROCESS OVERVIEW

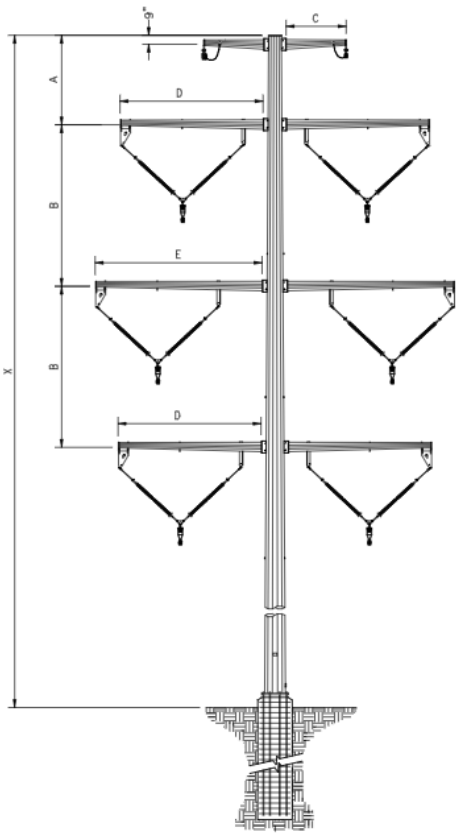
Grain Belt contracted with WSP to perform a Corridor Screening Study in November 2020 to assist in identifying a parcel for the proposed converter station along the Grain Belt HVDC Route. In March 2022, after the converter station parcel was secured, Grain Belt re-engaged with WSP to support the siting, public outreach, and regulatory process for the Project. Throughout spring/summer 2022, the Routing Team began evaluating routing concepts to connect the proposed converter station located along the approved Grain Belt HVDC Route, the existing McCredie Substation located off County Road 231 in Callaway County, Missouri, and a future interconnection substation expected to be adjacent to Highway FF in Callaway County. Using siting criteria and guidelines outlined in **Section 2.3**, the Routing Team refined the Conceptual Routes into 23 Potential Routes in June 2022. In July 2022, the Routing Team hosted public meetings (see **Section 3.2.1**) to present the Potential Routes to the public. More than 275 members of the public attended the meetings, and the attendees were asked to provide comments on the Project and the Potential Routes. Based on landowner and community members feedback during the public meetings, the Routing Team refined the assemblage of

Potential Route alignments and identified Alternative Routes. After analyzing and comparing the Alternative Routes, a Proposed Route was selected. This report presents the process, activities, analysis, and decision rationale for selection of the Proposed Route.

1.4 PROPOSED TRANSMISSION FACILITIES DESCRIPTION

As **Figure 2** shows, the proposed structures will consist of steel monopoles within a typical structural footprint of 6 to 8 feet in diameter. The monopoles will average approximately 140 feet in height. The access routes are anticipated to be temporary except in key areas where long-term maintenance access is required.

Figure 2. Typical Structure Types



DIMENSIONS	
A	20'
B	26'
C	10'
D	20'
E	21'
X	140' TYP

Note: Preliminary, subject to change with detailed engineering

1.5 RIGHT-OF-WAY CHARACTERISTICS

The Project will generally be constructed within a 150-foot-wide ROW, which would be primarily composed of easements across private land. The ROW would be cleared to its full width of tall growing vegetation or as necessary for the safe and reliable operation of the transmission line. Farming and grazing land uses are typically compatible and can continue under the transmission line. Only the area at the base of each structure would be removed from existing land use (roughly 39 square feet or 0.0009 acres for a typical monopole).

2 ROUTING PROCESS

2.1 GOAL OF ROUTE SELECTION STUDY

The Route Selection Study was conducted to identify the route for the Project. The goal of the Study is to gain an understanding of the opportunity and constraint features in the Study Area to facilitate development of Potential Routes, evaluate potential impacts associated with the route, and select a Proposed Route from one or more Alternative Routes. The Proposed Route is the route that is most consistent with the siting guidelines (see **Section 2.3**):

- Reasonably minimizes adverse effects on the natural and human environments.
- Minimizes special design requirements and unreasonable costs.
- Can be constructed and operated in a safe, timely, and reliable manner.

This document describes the route selection methodology, public and agency outreach processes, and the Proposed Route identification process for the Project.

2.2 PROCESS STEPS AND TERMINOLOGY

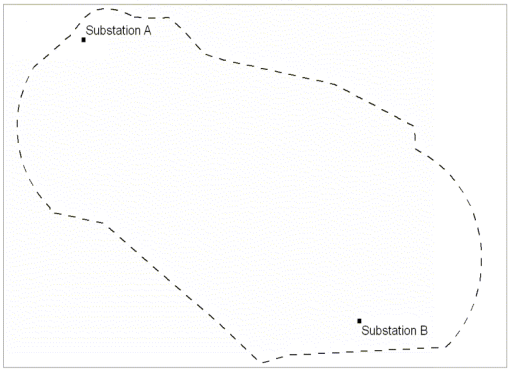
The route development process is inherently iterative with frequent additions or deletions of line segments and revisions to existing alignments as new constraints, opportunities, and inputs are received. Because of the evolutionary nature of the route development process, the Routing Team uses specific vocabulary to describe the routes at different stages of development.

Initial route development efforts start with identifying large-area constraints and opportunity features within the **Study Area**, which encompass the endpoints of the Project and areas in between. Large-area constraints are typically identified using various readily available public data sources.

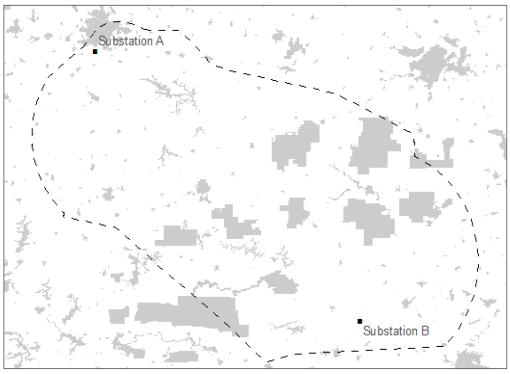
The Routing Team uses this information to develop **Conceptual Routes** adhering to a series of General and Technical guidelines (see **Section 2.3**). Efforts are made to develop Conceptual Routes throughout the Study Area to ensure that all reasonable alignments are considered. Alignments are approximate at this stage, but they are revised after ongoing review and analysis.

As the Routing Team continues to collect information, coordinate with regulatory agencies, and gather additional site-specific information, Conceptual Routes are refined. The revised Conceptual Routes are considered **Potential Routes**.

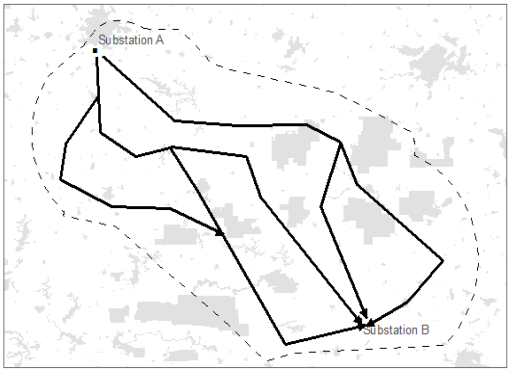
Study Area



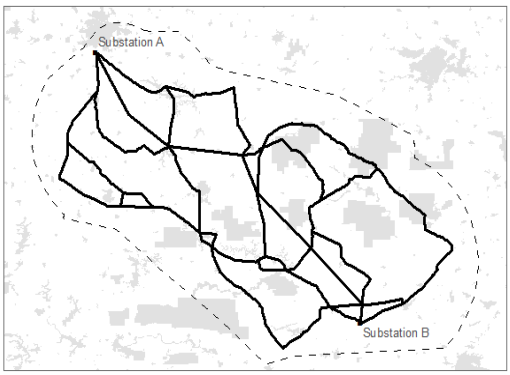
Data Gathering



Conceptual Routes



Potential Routes



Where two or more Potential Routes intersect, a **node** is created, and between two nodes, a **link** is formed. Together, the Potential Routes and their interconnected links are referred to as the **Potential Route Network**. The links are numbered for identification and evaluated both independently and collectively for refinements. The Potential Routes are presented to the public at Public Meetings. Attendees provide input on Potential Route links and additional site-specific information for the Routing Team to consider.

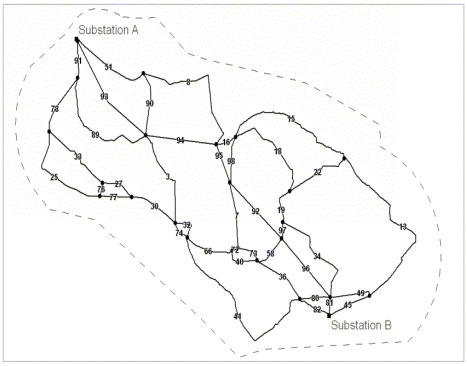
As the Routing Team continues to gather information and after public input is incorporated, links are modified, removed, or added. After an iterative process, a **Refined Potential Route Network** is developed.

The links of the Potential Route Network are further refined and compared, and a selection of the most suitable links is assembled into **Alternative Routes**.

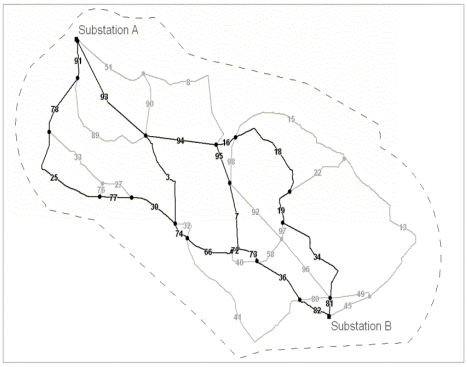
Alternative Routes begin and end at the same locations for direct comparison. Potential impacts are assessed and compared with land uses, natural and cultural resources, and engineering and construction concerns.

Ultimately, through analysis and comparison of the Alternative Routes, a **Proposed Route** is identified. The Proposed Route minimizes the effect of the Project on the natural and human environment, while avoiding circuitous routes, unreasonable costs, and non-standard design requirements.

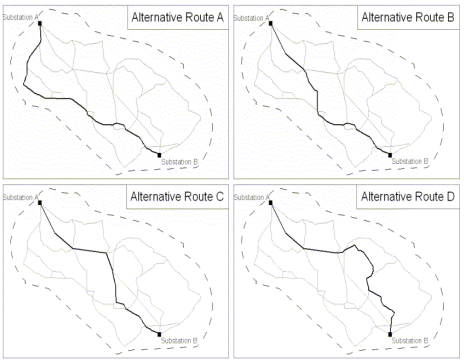
Potential Route Network



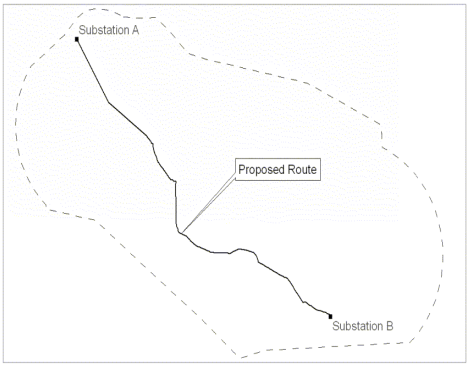
Refined Potential Route Network



Alternative Routes



Proposed Route



*Please note the above graphics are for illustration purposes only and do not reflect actual routes.

2.3 ROUTING GUIDELINES

As described above, the overall goal of this Route Selection Study is to identify a Proposed Route that minimizes the overall effect of the transmission line on the natural and human environment, avoids unreasonable and circuitous routes and unreasonable costs, and minimizes special design requirements. Routing guidelines help the Routing Team reach that goal by setting forth general principles that guide the development of alignments considered in the Study.

The Routing Team considered two types of Routing Guidelines: General Guidelines and Technical Guidelines. General Guidelines establish a set of principles that guide the development of alignments with respect to area land uses, sensitive features, and considerations of economic reasonableness. Technical Guidelines provide the Routing Team with technical limitations related to the physical limitations, design, ROW requirements, or reliability concerns of the Project infrastructure.

2.3.1 GENERAL GUIDELINES

The following are General Guidelines used for the Project:

- Minimize route length, circuity, cost, and special design requirements
- Maximize the separation distance from or minimize impacts on residences
- Maximize the separation distance from or minimize impacts on schools, hospitals, and other community facilities
- Minimize the removal of existing barns, garages, commercial buildings, and other nonresidential structures
- Minimize impacts on agricultural use, including the operation of irrigation infrastructure, where possible
- Avoid crossing cemeteries or known burial places
- Minimize crossing designated public resource lands, such as national and state forests and parks, large campgrounds and other recreational lands, designated battlefields or other designated historic resources and sites, and state designated wildlife management areas
- Minimize crossing large lakes, major rivers, and large wetland complexes
- Minimize impacts on critical habitat, protected species, and other identified sensitive natural resources
- Minimize substantial visual impacts on residential areas and public resources

2.3.2 TECHNICAL GUIDELINES

The following are Technical Guidelines used for the Project:

- Minimize the crossing of 345 kV transmission lines.
- Minimize paralleling corridors with more than one existing 345 kV or larger transmission lines.
- Maintain 150 feet of centerline-to-centerline separation when paralleling existing transmission lines of 345 kV or above[1].
- Maintain 135 feet of centerline-to-centerline separation when paralleling 138 kV or lower voltage transmission lines.
- Minimize turning angles in the transmission line greater than 45 degrees.
- Minimize placing structures on sloping soils more than 30 degrees (20 degrees at angle points).
- Avoid underbuild arrangements with existing alternating current (AC) infrastructure.
- Maintain a safe operational distance from existing pivot irrigation systems.

2.4 DATA COLLECTION

Data identifying features in the routing guidelines enabled the creation of Conceptual Routes, the comparison of Potential Routes, and ultimately the selection of a Proposed Route that best meets the routing guidelines. The following sources of data were used to support the analysis in the Study.

2.4.1 GEOGRAPHIC INFORMATION SYSTEM (GIS) DATA COLLECTION

GIS data are typically either publicly available as a digital data download or created based on interpretation of aerial imagery. Publicly available datasets are often refined or augmented based on aerial imagery, field reconnaissance, and information shared by landowners during Public Meetings.

Aerial Imagery

The primary sources of aerial imagery used for the Project include the following:

[1] The actual centerline-to-centerline separation will be determined during detailed design. The Tiger Connector ROW will not encroach upon existing transmission ROWs while in a parallel configuration.

- The National Agriculture Imagery Program (NAIP) 2020 color aerial photography
- Environmental Systems Research Institute (ESRI) world imagery basemap, which contains high-resolution imagery in the Study Area acquired between 2016 and 2019
- Aerial imagery captured by Grain Belt in 2021, which covers portions of the Study Area

Digital Data Sources

Many federal, state, local, non-profit, and commercial organizations provide downloadable GIS data to the public on their websites or through official agency GIS access portals. In some cases, the data comes with restrictions:

- Must be purchased from its provider (e.g., tax parcel data, which many counties provide for a fee).
- Can only be viewed in an online webmap at a limited scale (e.g., pipelines, which are restricted for security reasons).
- Must be digitized from aerial imagery (e.g., pivot irrigation systems).
- Can only be collected by an expert in the field (e.g., archaeological data, which state historic preservation offices restrict to Registered Professional Archaeologists).

The Routing Team also reviewed paper maps marked up by landowners at public meetings, as they provide essential information about their property that is not always accessible or accurate in state or national databases. **Appendix B** contains a complete listing of GIS data sources.

Regardless of its source, GIS data is used with regard to its limitations and the variance of its completeness and quality. Therefore, GIS-based calculations and maps presented in this Study should be considered reasonable approximations of a resource or geographic feature rather than absolute measures or counts. The data and calculations presented allow for equitable comparisons among Project alternatives. Where possible and practical, data is cross-checked for accuracy against other data sources or verified with field reconnaissance.

All GIS data was compiled, viewed, analyzed, and updated GIS software (ArcGIS Pro v3.0).

2.4.2 FIELD RECONNAISSANCE

Prior to field reconnaissance, some key features, such as residences, outbuildings, recognized places of worship, cemeteries, and commercial buildings were mapped based on publicly available building footprint data augmented by aerial imagery interpretation. In April, June, and July 2022, Routing Team members conducted windshield surveys of the Conceptual Routes and Potential Routes from public roadways and compared observed features to data contained in the GIS database. Where extant features differed from the GIS data – this occurred most frequently where buildings had been constructed or demolished since the 2020 imagery was collected – the GIS data was corrected, either via a tablet running ESRI's Field Maps application, or via a laptop

running ArcGIS Pro and supported by real-time Global Positioning System (GPS) location tracking.

Residences were categorized as either occupied or unoccupied, and when their status was unclear, they were assumed to be occupied. When intervening topography or vegetation prevented visual verification of a feature identified in the GIS database, it was marked as unverified and researched further using alternate sources of imagery, county tax records, and landowner feedback during the public outreach process (see **Section 3.2**).

As the name suggests, windshield surveys are conducted from a vehicle traveling on public roads and do not include land surveys, ecological surveys, geotechnical surveys, cultural resource surveys, or other environmental surveys requiring access to private property. Grain Belt expects to begin detailed environmental surveys in 2023.

3 AGENCY AND PUBLIC OUTREACH

3.1 REGULATORY AGENCY COORDINATION

The Routing Team contacted numerous federal, state, and local agencies to gather information for the route planning process. Coordination efforts focused on introductions to the Project, data gathering, and discussions concerning likely permitting and consultation requirements. The agencies consulted are provided in the list below. Copies of correspondence with federal and state agencies are provided in the testimony of Jen Stelzleni.

Federal Agencies and Regulatory Authorities

- National Park Service
- U.S. Environmental Protection Agency, Region 7
- U.S. Fish and Wildlife Service (USFWS) Missouri Ecological Services Field Office
- U.S. Army Corps of Engineers (USACE)
    - Kansas City District, Regulatory Branch
    - St. Louis District, Regulatory Branch

Missouri State Agencies

- Missouri Department of Conservation
- Missouri Department of Agriculture
- Missouri Historic Preservation Office

3.2 COMMUNITY INVOLVEMENT PROCESS

3.2.1 PUBLIC COMMUNICATIONS AND PUBLIC MEETINGS

Public Outreach

In July 2022, the Routing Team held four public meetings in Audrain County and Callaway County. The number of potentially affected landowners in Monroe County was less than 25, so a public meeting was not held in that county in accordance with regulatory requirements. However, landowners in Monroe County were notified by letter of the four meetings in Audrain and Callaway counties. All potentially affected landowners and other stakeholders were informed of the Public Meetings by mailed invitations and local newspaper advertisements. A full list of the Public Meetings is below.

Table 1. Public Meeting Locations			
City	**County**	**Date and Time**	**No. of Public Attendees***
Mexico	Audrain County	Noon to 2pm, July 26th	100
Mexico	Audrain County	5pm to 7pm, July 26th	75
Fulton	Callaway County	Noon to 2pm, July 27th	50
Fulton	Callaway County	5pm to 7pm, July 27th	50

**Landowners were not required to sign in with Project representatives, so final counts of attendees are estimated*

Landowner Notification Letters

Landowner notification letters were mailed directly to landowners within 1,000 feet of the centerline of any Potential Routes. The letters contained information for each meeting, Project information, and how landowners could leave comments for the Project team. A total of 283 notifications were mailed to landowners across the Study Area. Copies of the notification can be found in the testimony of Kevin Chandler.

County Clerk Letters

The county clerks for each of the Project counties received notification of each Public Meeting. The letter informed the clerk of the time, date, and location. Included with the letter was a map showing the Project area and a copy of the newspaper public notice that was scheduled to run in their county. Copies of the County Clerk letters can be found in the testimony of Kevin Chandler.

Newspaper Public Notices

A public notice ran in each county's newspaper of record and, to increase visibility, Audrain County had notices published in two papers:

- Audrain County – The Mexico Ledger, run date: July 16, 2022
- Audrain County – Vandalia Leader, run date: week of July 25, 2022
- Callaway County – Fulton Sun, run date: July 16, 2022
- Monroe County – Monroe County Appeal, run date: July 14, 2022

Affidavits, or certificate of the publisher, for each newspaper and advertisement placement can be found in the testimony of Kevin Chandler.

Meeting Attendance

Each meeting lasted two hours and included informational boards and large Study Area table maps; members of the Routing Team were available to discuss the Project and answer questions. Attendees were encouraged to provide their name, contact information, feedback, and questions on a comment card. In addition to the comment cards, each attendee was given a Project

handout with key information including a Project description, Project timeline, overview map of the Project area, routing process steps, and a diagram of typical structure types.

After attendees were greeted at the welcome table, they were directed to a series of poster boards that provided information on the purpose of the Project, Project benefits, physical characteristics of the transmission line, easement and compensation information, and the routing process. Members of the Routing Team stayed near the boards to answer any questions from attendees.

After reviewing the boards, Routing Team members assisted attendees in locating their properties or other features of concern on table maps displaying the Potential Routes on recent aerial imagery. Each map presented a specific portion of the Project area with information on known routing constraints, land areas, and existing infrastructure presented at a scale of 1 inch = 1,000 feet. Attendees were asked to help the Routing Team identify the location of their properties and mark it with a unique number, document the locations of their property boundaries, residences or other buildings, irrigation facilities, topographic features, or any other features of concern on their property.

A digital mapping station was also provided at each Public Meeting enabling attendees to locate their land and document their comments directly in the GIS database. A GIS analyst ran the station, which contained all the data presented on the printed table maps as well as a full parcel database to help search for parcels that landowners were unable to locate on the printed maps. The GIS station was most often used and most efficient for those attendees who were not familiar with their properties from an aerial map perspective, who owned multiple properties in the area, or had difficulty standing at the map tables.

After the public meetings, all the maps used to collect comments were scanned and any content relevant to routing was incorporated into the GIS database.

Virtual Meeting

To increase access to the public meeting materials and input opportunities, a supplemental virtual meeting was open for a period of time overlapping the in-person public meetings. The virtual meeting was hosted on the Project website, www.grainbeltexpress.com/Tiger-Connector and when the virtual meeting was live a homepage pop-up message provided a quick link to the meeting. The virtual meeting was self-paced and was accessible anytime July 25 through August 5.

3.2.2 SUMMARY OF PUBLIC COMMENTS

More than 275 members of the public attended the public meetings. Members of the public helped identify small area constraints or opportunities on their properties or in their communities. Meeting attendees provided specific information regarding the location of features such as residences, barns or outbuildings, irrigation facilities, existing utilities, other infrastructure, and landscape features that could affect routing or structure placement. They also provided information on current land use such as agriculture areas, pastureland, and recreational areas. Similar comments were collected through the virtual public meeting website. Overall, a total of 93 public comments were submitted to the Routing Team.

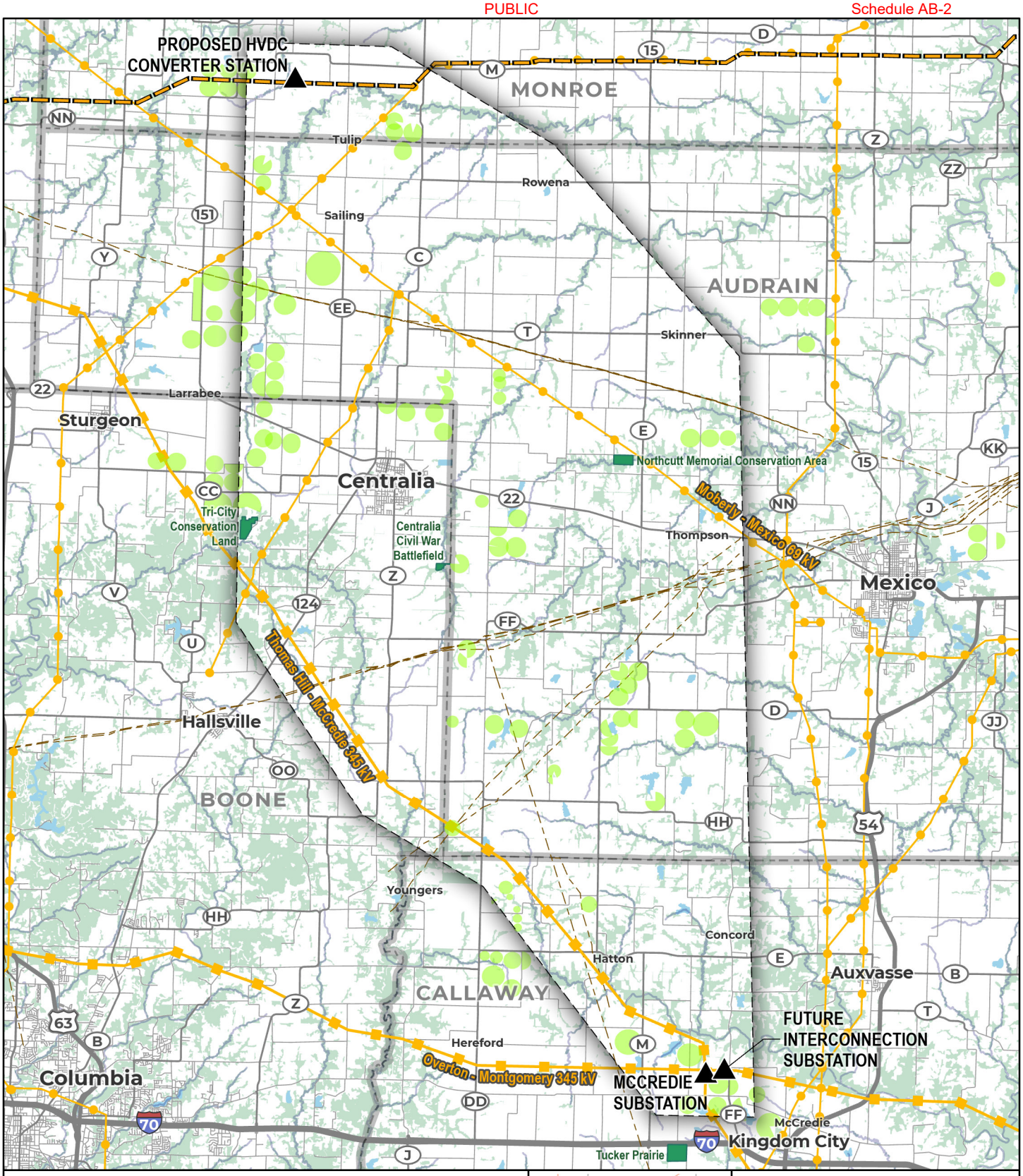
4 ROUTE DEVELOPMENT

4.1 STUDY AREA

The Project's end points initially define the Study Area: the Project begins at the proposed converter station site in southern Monroe County, Missouri, and it terminates at and near the existing McCredie Substation, located 2 miles north of I-70 in Callaway County, Missouri (**Map 1**). The western edge of the Study Area follows a straight line south from the proposed converter station site until it reaches the existing Thomas Hill – McCredie 345 kV transmission line, which defines the southwestern edge of the Study Area. Incorporating existing linear utility corridors in the delineation of the Study Area ensures that Potential Routes next to existing lines are considered; paralleling existing utility corridors is a common practice in transmission line siting supported by many state and federal regulatory authorities. Due to limited opportunities to parallel existing infrastructure on the eastern side of the Study Area, the eastern boundary is delineated by a straight line continuing north from the McCredie Substation until approximately Highway T in Audrain County, where the Study Area turns northwest back towards the proposed converter station site. Routes extending outside the Study Area would result in circuitous alignments that do not meet the routing guidelines.

The Study Area contains the city of Centralia in Boone County, Missouri as well as the smaller communities of Sailing, Rowena, Skinner, and Thompson in Audrain County and Hatton and Concord in Callaway County. Larger cities surrounding the Study Area include Columbia (in Boone County) 11 miles to the southwest, Moberly (in Randolph County) 11 miles to the northwest, Mexico (in Audrain County) 3 miles to the east, and Fulton (in Callaway County) 7 miles to the south. Outside of cities, the densest residential development occurs along state highways and routes, in scattered rural neighborhood clusters with 3- to 10-acre lots, and southwest of Centralia.

The terrain is generally flat to gently rolling and is predominantly used to grow crops and provide grazing for livestock. Waterways throughout the Study Area typically have some tree cover, with areas in the central and southern portions of the Project maintaining the most forested area along riparian corridors. West of Centralia, the terrain becomes increasingly incised by small streams and potential wetlands.



Map 1
Study Area

Invenergy Transmission

wsp

0 1 2 3 4 5 Miles

Local roads are generally aligned north to south and east to west with section lines. State Highway 22 connects Mexico to Centralia and passes through the center of the Study Area. No U.S Highways or Interstates cross through the Study Area, although I-70 runs east to west through Kingdom City south of McCredie Substation. Secondary state routes are evenly distributed throughout the Study Area.

Notable electric infrastructure in the area includes the existing Thomas Hill – McCredie 345 kV transmission line that runs southeasterly from Moberly to the McCredie Substation and the existing Moberly – Mexico 69 kV transmission line, which forms a nearly straight line connecting the two cities. Two major pipeline corridors cross the Study Area in Audrain County.

4.2 ROUTING CONSTRAINTS AND OPPORTUNITIES

Constraints

The Routing Team identified and mapped routing constraints in the Study Area. Constraints are areas that should be avoided to the extent feasible during the route selection process, and they are typically categorized by the geographic area encompassed by the constraint. Due to their size, large-area constraints are more difficult to avoid and are considered unfavorable or incompatible when developing Conceptual Routes. As the Conceptual Routes are refined, they are adjusted to avoid or minimize impacts to smaller localized constraints to the extent possible and practical. Routing constraints present in the Study Area are listed in **Table 2**.

Table 2: Routing Constraints

Routing Constraint	Relevance
Large-Area Constraints	
Urban areas (cities, towns, rural neighborhoods)	Routing near built-up areas increases proximity to more homes and landowners. Structures in the ROW would require purchase or demolition to ensure the safe construction and operation of the transmission line.
State lands, including state forests, parks, conservation lands, and wildlife management areas	Crossing public lands triggers National Environmental Policy Act (NEPA) or state equivalent, which can be lengthy and expensive. Transmission lines may also not be compatible with the designated use of the public land.

Table 2: Routing Constraints	
Routing Constraint	**Relevance**
Conservation lands designated for their natural importance or scenic value	Transmission lines can fragment rare and unique landscapes or habitats that were set aside for conservation. Conservation easement restrictions may also inhibit utility development.
Areas near airports and airstrips	Siting near airports and landing areas requires additional engineering and permitting to maintain safe flying operations.
National Register of Historic Places (National Register) Historic Districts and other large historic sites	Modern infrastructure can disrupt historic character and landscapes associated with historic districts listed on the National Register.
Large lakes or reservoirs that could not be spanned and large wetlands or wetland complexes	Reservoirs and wetland complexes that cannot be spanned require unique engineering solutions that add to Project timeline and cost. Crossing these areas could cause additional impacts to water resources and/or additional consultation with the Federal Aviation Administration (FAA) to allow taller structures and longer spans.
Localized (Small-Area) Constraints	
Occupied residences (including single-family and multi-family homes and permanently established mobile homes)	Proximity to homes is one of the most common concerns raised by landowners during public outreach. Homes and other structures in the ROW would require purchase or demolition to ensure the safe construction and operation of the transmission line.
Commercial and industrial buildings, public safety buildings, and places of worship	Transmission lines should be sited to minimize disruption to business, worship, and essential services which are used by or support many people. As with residences, structures cannot be in the ROW of the transmission line.

Table 2: Routing Constraints	
Routing Constraint	**Relevance**
Irrigation systems and any associated reservoirs and pumping facilities	Transmission structures can block the movement of irrigation systems, resulting in over- or under-watering and a reduction in crop yields. Although irrigation systems are large, relatively small routing changes can often minimize or eliminate impacts to the system.
Designated historic buildings and archaeology sites	Modern infrastructure can disrupt historic character and landscapes associated with historically significant structures and sites. Ground disturbance near identified archaeology sites may trigger enhanced surveys that add to Project cost and timeline.
Recorded occurrences and critical habitat of designated threatened, endangered, or special status species	Siting through areas with known concentrations of sensitive species often carries higher permitting costs and can result in negative impacts to these populations.
Small wetlands and waterbodies	Impacts to wetlands may trigger the USACE and state wetland permitting requirements, including potential wetland mitigation.
Communications towers, water towers, pipelines and pipeline pump stations, and other utility infrastructure	Transmission lines should be sited to avoid interference with other utility infrastructure serving the public need. Transmission lines most clearly have the potential to interfere with other utility infrastructure at crossings (for example, where a transmission line crosses a pipeline) but interference can also occur if the transmission line passes too close to the existing infrastructure to allow for maintenance and maintain safe clearances.

Opportunities

The Routing Team identified routing opportunities as locations where the proposed transmission line might be located with less disruption to surrounding land uses and the natural and cultural environment. Opportunity features in the Study Area typically included other linear infrastructure and utility corridors, transportation networks, and parcel boundaries (detailed in

Table 3). Although these types of features are all considered potential opportunities, individual features were only identified as routing opportunities if they were aligned in a suitable direction within the Study Area and were not constrained by other features. The Project connects a northern point to a southern point, so opportunity features that cross the Study Area in an east-west direction could not be followed for long distances without creating a circuitous route.

Table 3: Routing Opportunities

Routing Opportunity	Relevance
Existing Electric Transmission Line	Paralleling existing transmission lines consolidates utility corridors and avoids new fragmentation of existing land uses and habitats. Locating a new transmission line next to an existing transmission line can also reduce impacts on visually sensitive resources (e.g., historic sites, parks, and residences), avian resources, and airport landing areas, as impacts from the new line are considered with respect to impacts of the existing line. Although paralleling a transmission line is considered a routing opportunity, crossing existing transmission lines results in additional engineering constraints that govern the location and angle of the crossing (crossing the existing line perpendicularly and mid-span is preferred) and the height of the proposed structures (taller structures are required to maintain clearance between the lines), as well as future operation and maintenance challenges. For these reasons, routes typically stay on one side of an existing transmission line rather than crossing back and forth.
Major pipeline corridors	Like transmission lines, pipeline ROWs are cleared linear corridors of existing disturbance; paralleling an existing pipeline ROW can also avoid new fragmentation of the landscape and consolidate linear ROWs with similar construction and use limitations. However, because pipelines are buried underground, paralleling a pipeline does not reduce visual impacts, avian collision risk, or aviation concerns to the same extent as paralleling existing aboveground infrastructure. Potential induced voltage effects from high voltage AC electric transmission lines on nearby metal pipelines can also be a concern when paralleling or crossing a pipeline ROW.
Roads and railroads	Roads and railroads are typically considered a logical linear opportunity for planning transmission lines, and lower voltage

	transmission and distribution lines commonly parallel them. However, for higher voltage lines with larger structures, wider ROWs, and longer spans, alignments along transportation corridors often conflict with residential and commercial development.
Parcel boundaries and section lines	In addition to linear infrastructure, the grid-based section lines of the public land survey system and parcel boundaries that further dissect each section also served to guide the development of alignments along logical divisions of land ownership. To the extent possible and practicable, the Routing Team aligned routes along parcel boundaries in areas where other opportunities did not exist. Following existing divisions of land is most relevant in farmed areas, since structures placed along the edges of fields typically cause less disruption to farming operations than structures placed across a field.

4.3 CONCEPTUAL ROUTE DEVELOPMENT

Conceptual Routes are the first step in route development. As the name suggests, Conceptual Routes are initially developed as broad routing approaches that connect the Project start and end points, avoid large area constraints, and collocate with notable opportunity features where possible. Conceptual Routes for the Project are illustrated on **Map 2**.

Major constraints included the following:

- the city of Centralia.
- Dense residential development in the forested areas southwest of Centralia, east of Mexico between Highway 22 and Highway FF, and scattered in rural neighborhoods throughout the Study Area.
- Clusters of center pivot irrigation systems and irrigation reservoirs.
- Three designated conservation areas.

The Moberly – Mexico 69 kV transmission line and the Thomas Hill – McCredie 345 kV transmission line crossed the Study Area with a northwest-to-southeast alignment that was favorable for Conceptual Routes connecting the Project endpoints and were considered the primary opportunity features. The two major pipeline corridors in the Study Area were less favorably aligned for routing, so no Conceptual Routes paralleling these corridors were developed. Residences along major roads in the Study Area limited the development of

Conceptual Routes along roads except for short distances. Where no other routing opportunities existed, the Routing Team sought to draw routes predominantly along parcel boundaries, although the diversity of parcel sizes and the presence of localized constraints necessitated the development of some diagonal alignments.

The Conceptual Routes followed one of three general paths:

- A western path that extended nearly due south from the converter station site, bypassed Centralia to the west and south, continued south in Boone County near the Boone/Audrain County line, and paralleled the Thomas Hill – McCredie 345 kV transmission line to the Project endpoint
- An eastern path that would exit the converter station generally to the east/southeast before turning southward towards the McCredie Substation. The eastern path would primarily seek to follow parcel boundaries and roads, with a possible short segment of parallel along the Moberly – Mexico 69 kV transmission line
- A central path that maximized parallel of the Moberly – Mexico 69 kV transmission line, bypassed Centralia to the east, and allowed for multiple possible connections to and combinations with the eastern and western paths

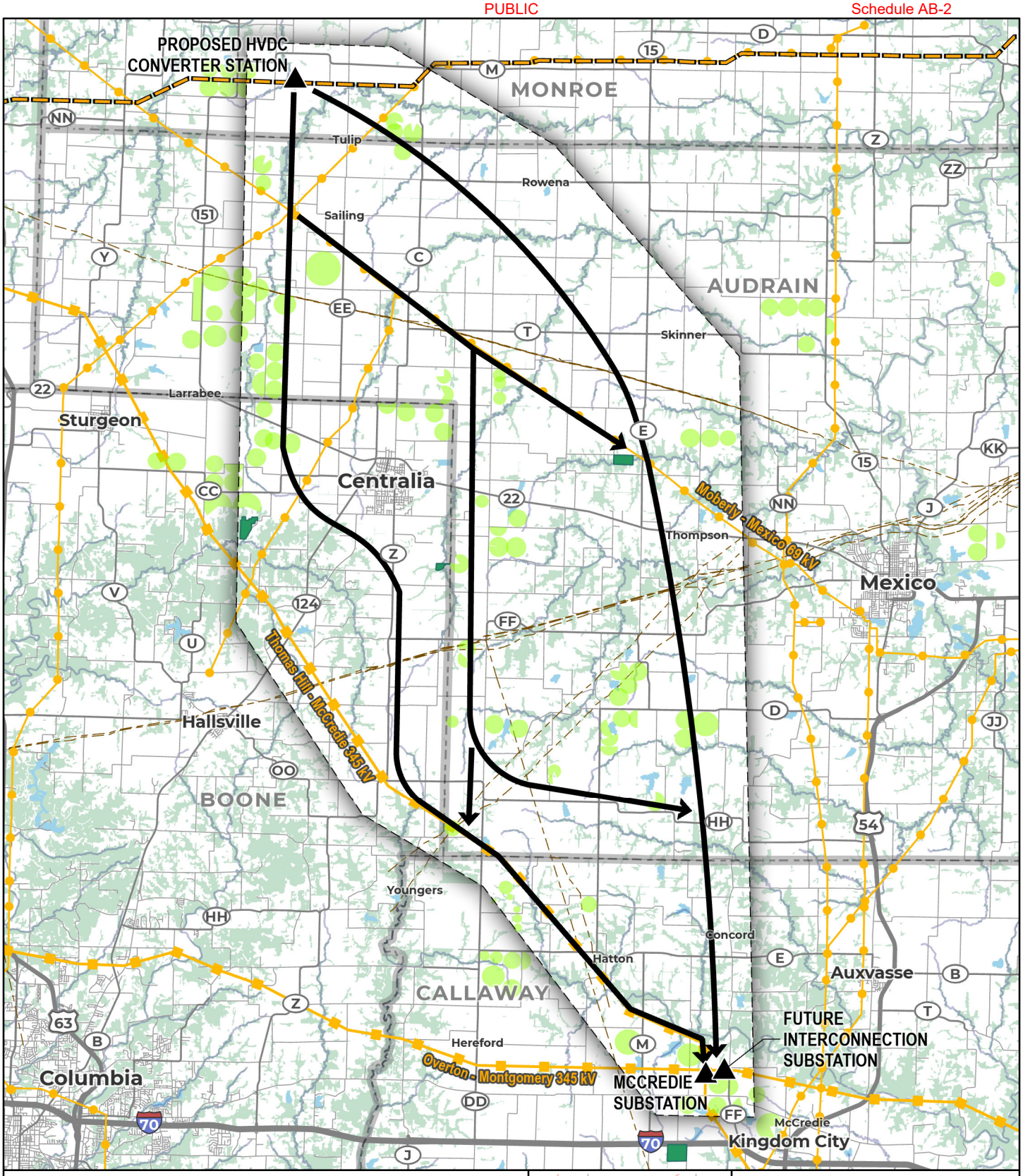
Once the network of Conceptual Routes was developed, the Routing Team conducted a windshield survey (**Section 2.4.2**) to confirm and update information in the GIS database.

4.3.1 IDENTIFICATION OF THE REFINED STUDY AREA

Although the term Study Area boundary suggests that the Study Area is a fixed boundary throughout the routing process, the identification of new opportunities and constraints can necessitate modifications to the Study Area boundary.

In the case of the Project, the windshield survey identified significant new development on the southern edge of Centralia, much of which was not captured by aerial imagery. Any route traversing east of Centralia would have to stay within a narrow 0.5-mile-wide corridor to avoid both the new urban development along Gano Chance Road in Centralia and existing rural residences along Highway 124, Highway Z, North Jay Jay Road, and East Greenfield Road.

To stay within this corridor, routes would require either long diagonal alignments across farmland or a stair-step pattern consisting of short sections of transmission line along parcel boundaries joined by 90-degree angles. In either case, the routes would pass within 0.5 miles of Centralia, which would complicate future development in a rapidly expanding area.



Project Endpoint
Conceptual Route
Study Area
County Boundary
Pivot Irrigation

Approved Grain Belt Express HVDC Route
Existing Transmission Line
69 kV
345 kV
Pipeline
Major Road
Local Road

River or Stream
State or Local Park
Forested Area

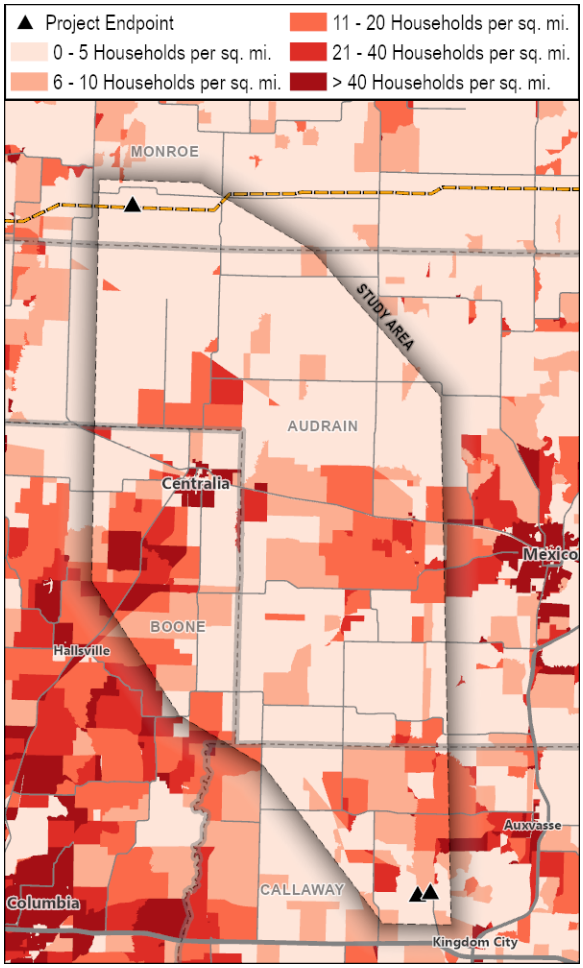
Map 2
Conceptual Routes

Invenergy Transmission
wsp

0 1 2 3 4 5 Miles

Options further west, including options maximizing parallel of the existing 345 kV transmission line, were not considered due to residential density southwest of Centralia and the presence of approximately 15 residences within 300 feet of the existing transmission line in Boone County. **Figure 3** shows household density in the Study Area based on 2020 U.S. Census data. Areas in Boone County south and west of Centralia have consistently higher household densities than the rest of the Study Area.

Figure 3. Household Density in the Study Area



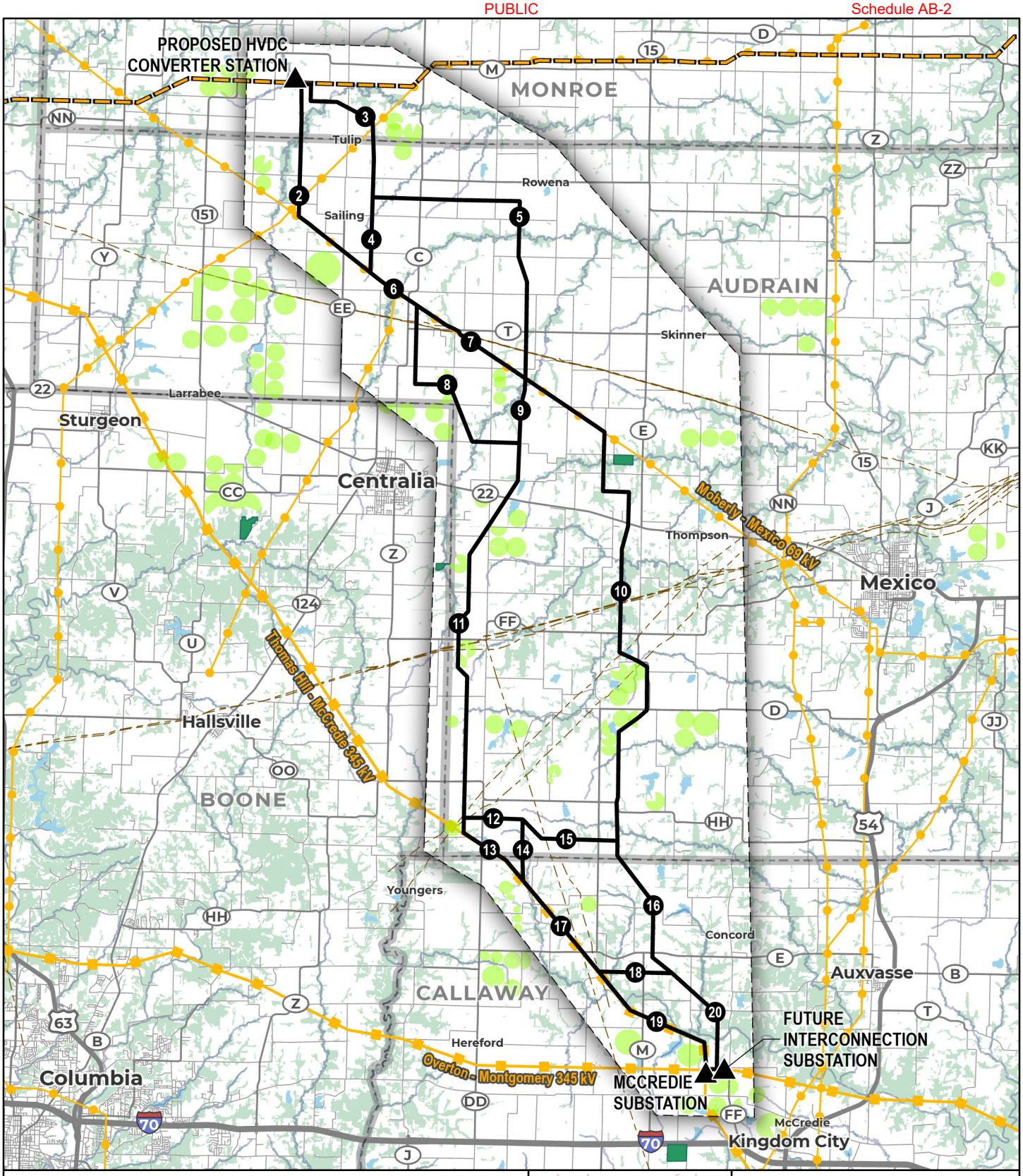
Combined, the issues of proximity to many residences, constraints on future development, additional forest clearing, and the added length and angles required to minimize these impacts indicate that routes west of Centralia are unlikely to meet the routing guidelines.

Because the Routing Team could not identify a suitable alignment for routes west of Centralia, these routes were eliminated from further consideration and the Study Area was refined accordingly (**Map 3**). The elimination of these routes inherently affects the suitability of routes further south in Boone County; a route would be circuitous if it bypassed Centralia to the east, turned west to cross into Boone County, and then reversed direction again to reach the McCredie Substation to the east.

4.4 POTENTIAL ROUTES

4.4.1 DEVELOPING THE POTENTIAL ROUTE NETWORK

After revising the Study Area, the Routing Team formalized the remaining Conceptual Routes into a network of Potential Routes. Organizing the Potential Routes into a network, or a series of shorter links that join at common nodes, allowed the Routing Team to iteratively compare combinations of Potential Routes connecting the Project end points. Based on this analysis and new constraints identified during additional field reconnaissance, Potential Routes were added, removed, and modified before being finalized for presentation to the public. Potential Routes shown at public meetings are shown on **Map 3**.



Project Endpoint
Potential Route/Link
Refined Study Area
County Boundary
Pivot Irrigation

Approved Grain Belt Express HVDC Route
Existing Transmission Line
69 kV
345 kV
Pipeline
Major Road
Local Road

River or Stream
State or Local Park
Forested Area

Map 3 Potential Route Network

Invenergy Transmission
wsp

0 1 2 3 4 5 Miles

Northern Study Area

The three main Potential Route options in the north (Routes numbered 2, 3, 4, and 5) aimed to generally follow parcel boundaries or section lines to connect the proposed converter station to alignments paralleling the Moberly – Mexico 69 kV transmission line. Route 8 diverted from the transmission line parallel and primarily followed an existing distribution line, parcel boundaries, and a road; this option provided a viable alternate path to the transmission line parallel.

Central Study Area

Potential Routes 10 and 11 formed the two options through the middle of the Study Area. Due to the lack of north-south-oriented utility infrastructure and the number of residences along roads throughout the Study Area, these routes paralleled parcel boundaries to the extent possible and practicable. Both routes required diversions with diagonal alignments to avoid existing irrigation systems and residences along Highway 22. As an effect of maximizing distance from homes, both routes paralleled riparian corridors; Route 11 follows the same path as Davis Creek for approximately 1.5 miles across agricultural fields, and Route 10 crosses wooded areas surrounding Davis Creek for approximately 1.9 miles.

Southern Study Area

In the southern portion of the Study Area, Potential Routes 13, 17, and 19 paralleled the north side of the existing Thomas Hill – McCredie 345 kV transmission line. The Routing Team chose to parallel the north side of the existing transmission line primarily because paralleling the south side of the line would require crossing the existing transmission line twice. Transmission line crossings require taller and more robust structures to maintain line clearances and support the conductors as one of the lines passes over the other, have special engineering requirements that reduce flexibility when attempting to site individual structures in a way that minimizes impact to farm fields, and necessitate scheduled outages on both lines during construction and maintenance.

East of the 345 kV transmission line parallel, Potential Routes 16 and 20 formed a second option to connect the middle of the Study Area with McCredie Substation. Existing residential development, particularly along the Audrain/Callaway County border and County Road 245 in Callaway County, pushed significant portions (approximately 85%) of these routes onto diagonal alignments.

Potential Routes 12, 14, 15, and 18 were designed as connector links between the two main north-south options in the southern portion of the Study Area. If portions of the routes paralleling the existing transmission line proved to have too many constraints to be feasible options, the connector links would allow the Project to connect to other Potential Routes and bypass the constrained area. All four connector routes predominantly parallel parcel boundaries, although in some cases the same landowner owns or farms the parcels on both sides of the route.

4.4.2 REVISIONS TO THE POTENTIAL ROUTE NETWORK

Immediately following public meetings, the Routing Team met to review comments that were written on comment cards or maps, shared in conversation with Project representatives, and submitted online via the virtual meeting (see **Section 3.2.1**). In addition to making the Routing Team aware of general landowner concerns about the Project, these meetings provided an opportunity to revise the Potential Routes, where feasible, based on new information provided by landowners and technical guidance provided by the engineering team. Revisions to the Potential Route Network, including eliminated Potential Routes, are shown in the Refined Potential Route Network on **Map 4**.

Potential Route 3

At its northern end, Potential Route 3 made three 90-degree angles turning east, then south, then east again. To reduce the number of heavy angles and improve constructability of the route, the line was straightened to connect to Route 2 approximately 0.5 mile south of its previous connection point. This revision eliminated two of the 90-degree angles and changed the 0.25-mile-long east-west segment so that it followed the landowner's parcel boundary instead of being offset several hundred feet into a cultivated field.

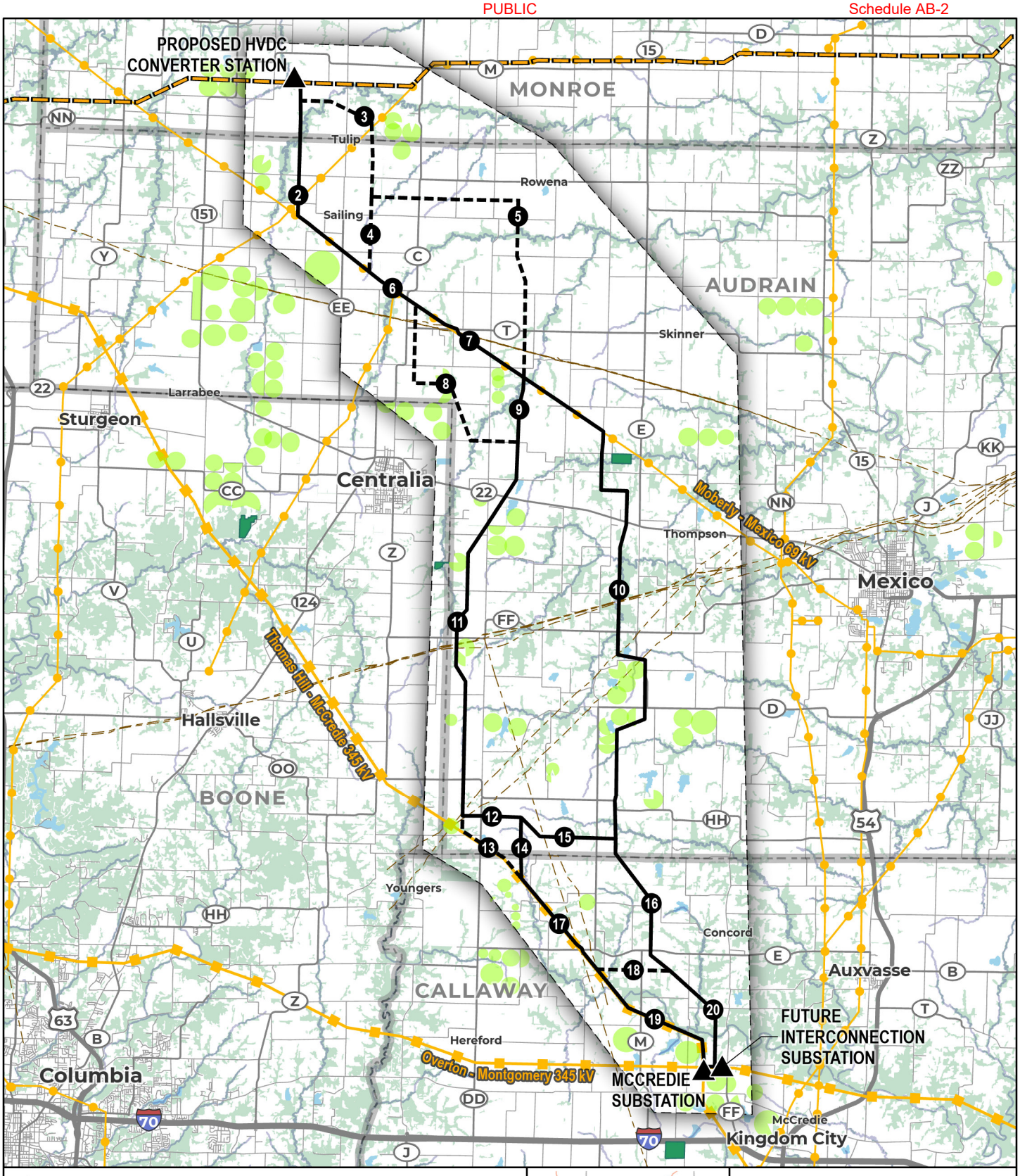
Slightly further east, just after it crossed Long Branch, Potential Route 3 passed within approximately 250 feet of a former home site which the landowner is actively developing into a new home site. The two angles closest to the home site were adjusted to shift the route approximately 450 feet from the development. This change did not meaningfully affect the alignment of the route on any neighboring parcels.

Potential Route 8

On Potential Route 8, the Routing Team identified an approximately 1,100-foot span of a pivot irrigation system. The typical span length for the Project is 800 feet, so this crossing would require special engineering to span the additional length without placing a structure in the path of the irrigation system. A light angle was added to shift the route approximately 200 feet and ensure that the irrigated area could be completely spanned or avoided.

Potential Route 10

Potential Route 10 made a significant diversion to avoid a cluster of pivot irrigation systems, although it crossed over an associated irrigation reservoir in the process. At the public meetings, landowners marked a pump system next to the reservoir that was directly under the route centerline. To avoid interference with the pump and improve the crossing of the reservoir, the two angles marking the north end of the diversion were adjusted by several hundred feet. The route revision added two new crossings of Route M, but it also shifted the route centerline so that it did not cross directly over a road intersection and improved the route's crossing of a distribution line.



- Project Endpoint
- Retained Potential Route
- Removed Potential Route
- Refined Study Area
- County Boundary
- Pivot Irrigation
- Approved Grain Belt Express HVDC Route
- Existing Transmission Line
  - 69 kV
  - 345 kV
- Pipeline
- Major Road
- Local Road
- River or Stream
- State or Local Park
- Forested Area

Map 4
Refined Potential Route Network

Invenergy Transmission

wsp

0 1 2 3 4 5 Miles

At the southern end of its diversion, Potential Route 10 was modified again to minimize impacts to pivot irrigation systems. Landowners identified a pivot irrigation system that was missing from the maps, and the route would require an approximately 1,350-foot span to avoid impacting it. By shifting the angle of the route, the span over the pivot was reduced to approximately 790 feet.

Potential Route 11

Along one of the diagonally aligned portions of Potential Route 11, the landowner identified a drainage that formed an existing break in the farm ground. They requested that the route be shifted to follow the drainage, which would align any transmission structures next to an existing break in the cultivated field and minimize the likelihood of transmission structures being placed in the middle of a cultivated area.

Potential Routes 17 and 19

Landowners along Potential Routes 17 and 19, which parallel the existing 345 kV transmission line, shared concerns about the proximity of the Project to their homes and farm buildings. The Routing Team developed and analyzed two alternative options that would break away from the parallel alignment and reduce the number of structures close to the route.

The first option (called 17A here for reference) began about 0.6 miles north of Highway E. The option would make a perpendicular, mid-span crossing of the existing 345 kV transmission line and angle southwest for approximately 800 feet to a parcel boundary, which it followed south for 1 mile. The route then made another 90-degree turn to the east for 1 mile, where it would cross the existing transmission line again before continuing straight on Route 18.

Although the revision moved the route more than 500 feet from three homes, it added 0.7 miles of length, two 90-degree angles, two crossings of an existing high-voltage transmission line, and approximately 8.7 acres of tree clearing compared to the original alignment. The revised option would also create a triangle-shaped area containing three residences with the existing 345 kV transmission line to the northeast and the Tiger Connector to the west and south. Due to the engineering challenges and taller structures required to cross the existing line, increased visual impacts of diverting from parallel, and generally greater impacts from the longer line length, Potential Route 17A was eliminated from further consideration.

The second option (19A for reference) utilized the same diversion from parallel as Potential Route 17A, but instead of crossing the existing transmission line and connecting to Route 18, 19A turned south and paralleled the west side of the transmission line for an additional 1.3 miles before crossing back to parallel the east side of the transmission line. The south end of Potential Route 19A would be offset from the existing transmission line by up to 400 feet to reduce tree clearing along Auxvasse Creek. Although Potential Route 19A avoided passing within 500 feet of a fourth residence (in addition to the three avoided by 17A), it was ultimately eliminated from further consideration for the same reasons as Potential Route 17A.

4.4.3 POTENTIAL ROUTE LINKS REMOVED FROM FURTHER CONSIDERATION

To eliminate less suitable Potential Routes, the Routing Team compared combinations of Refined Potential Route links with common start and end points, which ensured equitable comparisons between options. Potential Routes were evaluated for elimination based on both a quantitative and qualitative analysis of their impacts to constraints (including land use, environmental, and engineering constraints) and their use of opportunity features in the Study Area.

Elimination of Potential Routes 3, 4, and 5

At the north end of the Project, the Routing Team compared three potential paths combining Links 2, 6, and 7; Links 3, 4, 6, and 7; and Links 3 and 5. All three paths passed near a similar number of residences and outbuildings, crossed a similar number of landowners and parcels, spanned the same number of roads and transmission lines, and had similar impacts on water resources. However, the combination of Links 3 and 5 was more than 2 miles longer than the shortest combination, it had more heavy angles, and it required more than 20 additional acres of tree clearing compared to the other two options. Thus, Link 5 was eliminated first, with Link 3 retained temporarily as part of its combination with Link 4.

The two remaining paths (effectively Link 2 or Links 3 and 4) had substantially similar impacts in the remaining categories analyzed, but because the combination of Links 3 and 4 was slightly longer, had two more heavy angles, and did not take full advantage of the 69 kV transmission line parallel, those links were eliminated. Links 2, 4, 6, and 7 were retained to become part of the Alternative Routes.

Elimination of Potential Route 8

Near the northeast corner of Boone County, the Routing Team compared Link 8 with a combination of Links 7 and 9. The two options had similar impacts on residences, existing infrastructure, and water resources, but the combination of Links 7 and 9 was slightly shorter, had significantly fewer heavy angle structures, and consolidated utility infrastructure by paralleling the existing 69 kV line. Link 8 had slightly less tree clearing overall (by 6.9 acres), but tree clearing along Links 7 and 9 was mitigated by existing tree clearing and habitat fragmentation along the existing transmission line. Ultimately, the slight reduction in tree clearing along Link 8 was not enough to surpass the advantages of Links 7 and 9, and Link 8 was eliminated.

Elimination of Potential Route 13

Potential Route 13 was eliminated not because of a direct comparison with other routes, but because of impacts it would cause to existing residences and outbuildings. Over a 2.5-mile length of route, Potential Route 13 would have passed within 300 feet of two houses and required the removal of three large barns in the ROW. Although the routing guidelines typically favor alignments that parallel existing transmission lines, and the alternate path to Link 13 (Links 12

and 14) was longer and had more heavy angles, the Routing Team determined that the disproportionate impacts to buildings along Link 13 rendered it unsuitable to be carried forward as part of the Alternative Routes.

Elimination of Potential Route 18

Comparing Links 15 and 16 to Links 14, 17, and 18, Links 15 and 16 passed within 300 feet of one fewer house and within 500 feet of four fewer houses, while Links 14, 17, and 18 had the advantage of paralleling the existing transmission line. The two paths had substantially similar impacts outside of those categories. Because the quantitative comparison did not strongly favor one option over the other, the Routing Team elected to eliminate Link 18 and retain Link 15, which created one option on the west that maximized parallel of the existing transmission line and one route on the east that avoided the constraints present along the existing transmission line.

4.4.4 DESCRIPTION OF ALTERNATIVE ROUTES

After the Potential Routes were refined via their removal or via revisions to their alignment, the remaining Potential Route links were assembled into Alternative Routes, each of which formed a single complete path linking the Project start and end points. The Alternative Routes are shown on **Map 5.**

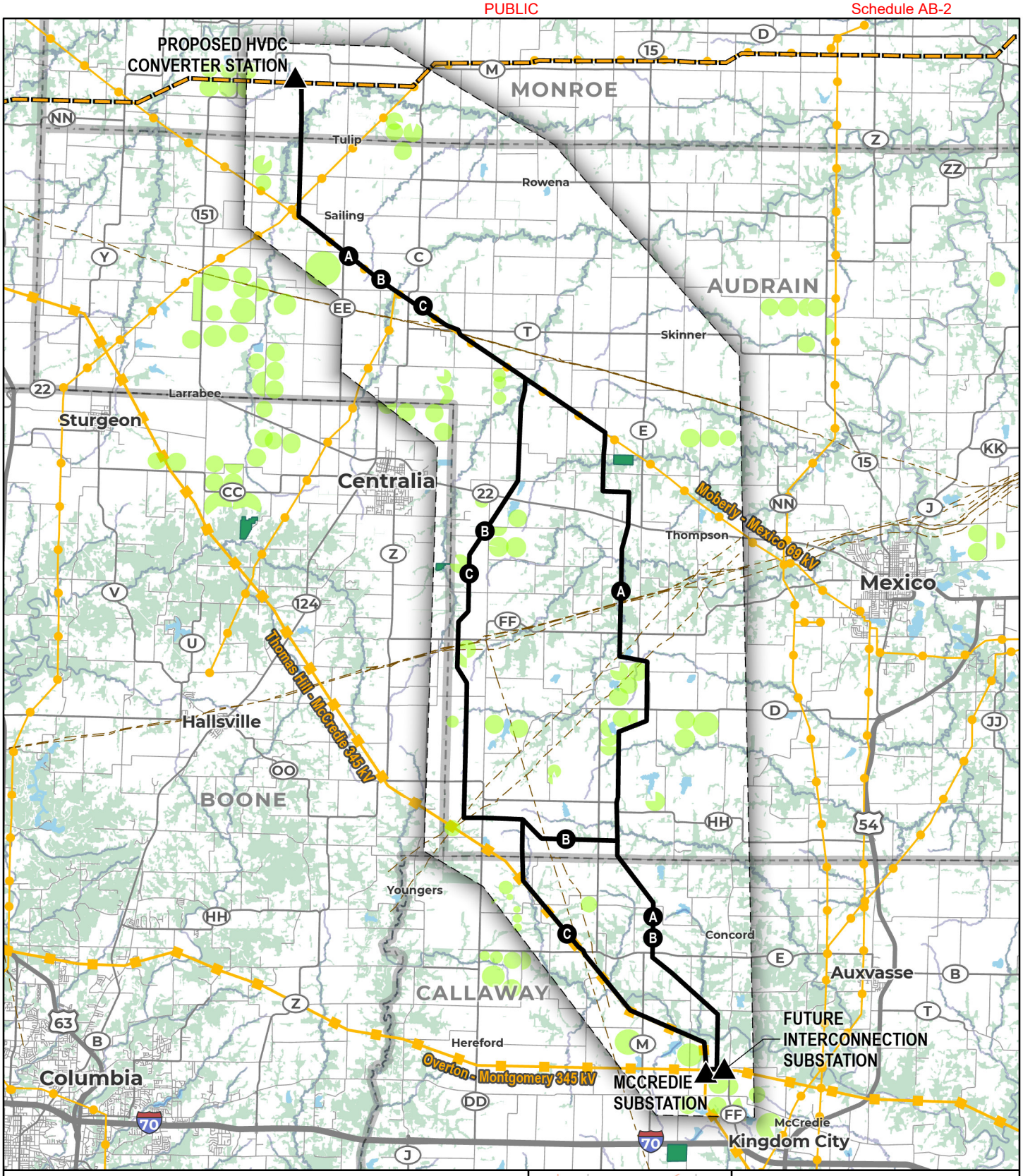
Alternative Route A

The first 11.2 miles of Alternative Routes A, B, and C share the same alignment. The routes exit the proposed converter station and head due south for 3.7 miles, crossing from Monroe County into Audrain County, until reaching the Moberly – Mexico 69 kV Transmission Line. Approximately 43% (1.6 miles) of this alignment parallels parcel boundaries. All three routes parallel the north side of the existing 69kV transmission line for 7.5 miles, with a small diversion to avoid pipeline infrastructure near the intersection of Highway T and Audrain Road 241.

From this point, Alternative Route A splits from Alternative Routes B and C and continues to parallel the north side of the existing transmission line for an additional 2.6 miles.

About 0.25 mile west of Northcutt Memorial Conservation Area, the route turns south and parallels parcel boundaries for 1.6 miles across farm fields and wooded corridors along Skull Lick Creek. This section of the route is shifted slightly off the parcel boundary to increase distance from and maintain tree cover around two homes.

After making a 90-degree turn to the east and paralleling parcel boundaries for 0.7 miles, the route makes another 90-degree turn and heads generally south for 4.4 miles, crossing farm fields, State Highway 22, and wooded areas along Davis Creek.



Project Endpoint
Alternative Route
Refined Study Area
County Boundary
Pivot Irrigation

Approved Grain Belt Express HVDC Route

Existing Transmission Line
69 kV
345 kV
Pipeline
Major Road
Local Road

River or Stream
State or Local Park
Forested Area

Map 5
Alternative Routes

Invenergy Transmission
wsp

0 1 2 3 4 5 Miles

To avoid residences and a cluster of pivot irrigation systems on this trajectory, the route makes a series of turns, angling 0.8 miles southeast, 1.6 miles south, and then 0.8 miles back to the southwest. This section of route crosses Highway M twice, spans the edges of two pivot irrigation systems, and passes about 450 feet west of the Little Dixie Fire Protection District Fire Station.

The route continues straight south from this point entirely along parcel boundaries for 3.3 miles until the Audrain/Callaway County border.

In Callaway County, Alternative Route A angles southeast diagonally across agricultural fields for 1.6 miles to avoid residential development present along roads and parcel boundaries. The route then turns south along a parcel boundary and half section line for 1.5 miles.

About 600 feet south of its crossing over Highway E, the route takes another diagonal alignment to the southeast for 2.3 miles before turning due south for 2.9 miles until it reaches the north side of the Overton – Montgomery 345 kV transmission line, which it follows into the McCredie Substation and the future interconnection substation.

Alternative Route B

Following the first 11.2 miles that they share with Alternative Route A, Alternative Routes B and C share the same alignment for the next 13.9 miles.

After separating from Alternative Route A, Alternative Routes B and C turn south for 2.8 miles, crossing the Moberly – Mexico 69 kV transmission line, Youngs Creek, and several farm fields. Approximately 53% (1.5 miles) of this alignment follows parcel boundaries.

To avoid two irrigation reservoirs and several pivot irrigation systems along this trajectory, the routes turn to the southwest, spanning State Highway 22 and passing diagonally over farm fields for 2.4 miles.

Routes B and C then turn and continue nearly due south along parcel boundaries and a half section line for 7.3 miles, with a 2.1-mile diversion in the middle that avoids crossing an irrigation reservoir and minimizes impacts to two pivot irrigation systems. The diversion includes 0.4 miles of diagonal alignment to the southwest, 1.2 miles of route along a parcel boundary, and 0.5 miles of diagonal alignment to the southeast, which is aligned along the edge of a waterway to reduce disruption to farming operations.

One mile north of the Audrain/Callaway County border, Alternative Routes B and C make a 90-degree turn to the east for 1.6 miles, at which point the two routes split to follow different paths into McCredie Substation.

From the split, Alternative Route B angles southeast for 0.7 miles before turning due east and paralleling parcel boundaries for 2.0 miles. At this point, approximately 0.5 miles north of the Audrain/Callaway County border, Alternative Route B rejoins Alternative Route A and follows the same trajectory through Callaway County and to the Project endpoints.

Alternative Route C

Following the first 11.2 miles that it shares with Alternative Routes A and B and the subsequent 13.9 miles that it shares with Alternative Route B, the unique portion of Alternative Route C begins approximately 1 mile north of the Audrain/Callaway County border and 2 miles east of the Audrain/Boone County border.

Alternative Route C makes a 90-degree turn south to split from Alternative Route B, and it continues south along a section line for 1.6 miles, crossing into Callaway County, until it reaches the north side of the Thomas Hill – McCredie 345 kV transmission line. Other than a small (0.3 mile) diversion to avoid a pipeline pump station, the route parallels the existing transmission line for the remaining 7.4 miles into the McCredie Substation. All three routes share a 0.6-mile alignment on the north side of the Overton – Montgomery 345 kV transmission line that connects the McCredie Substation to the future interconnection substation.

5 ALTERNATIVE ROUTE EVALUATION

This chapter describes the key resources in the Study Area and a comparative analysis of the potential impacts of each Alternative Route on these resources. The analysis relies on a combination of information collected in the field, GIS data sources, supporting documents, stakeholder input, and the knowledge and experience of the Routing Team. Information presented throughout the chapter is based on an aerial photo-aligned centerline for each Alternative Route. The final location of any route is subject to modification based on final engineering, ground surveys, minimization of impacts on site specific resources, and landowner negotiations.

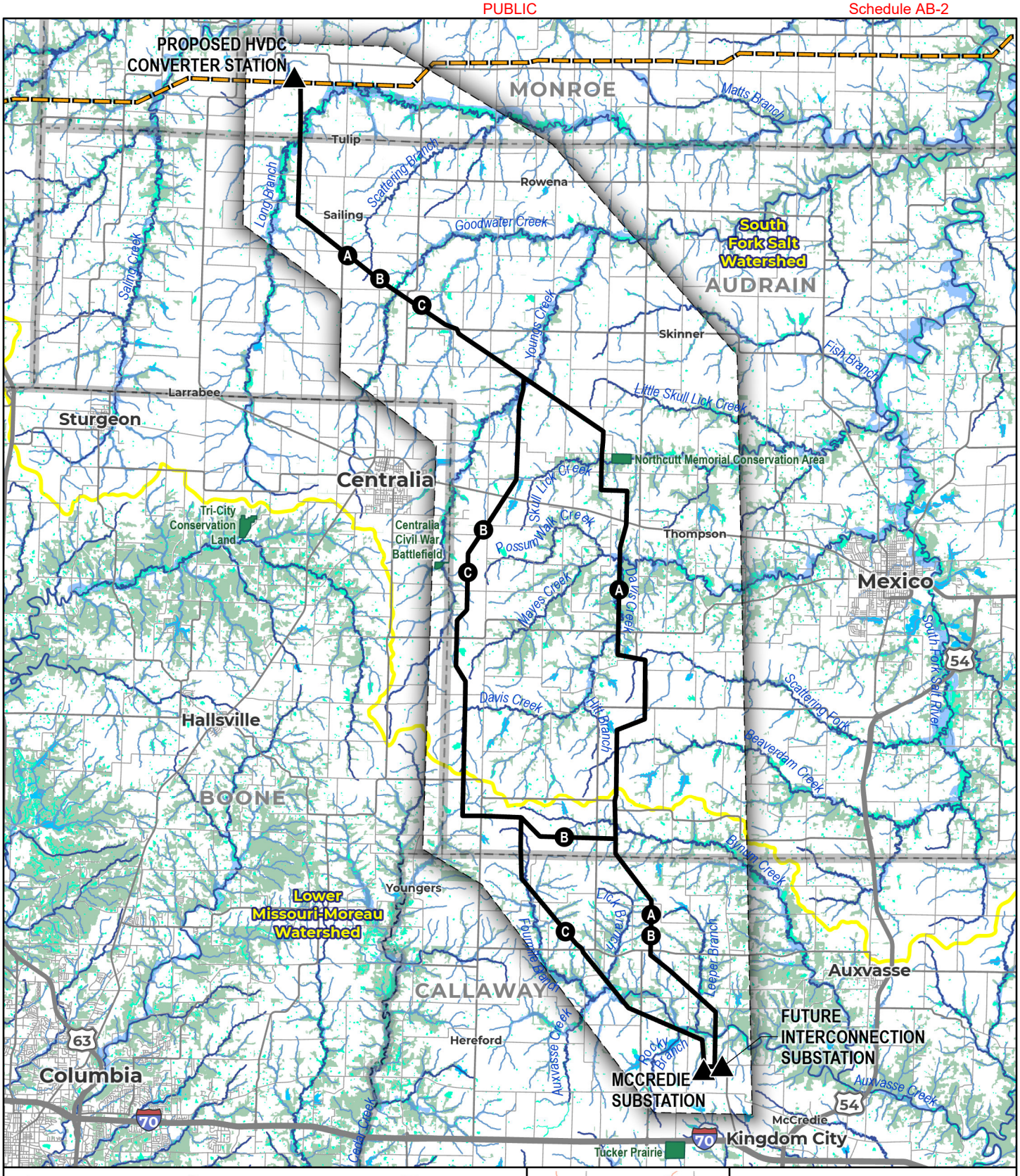
5.1 NATURAL ENVIRONMENT

The natural environment includes water resources, soil and geology, sensitive species, and wildlife habitat. Potential impacts are based on publicly available maps and data as well as coordination with federal, state, and local agencies. The Route Selection Study goal is to avoid or minimize impacts on the natural environment to the extent practicable during construction, operation, and maintenance of the transmission facilities. A comparison of the natural environment considerations for the Alternative Routes is presented in **Table 4** at the end of **Section 5.1.1** and shown on **Map 6**.

5.1.1 WATER RESOURCES

Resource Characteristics

Water resources of northern Missouri fall within the Missouri River and Upper Mississippi River basins. As a result of the area's glacial past, the drainage patterns consist of nearly parallel streams that trend southeast and into the Mississippi River. The glacial till of northern Missouri has low permeability; therefore, infiltration is low, and runoff is rapid (Vandike 1995). This low permeability and a lack of groundwater inflow make for low base flows during dry weather. Northern Missouri is extensively row-cropped, and glacial till is easily eroded, especially on steeper slopes. This combination leads to high suspended sediment loads in many streams and rivers in northern Missouri (Vandike 1995). Water resources in the Study Area are presented in **Table 4** and shown on **Map 6**.


PROPOSED HVDC CONVERTER STATION
MONROE
AUDRAIN
BOONE
CALLAWAY
Tulip
Rowena
Sailing
Skinner
Larrabee
Sturgeon
Centralia
Hallsville
Columbia
Thompson
Mexico
Auxvasse
Hereford
Youngers
Tucker Prairie
Kingdom City
McCredie
Tri-City Conservation Land
Centralia Civil War Battlefield
Northcutt Memorial Conservation Area
South Fork Salt Watershed
Lower Missouri-Moreau Watershed
MCCREDIE SUBSTATION
FUTURE INTERCONNECTION SUBSTATION
A
B
C
Matts Branch
Long Branch
Scattering Branch
Goodwater Creek
Salling Creek
Youngs Creek
Fish Branch
Little Skull Lick Creek
Skull Lick Creek
Possum Walk Creek
Waves Creek
Davis Creek
Hix Branch
South Fork Salt River
Scattering Fork
Beaverdam Creek
Burnett Creek
Dick Branch
Loeper Branch
Rocky Branch
Auxvasse Creek
Cedar Creek
Fourmile Branch
63
70
54
Project Endpoint
Alternative Route
Refined Study Area
Approved Grain Belt Express HVDC Route
County Boundary
Named River or Stream
Unnamed Stream
Lake or Pond
Wetland
Floodplain
HUC-8 Watershed Boundary
Forested Area
State or Local Park
Map 6
Natural Environment
Invenergy Transmission
wsp
0 1 2 3 4 5 Miles
N

The many of the ponds and lakes in the Study Area are privately owned and used for agricultural or recreational purposes. The USACE has constructed numerous reservoirs for flood control through northeastern Missouri. Wetlands are typically located in the floodplains along rivers and streams, in swales associated with rivers, or as margins of lakes and impoundments.

Because the Study Area is located in northeastern Missouri, streams and rivers in the area drain to the Missouri and Mississippi Rivers within the Lower Missouri-Moreau and South Fork Salt watersheds. Major surface water features include Long Branch, Scattering Branch, Goodwater Creek, Youngs Creek, Little Skull Lick Creek, Skull Lick Creek, Possum Walk Creek, Mayes Creek, Davis Creek, Hitt Branch, Scattering Fork, Beaverdam Creek, Bynum Creek, Fourmile Branch, Lick Branch, Leeper Branch, Rocky Branch, and Auxvasse Creek. Ten reservoirs are located throughout the Study Area but predominately in the central/eastern area. Reservoirs within the Study Area are generally used for agricultural purposes (e.g., irrigation systems) and flood control. Groundwater resources are more diverse in the northeastern part of the state and can have areas of moderate yields for irrigation (Miller and Vandike 1997).

No streams or rivers within the Study Area are designated Outstanding State Resource Waters (State of Missouri 2012). Similarly, no streams or rivers in the Study Area are listed on the state's 303(d) list that identifies impaired waterbodies that are not currently meeting water quality standards (EPA 2020).

Alternative Route Comparison

All streams and waterbodies in the Study Area can be spanned or avoided. Wetlands will be spanned when feasible. A goal during siting is to minimize the need for wetland permitting through reducing wetland acreage impact. Potential riverine wetland acreage within the ROW of the Alternative Routes is generally comparable (**Table 4**). Similarly, all three Alternative Routes span a similar number of tributaries and streams. The northern and southern routing options (Routes A and C) show less favorably than the central option (Route B), with Routes A and C requiring the most combined stream crossings (45 and 51, respectively). It is possible that taller structures and longer spans will be required for wider stream crossings.

Overall, Alternative Route B crosses the fewest streams, the least total wetland acreage, and substantially less FEMA floodplain. Therefore, from a water resource perspective, Alternative Route B ranks best. Nevertheless, regardless of the route chosen, wetland, riparian, and flood hazard mitigation for permanent impacts to regulated areas are required for any of the routes selected.

Table 4. Natural Environment Evaluation Criteria				
Alternative Route	**Unit**	**A**	**B**	**C**
General				
Length	miles	34.4	35.8	34.8
150-foot ROW	acres	626.1	650.4	632.9
Water Resources				
NHD Stream Crossings	count	45	40	51
NHD Waterbody Crossings	count	5	3	2
PEM/PSS/PFO/PUB Wetlands in the ROW (NWI)	acres	19.0	7.7	9.8
Riverine Wetlands in the ROW (NWI)	acres	5.4	5.1	6.6
FEMA 100-year Floodplain in ROW	acres	43.4	23.6	40.9
Habitat Type				
Forested habitat within the ROW	acres	131.8	90.2	98.0
Wetland habitat within the ROW	acres	24.4	12.8	16.5
Pasture/grasslands within the ROW	acres	82.0	84.2	86.6

5.1.2 WILDLIFE AND HABITAT

Vegetation and Habitats

Missouri was once a complex mixture of grassland (or prairie), savanna, woodland, and forest occurring on a diversity of landforms that vary in degree of relief, dissection, and geologic parent materials. Grasslands occupied approximately one-third of the state occurring as both upland grasslands and wet grasslands on the wide alluvial plains along rivers.

Today, native grasslands are rare with most converted to pastures composed of planted nonnative pasture species. Existing native vegetation in Missouri has undergone extensive fragmentation into smaller tracts. The general land cover today is a complex mixture of cropland on smoother surfaces and better soils, pasture on irregular surfaces and eroded soils, and woodlands and forests on steeper soils and rougher areas (Nigh and Schroeder 2002).

Northeastern Missouri, north of the Missouri River and west of the Mississippi River, consists of claypan prairie with topography that is mostly flat or gently rolling. Most former prairies are now used as cropland with extensive nonnative pasture and hay land on rolling lands with an emphasis on livestock production. Most woodlands are mixed with invasive woody species, and very little natural vegetation remains (Nigh and Schroeder 2002).

Wildlife

The mosaic of grassland, savanna, woodland, and forest communities and their associated edge habitat significantly affected the types and numbers of wildlife that occurred historically in Missouri (MDC 2003).

Missouri's natural communities support and provide habitat for a great diversity of wildlife species including more than 150 native breeding bird species (Jacobs and Wilson 1997), 108 native reptile and amphibian species (Johnson 2000), 67 native mammal species (Schwartz 2001), 200 native fish species (Pflieger 1997), 65 native mussel species (Oesch 1995), 32 native crayfish species (Pflieger 1996), and more than 130 native dragonfly and damselfly species (Trial 2005). Missouri ranks 21st in a ranking of the aggregate native species diversity of vascular plants, mammals, birds, reptiles, amphibians, and freshwater fishes of the 50 states (Stein 2002). Many of these species depend partially or wholly on woodlands and forests (MDC and U.S. Department of Agriculture [USDA] Forest Service 2010). Game species managed for hunting include big and small game animals, furbearing animals, upland game birds, migratory game birds, and waterfowl.

In addition, Missouri lies within the Mississippi Flyway, one of the four major North American migratory bird corridors. The Mississippi Flyway stretches from the Gulf Coast of Louisiana, Mississippi, and Alabama up through Canada. During early spring and late fall, many bird species migrate between wintering grounds and summer nesting grounds along the Flyway.

Currently, in the area north of the Missouri River very little natural habitat remains with a small percentage of land covered by forests and native grasslands. A large percentage of land is cropland with approximately 20% pasture or hay lands. Some species of grassland birds will nest in cropland, grass waterways, pastures, hayfields, and roadsides adjacent to agricultural lands. However, species diversity in these altered habitats typically is very low, and reproductive success appears to fall far below what is necessary to maintain stable populations (MDC and USDA Forest Service 2010).

Remaining forest, woodland, and savanna communities provide nesting, cover, and foraging sites for a variety of wildlife from amphibians and reptiles, birds, and small mammals to large mammal species. Riparian forest cover is also important to fishes and other aquatic organisms while ephemeral pools in forest and woodland are important breeding sites for amphibians.

Native prairies are important habitats in Missouri, although few remain. Fewer than 90,000 acres of native prairie still exist in Missouri today and only approximately 25,000 acres are protected by state or private entities. Prairies are important areas of biodiversity, and more than 800 different species of plants can be found on Missouri prairies (Missouri Prairie Foundation 2014). Numerous bird species also use prairies for summer breeding habitat and migration layovers, while fewer use these areas for overwintering. Additionally, up to 3,000 insect species can occur on high quality prairie remnants (Nelson 2005).

Conservation Lands

Conservation lands in Missouri primarily include lands in the Natural Resources Conservation Service (NRCS) Wetland Reserve Enhancement Partnership (WREP), lands in the USDA's Conservation Reserve Program (CRP), and lands in Missouri Department of Conservation (MDC) conservation areas. The NRCS WREP is a voluntary program that allows landowners to protect wetlands on their property under conservation easements. It is part of the Wetland Reserve Easement component of the Agricultural Conservation Easement Program (ACEP), a Farm Bill conservation program (USDA NRCS. n.d). MDC administers 995,628 acres of conservation area lands located throughout the state, some of which is leased, but the majority is owned in fee.

The Nature Conservancy designs conservation plans on an ecoregional basis and maintains portfolios of sites within an ecoregion that would collectively conserve the native species and community types found in that ecoregion. These portfolios are intended to provide a framework for The Nature Conservancy and its partners to make decisions regarding conservation actions on a site-by-site basis. No Nature Conservancy sites or ecoregions are located within the Study Area. Similarly, no wildlife management areas, refuges, or Audubon Important Bird Areas (IBAs) are within the Study Area. Tucker Prairie Natural Area is located directly south of Interstate 70 (I-70) outside of the Study Area's southern boundary. The area consists of a 146-acre tall grass prairie supporting more than 250 species of plants used as a University of Missouri-Columbia research site. Tucker Prairie is also identified as a local IBA to multiple bird species (University of Missouri 2022 and Audubon 2013). The MDC Northcutt Memorial Conservation Area is located in the northeastern portion of the Study Area. The dominant features within the conservation area include mature trees and Skull Lick Creek. The area is nearly all forested with exception of an old field in early successional advancement (MDC n.d.).

Alternative Route Comparison

Impacts to habitats and wildlife can be generally assessed by comparing each Alternative Route with respect to the amount of natural land crossed, including forested land cover, wetlands, and grassland areas. Additional assessment criteria include the length of each route through grassland/pasture habitats and the length of new transmission line paralleling existing transmission lines and other linear features. Windbreak forest cover and hedgerows are less frequent in the northern portion of the Study Area, with much of the forest cover occurring in the drainages and on steeper hillsides that are less suitable for farming farther south.

As shown in **Table 4**, although all three Alternative Routes are of similar length, Route B is slightly longer (by 1.4 miles) compared with the shortest route (Route A). In the northern portion of the Study Area, all three routes share the same corridor for 11.2 miles. Before crossing Youngs Creek, Route A splits off from Routes B and C to parallel the existing 69 kV transmission line for an additional 2.6 miles, while Routes B and C turn south paralleling property boundaries and farm fields.

In the central portion of the Study Area, Route A passes through a mix of wooded areas and agricultural fields. Most wooded areas are located adjacent to streams, including Skull Lick Creek, Possum Walk Creek, Mayes Creek, Davis Creek, Scattering Fork, Beaverdam Creek, and Bynum Creek. As discussed in **Section 5.1.1**, Route A spans these streams. By taking this trajectory, Route A requires at least 33 acres of additional tree clearing compared with Routes B and C. Alternative Routes B and C minimize tree clearing in the central portion of the Study Area by traversing mostly agricultural properties comprised of both cultivated crops and pasture/grasslands.

In the southern portion of the Study Area, Route B splits off from Route C by following the same cross-country path as Route A. In this area, Alternative Routes A and B pass through more wetland and woodland habitat. Pasture and grassland habitat is more prevalent along Route C. No wildlife refuges or conservation areas are crossed by the routes. During the public meetings (**Section 3.2.1**), a landowner in the southern portion of the Study Area indicated that bald eagles forage along waterbodies south of Auxvasse Creek and northwest of McCredie Substation. Although no IBAs are located in the Study Area and no active bald eagle nests were observed in the area via aerial survey[2], the Routing Team took the bald eagle activity into consideration during the siting process. By paralleling the existing 345 kV transmission line, Alternative Route C is closer to the bald eagle activity than the other routes. Alternative Routes A and B have the potential to minimize risks to bald eagles by passing farther east from the areas of identified eagle activity.

Avian collisions with power lines are a recognized concern for transmission line development. Typically, the risk of avian collision is associated with the smaller diameter and less visible shield wire. In areas with high bird use, collision risk can be avoided or minimized by marking the wire to increase visibility. To minimize avian risk, Grain Belt will develop an Avian Protection Plan in accordance with the suggested guidance and best practices identified by the Avian Power Line Interaction Committee. The Avian Protection Plan will evaluate potential risks to avian species and develop specific measures to avoid, minimize, and mitigate avian collisions with the transmission line.

Although it is the shortest route, Alternative Route A crosses the most wooded areas (131.8 acres) and wetlands (24.4 acres) compared with Route B which crosses the least forested lands and wetlands (90.2 and 12.8 acres, respectively). Both Routes A and B diminish potential impacts to bald eagle foraging by following a cross-country path farther east. Overall, Route B is observed as the best route for its limited interference with typical wildlife habitat in the Study Area.

[2] The aerial survey was performed in April 2012 via fixed-wing aircraft for the purpose of identifying bald eagle nests in the vicinity of the Grain Belt corridor screening study.

5.1.3 SPECIAL STATUS SPECIES

Resource Characteristics

Grain Belt coordinated with the USFWS and MDC to identify threatened and endangered species or sensitive species that may potentially be affected by the Project. The Routing Team used the USFWS Information for Planning and Consultation (IPaC) online tool to obtain a federal protected species resource list for the Study Area (USFWS 2022). A search of the Missouri Natural Heritage Program (MONHP) websites resulted in a list of threatened and endangered and rare wildlife and plant species with known current ranges within the counties where the Alternative Routes cross (MONHP 2022; MDC n.d.). **Table 5** presents all federally and state-listed species that may exist in the counties crossed by the Alternative Routes. Specific information for the location of known occurrences of federally threatened or endangered species is not publicly available in Missouri; therefore, potential impacts to sensitive species were analyzed by the potential for suitable habitat to occur along the Alternative Routes.

Federal Species

According to the USFWS' Missouri County Distribution of Federally-Listed Threatened, Endangered, Proposed, and Candidate Species list (USFWS 2022) and the Missouri Species and Communities of Conservation Concern Checklist (MDC n.d.), one federally threatened plant species (eastern prairie fringe orchid), seven federally endangered species (gray bat, Indiana bat, interior least tern, greater prairie chicken, western massasauga, Topeka shiner, and pallid sturgeon) and one federally threatened species (northern long-eared bat) have known current ranges within the counties crossed by the Alternative Routes (see **Table 5**). Additionally, all counties crossed by the Alternative Routes have potential habitat for Indiana bat, northern long-eared bat, interior least tern, and Topeka shiner.

Table 5. Federal and State Special Status Species

Common Name	Scientific Name	Status[1]	Habitat Association	Known Current Range Within Study Area		
				A	B	C
Mammals						
Gray bat	*Myotis grisescens*	FE/SE	Caves	X	X	X
Northern long-eared bat	*Myotis septentrionalis*	FT	Caves, mines, woodland, forest	X	X	X
Indiana bat	*Myotis sodalis*	FE/SE	Caves, mines, stream corridors, riparian, forest	X	X	X
Plains spotted skunk	*Spilogale putorius*	SE	Grassland, forest, brushy areas, cultivated land	X	X	X
Birds						

Table 5. Federal and State Special Status Species						
Common Name	**Scientific Name**	**Status[1]**	**Habitat Association**	**Known Current Range Within Study Area**		
				A	**B**	**C**
American bittern	*Botaurus lentiginosus*	SE	Marsh	X	X	X
Northern harrier	*Circus cyaneus*	SE	Marsh, grassland, shrubland	X	X	X
Interior least tern	*Sterna antillarum athalassos*	FE/SE	Bare alluvial deposits	X	X	X
Greater prairie-chicken	*Tympanuchus cupido*	SE	Grassland, oak woodland	X	X	X
Reptiles						
Western massasauga	*Sistrurus catenatus tergeminus*	SE	Bottomlands, wet grasslands	X	X	X
Fish						
Lake sturgeon	*Acipenser fulvescens*	SE	Mississippi and Missouri Rivers	-	-	-
Topeka shiner	*Notropis topeka*	FE/SE	Small to large streams	X	X	X
Pallid sturgeon	*Scaphirhynchus albus*	FE/SE	Mississippi and Missouri Rivers	-	-	-
Flathead chub	*Platygobio gracilis*	SE	Mississippi and Missouri Rivers	-	-	-
Plants						
Eastern prairie fringed orchid	Platanthera leucophaea	FT/SE	Mesic to wet prairies and meadows	X	X	X

[1]FE= Federally Endangered FT= Federally Threatened FPE= Federally Proposed Endangered FT/SA=Threatened/Similar Appearance SE=State Endangered ST=State Threatened

State Species

According to the information presented in **Table 5**, 10 state endangered species (four of which are also federally endangered and one listed as federally threatened) have known ranges within the counties crossed by the Alternative Routes. Most fish species are associated with the Missouri and Mississippi Rivers and are not likely to be impacted by the Project because the two rivers are located outside of the Study Area. Grain Belt will implement environmental protection measures, developed in coordination with MDC, to minimize any potential impacts to the state-listed endangered species from construction activities.

Alternative Route Comparison

None of the routes cross the Missouri or Mississippi Rivers. Therefore, no routes present anticipated impacts to the lake sturgeon, pallid sturgeon, and flathead chub. Furthermore, no

impacts are anticipated to aquatic species because the Project would span all streams and tributaries. Even though the project footprint is expected to avoid tributaries, construction equipment will still need to cross the tributaries. Grain Belt will employ best management practices and environmental protection measures to avoid and minimize impacts to environmental resources, including tributaries, from construction equipment. Therefore, construction activities are not proposed to take place within or nearby aquatic habitats that are designated as state or federal critical habitat for protected aquatic species.

From an overall special status species perspective, the removal of forested habitat was considered the main potential impact to both the Indiana bat and northern long-eared bat for the Alternative Routes. As mentioned in **Section 5.1.2**, the majority of the wooded areas occur farther south within the Study Area. By paralleling a greater distance of 69 kV transmission line, Route A travels farther eastward and requires the most tree removal through riparian areas. Route B diverts from the existing 69 kV transmission line farther westward, avoiding many of the wooded riparian areas. Like Route B, Alternative Route C travels west and south. A large amount of tree clearing required for Alternative Route C is parallel to the 345 kV transmission line. No known caves are crossed or are in the vicinity of the Alternative Routes; therefore, impact to potential habitat for gray bats is not anticipated. With these considerations, Route B requires the least amount of tree clearing and was therefore chosen as the best route from a special status species perspective.

State endangered species that are identified as occurring in counties crossed by the Alternative Routes are summarized in **Table 5**. Overall, Alternative Route B is most viable from a state status species perspective because the route crosses the fewest acres of potentially suitable habitat for state-listed species (forest and grassland).

5.1.4 GEOLOGY AND SOILS

Resource Characteristics

The Study Area is located within two physiographic ecoregions within the Dissected Till Plains of the Central Lowland physiographic province. The Study Area is predominately located within the Central Irregular Plains ecoregion with a small portion of its southern section located in the Interior River Valleys and Hills ecoregion (U.S. Environmental Protection Agency 2015). The Central Irregular Plains ecoregion represents underlaying karst topography. Relatively small areas in the south are located within the Interior River Valleys and Hills ecoregion. This ecoregion represents the most sensitive geological area because it is primarily underlain by karst topography.

Karst topography is characterized as being formed from limestone that readily dissolves in the presence of water; caves and sinkholes are formed by this process and can sometimes be a conduit to groundwater, making these areas environmentally sensitive. Caves and underground streams and rivers in karst areas provide habitat for animals specially adapted to this

environment. Common animals, including sensitive bat species, that hibernate and breed in these geological formations are considered in **Section 5.1.3**. Sinkholes and other karst features are not present in the Study Area.

The Study Area is divided into four major land resource areas with geographically similar land use, water, soil, topography, and physiography. The two major land resource areas are the Central Claypan Areas and Central Mississippi Valley Wooded Slopes (Western Part) (USDA 2006). In general, the soil associations for each of these major land use areas suggest soils are deep and productive, and not surprisingly, much of the area is used as cropland (USDA 2022). Major soil resource concerns include erosion via wind and water, and loss of organic matter through poor management practices (USDA 2006).

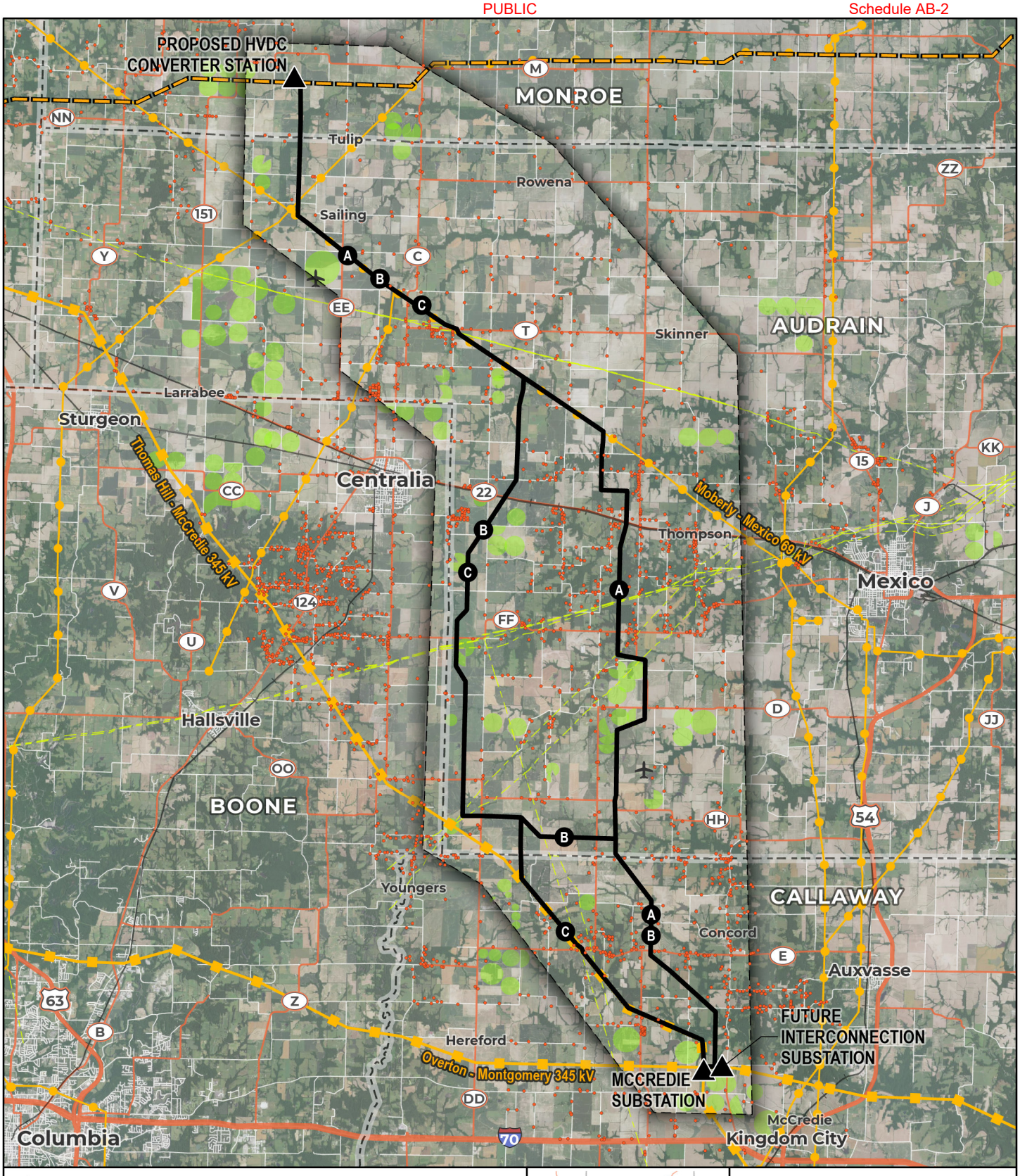
Alternative Route Comparison

As a result of the implementation of environmental protection measures similar to those discussed above and the limited footprint of permanent impacts on soil productivity created by the transmission structures themselves, any impacts to soils would likely be minor for all Alternative Routes; therefore, impacts on soil resources do not provide a usable comparison between all three Alternative Routes.

Karst topography, including sinkholes and caves, are not present in the Study Area. In general, there are no notable differences between the Alternative Routes with respect to soil resources. As discussed above, areas with karst would be identified prior to construction and avoided when possible.

5.2 HUMAN ENVIRONMENT

The human environment impacts may include direct and indirect impacts to residential, commercial, and industrial development, institutional uses (e.g., schools, places of worship, cemeteries, hospitals), cultural resources, and land use. A Study goal is to avoid or minimize conflicts with existing and proposed land uses that are not compatible with a new transmission line. A comparison of the human environment considerations for the Alternative Routes is presented in **Table 6** and shown in **Map 7**.



Project Endpoint
Alternative Route
Refined Study Area
Approved Grain Belt Express HVDC Route
County Boundary
Pipeline
Existing Transmission Line
69 kV
345 kV
Residence
Airport or Airstrip
Pivot Irrigation
Major Road

Map 7
Built Environment

Invenergy Transmission
wsp

0 1 2 3 4 5 Miles

5.2.1 AGRICULTURAL USE (FARM AND PASTURE/GRASSLAND)

Resource Characteristics

The Alternative Routes cross three counties in the state of Missouri including Monroe, Audrain, and Callaway. The predominant type of land use throughout the Study Area is agriculture and includes farmlands, range or grasslands, and pastures. The main crop commodities include soybeans, corn, and wheat. The main livestock commodities include beef and poultry (USDA NASS 2021). Market value of products sold for crop and livestock sales was estimated at approximately $7.3 billion dollars in 2021 in all three counties (USDA NASS 2021).

Land use is predominately cultivated fields interrupted by forests and grasslands. Grasslands are used for grazing cattle and for the production of hay to feed livestock in the winter. Most of the Study Area uses dry land farming techniques with select areas near water resources also using pivot irrigation systems. Land use, based on aerial imagery, is shown in **Map 7**.

Alternative Route Comparison

All three Alternative Routes cross a similar distance of agricultural land (see **Table 6**). Minimal vegetative clearing is required in agricultural areas and permanent impacts would be limited to the foundations of the structures and areas requiring permanent access roads. Access to these areas is typically straight forward, as farm tracks and dirt roads are common and the terrain is flat, reducing complications with heavy cut and fill road construction.

The Routing Team attempted to minimize impacts to cultivated croplands by following property boundaries and natural field breaks with alternative alignments. Based on these efforts and subsequent efforts to mitigate impacts on farmed properties during ROW negotiations, Grain Belt anticipates that agricultural land use impacts will generally be limited and similar across each Alternative Route.

Table 6. Human Environment Evaluation Criteria

Alternative Route	Unit	A	B	C
Length	miles	34.4	35.8	34.8
150-foot ROW	acres	626.1	650.4	632.9
Residential Resources				
Outbuildings within ROW	count	-	-	1
Residences within 250 feet centerline	count	2	1	4
Residences within 300 feet centerline	count	3	1	4
Residences within 500 feet centerline	count	3	1	7

Table 6. Human Environment Evaluation Criteria				
Alternative Route	**Unit**	**A**	**B**	**C**
Property Resources				
Parcels < 10 acres crossed	count	4	3	5
Parcels 10-30 acres crossed	count	5	6	7
Parcels 30-80 acres crossed	count	54	38	40
Parcels > 80 acres crossed	count	76	78	73
Total number of parcels crossed	count	139	125	125
Landowners in the ROW	count	103	89	84
Pivot irrigation within 500 feet	count	2	-	-
Land Use				
Agriculture	acres	402.8	467.9	438.4
Developed	acres	6.9	6.1	6.7
Forest	acres	131.8	90.2	98.0
Grassland/Pasture	acres	82.0	84.2	86.6
Residential	acres	0.3	0.3	1.2
Open Water	acres	2.3	1.8	1.9
Utility Parallel				
345 kV transmission line	miles	0.7	0.7	7.8
69 kV transmission line	miles	9.6	7.0	7.0
State or local road	miles	0.5	-	-
Parcel boundaries	miles	9.4	11.1	8.3
Transmission line parallel	percent	30%	21%	42%
State or local road parallel	percent	1%	-	-
Parcel boundary parallel	percent	27%	31%	24%
Total Percent ROW Parallel	percent	**31%**	**21%**	**42%**

5.2.2 EXISTING AND PROPOSED DEVELOPED LAND USE

Resource Characteristics

The Study Area is located within Union Township, Monroe County; Sailing and Wilson Townships, Audrain County; Liberty and McCredie Townships, Callaway County; and Centralia and Rocky Fork Townships, Boone County, Missouri. The majority of the Study Area is agricultural, consisting of grasslands, pasture, and cultivated crops. Wooded areas are concentrated adjacent to streams and waterbodies, including Long Branch, Scattering Branch, Goodwater Creek, Youngs Creek, Little Skull Lick Creek, Skull Lick Creek, Possum Walk Creek, Mayes Creek, Davis Creek, Hitt Branch, Scattering Fork, Beaverdam Creek, Bynum Creek, Fourmile Branch, Lick Branch, Leeper Branch, Rocky Branch, and Auxvasse Creek. As shown on

Map 7, development outside of the Study Area is heaviest within the Cities of Centralia and Mexico. As discussed in greater detail in **Section 5.1.2**, the MDC Northcutt Memorial Conservation Area is located in the northeastern portion of the Study Area. The privately owned Centralia Civil War Battlefield is located southeast of Centralia, along the western boundary of the Study Area. The battlefield is recognized for the September 27, 1864, massacre on the grounds (Columbia Convention and Visitors Bureau 2018).

As discussed in greater detail in **Section 5.3.3**, existing linear infrastructure within the Study Area was identified by the Routing Team as routing opportunities, including the existing Moberly - Mexico 69 kV Transmission Line and Thomas Hill - McCredie 345 kV Transmission Line. State and local roads were considered for routing, but none were viable options within the Study Area. Multiple oil and gas pipelines also intersect the Study Area.

As shown on **Map 7**, two private airstrips are present in the Study Area: one is approximately 0.8 mile south of the existing 69 kV transmission line and the other is 0.5 mile south of the Highway D/Audrain Road 953 intersection. No public airports are located within the Study Area. The closest public airports are the Mexico Memorial Airport, located 7.6 miles east of the Study Area, and the Elton Hensley Memorial Airport in Fulton, located 8.6 miles south of the Study Area.

Pivot irrigation systems are present throughout the Study Area. Existing oil and gas pipeline corridors are also present throughout the Study Area, predominately south of Centralia and west and north of Mexico. Crossings of both pivot irrigation and oil and gas pipelines were considered constraints and avoided.

During the public meetings (**Section 3.2.1**), members of the public mentioned the proposed development of a new solar farm northwest of Kingdom City, Callaway County. Ranger Power plans to lease approximately 3,000 acres of land, but the overall footprint of the solar project will be smaller. The solar project is located north of McCredie Substation and south of Auxvasse Creek in the southern portion of the Study Area (Columbia Missourian 2022).

Alternative Comparison

Development across the Study Area is relatively low density. A majority of the land is used for agricultural purposes. Developed lands are centered near cities, including Centralia and Mexico but sparsely located in the Study Area. As shown on **Map 7**, existing transmission lines are located in the northern and southern portions of the Study Area. Land use across all three Alternative Routes is similar. The northern, western, and southwestern portions of the area are composed nearly exclusively of farm fields used for cultivated crops and grasslands/pastures. Windbreak woodlots and hedgerows are less frequent. Much of the forest cover occurs in riparian zones.

As shown in **Table 6**, Alternative Route C parallels an existing transmission line for nearly 43% of its length. Alternative Routes A and B only parallel existing transmission lines for 30% and 21% of their length, respectively. Typically, paralleling transmission lines for a longer distance

provides opportunity for Grain Belt to potentially use existing access. However, in some areas, this increases impacts to existing residences that are located in proximity to existing transmission lines.

Alternative Route C has the most residences within 500, 300, and 250 feet of the centerline. Alternative Routes A and B have fairly similar numbers, although Alternative Route B has the fewest residences within 500, 300, and 250 feet. Grain Belt evaluated potential options to avoid coming so close to residences within 300 feet. The Routing Team noted that the residence within 300 feet of Route B could be avoided if the centerline were shifted during detailed engineering. The residence is located on a large parcel that gives Grain Belt room to avoid the house without impacting new landowners. The location of this residence is adjacent to the shared corridor of Routes A, B, and C. The remaining two residences located within 300 feet of Route A could be avoided if Grain Belt adjusted the route farther away from the houses, although this adjustment would move the route away from a parcel boundary and reduce the overall parcel boundary parallel. Inversely for Route C, shifting the centerline of the remaining three residences within 300 feet of the route affects additional landowners.

All the Route Alternatives pass through a similar number of properties: Alternative Route A crosses the most at 139, with Alternative Routes B and C both crossing 125. However, Alternative Route B crosses more land per property compared with Alternative Route A, which is the shortest route.

Regardless of the route chosen between the proposed HVDC converter station, McCredie Substation, and a future interconnection substation, a new 345 kV transmission line will result in at least some aesthetic impact to the existing landscape. Pivot irrigation systems in proximity to the routes mitigate aesthetic impact for a new 345 kV transmission line as the existing landscape is already altered by infrastructure. The proposed solar farm northeast of McCredie Substation further mitigates aesthetic impacts for a new line, especially for Alternative Routes A and B, which both span over the property. Because Alternative Route A requires substantial tree clearing and Alternative Route C has more residences within 250 feet, it is likely that both routes will have incrementally more aesthetic impacts than Route B. Alternative Route B likely has the least aesthetic impact as it passes by less residences within 300 feet of its centerline and requires less tree clearing. Regardless of the route chosen, new aesthetic impacts are anticipated, as the existing landscape will be altered by a new 345 kV transmission line.

From an existing and proposed development perspective, Alternative Route B appears to have the least potential impact. Grain Belt will coordinate with property owners along the Proposed Route to determine if there are specific design or construction measures or preferences that can be incorporated to minimize potential impacts to existing and proposed development.

5.2.3 HISTORIC AND ARCHAEOLOGICAL RESOURCES

Archaeological and Architectural Resources

Cultural resources generally refer to historic and prehistoric archaeological resources and historic architectural resources. Impacts on architectural historic properties would be primarily visual from the construction of new structures and transmission line. Impacts would vary based on local topography, height of existing vegetation, and any intervening recent development. Aesthetic impacts to architectural historic properties would be mitigated, where practical, by strategically locating access routes, staging areas, and structures. No listed or eligible architectural resources on the National Register of Historic Places (NRHP) are located within the Study Area, which includes an area extending out to 0.5 miles from the Alternative Routes.

Based on a preliminary desktop review of available data, five known archaeological resources were identified within the southern portion of the Study Area. According to site file information gathered from the Missouri State Historic Preservation Office (SHPO) database, there are no records that any of the sites have been evaluated for NRHP eligibility.

Electric transmission lines do not typically affect buried archaeological resources as the structures can usually be located to avoid specific sites, and the ground disturbance footprint is small. Aboveground archaeological sites can also be avoided where possible. Where practical, archaeological resources that are identified within the transmission line corridor, in the direct path of any needed access routes, or at the locations of proposed work areas will be avoided; this is accomplished by spanning the resource or, if necessary, shifting transmission structure positions, re-routing access, and reconfiguring or relocating work areas. An initial coordination letter was sent to the State Historic Preservation Office (SHPO) within the Missouri Department of Natural Resources informing them of the Project; however, additional Project information on the Proposed Route will need to be provided to the SHPO before obtaining official notice of potential listed or eligible archaeological resources.

Alternative Route Comparison

From a historic and archaeological resource perspective, no Alternative Route is more favorable than another. No listed or eligible NRHP architectural sites were identified in the Study Area of the Alternative Routes. Based on a preliminary desktop review, two previously identified archaeological resources are crossed by the Alternative Routes. The southwestern resource is crossed by the existing 345 kV transmission line and Route C, while the other is crossed by Routes A and B south of Auxvasse Creek. Both archaeological resources have unknown statuses and no descriptive properties in the database search for relative NRHP or SHPO determination.

5.3 CONSTRUCTABILITY

Potential engineering and construction challenges are important to consider when routing a transmission line. Major factors that affect constructability include, but are not limited to, condensed ROWs, sharp turn angles, existing infrastructure, distance, construction access, and operation and maintenance access. These are all elements that could ultimately require extensive or non-standard engineering and lead to increased impacts to overall Project schedule and cost. A comparison of the engineering and construction considerations for the three Alternative Routes is presented in **Table 7**.

5.3.1 ENGINEERING

Land features and characteristics that require more complicated design or construction are considered engineering constraints. This includes but is not limited to existing facilities, paralleling and crossing existing transmission lines, constraints such as airfields, turn angle structures, pivot irrigation, and terrain (slopes/valleys/waterbodies that require longer spans). Engineering constraints often require consideration from multiple perspectives as some impacts may be offset by other benefits. For example, paralleling existing infrastructure and crossing over/under transmission or distribution lines and pipelines can require specialized construction techniques and scheduled outages on the existing lines. At the same time, paralleling existing infrastructure like roads and transmission lines can reduce access road construction needs and overall ROW acquisition.

As mentioned later in **Section 5.3.3**, the primary linear infrastructure features recognized as siting opportunities include the existing Moberly – Mexico 69 kV Transmission Line and Thomas Hill – McCredie 345 kV Transmission Line. Grain Belt sought to minimize impacts to residences by paralleling the Moberly – Mexico 69 kV Transmission Line and Thomas Hill – McCredie 345 kV Transmission Line for as long as possible. However, existing development abuts the transmission lines in several locations within the Study Area.

Alternative Comparison

As discussed in **Section 4.2**, paralleling existing transmission lines is considered an opportunity as it minimizes fragmentation of existing land uses, and reduces the visual impact of a new transmission line. Alternative Routes C parallels the most existing HV existing transmission lines. Route A parallels the existing 69 kV transmission line the greatest distance, while Route B parallels the least overall existing HV existing transmission lines.

Because crossing existing transmission infrastructure inherently increases reliability concerns as well as operational and engineering design challenges. Therefore, the Alternative Routes were developed to reduce the number of crossings required. Crossings of other 345 kV transmission lines are to be avoided when possible, to avoid challenges with outage requirements for normal

operations and maintenance. Therefore, the Alternative Routes were developed to reduce the number of crossings required. All Alternative Routes cross the existing transmission line once north of McCredie Substation. Similarly, all routes cross existing 69 kV transmission lines twice in the northern and central portions of the Study Area. The first 69 kV transmission line crossing takes place west of Sailing along the shared corridor. The second 69 kV crossing occurs the routes split, before the Youngs Creek crossing along Routes B and C and north of the Skull Lick Creek crossing along Route A. Route A paralleling the north side of the existing Moberly – Mexico 69 kV Transmission Line eliminates extra 69 kV crossings north of Centralia. Similarly, Route C paralleling the north side of the existing Thomas Hill – McCredie 345 kV Transmission Line minimizes crossing multiple 345 kV lines to enter McCredie Substation and the future interconnection substation.

All Alternative Routes are located within 1 mile of two private airfields (see **Map 7**). The northwestern airfield is located south of the routes shared corridor, west of State Highway EE. The alignment of the runway is in a north/south orientation, whereas the existing transmission lines in the vicinity are along a northwest/southeast alignment and along the northern side of the airfield. The Alternative Routes parallel the north side of the existing 69 kV transmission line in this area. The southeastern airfield is located generally east of Route A and north of Highway HH. The alignment of the runway is in a southwest/northeast alignment. Route A is located approximately 0.5 miles west side of the runway. As is standard practice, Grain Belt will file structure heights and locations to conduct consultation with the FAA regarding potential aviation impacts. Mitigation, if needed, will be specified by the FAA and will be adhered to throughout design and construction.

Line angles and the related need for more substantial structures can significantly increase construction timeframe, thus having a larger impact on landowners and overall Project cost. The Routing Team compared the Alternative Routes with respect to the need for angle structures greater than 10° (i.e., the sharpest turns requiring the most robust structures). Alternative Route B contains slightly more angle structures than Routes A and C, thus Alternative Routes A and C are the more favorable from an angle perspective. From an engineering and constructability perspective, proximity to pivot irrigation poses the risk of structural damage to transmission line equipment and increases potential impacts to landowners. By paralleling the 69 kV transmission line a greater distance, Route A traverses within 500 feet of two pivot irrigation systems north and south of State Route D. No other Alternative Route crosses within 500 feet of pivot irrigation.

From a purely design and engineering perspective, Routes A and C require fewer angle structures than Route B. Both Routes B and C avoid pivot irrigation while Route A passes near two such systems. Route A also crosses approximately twice as much length within 1 mile of private airfields than Routes B and C. Therefore, although it's a slightly shorter route, Alternative Route A is less desirable than Routes B or C from an engineering perspective.

Table 7. Constructability Evaluation Criteria				
Alternative Route	**Unit**	**A**	**B**	**C**
General				
Length	miles	34.4	35.8	34.8
150-foot ROW	acres	626.1	650.4	632.9
Transportation Resources				
State highway crossings	count	1	1	1
State route crossings	count	9	8	8
County/local road crossings	count	18	20	20
Public airfields (FAA notification zones crossed)	miles	-	-	-
Private airfields (length of centerline within 1 mile)	miles	5.7	2.3	2.3
Utility Resources				
Existing oil and gas pipeline crossings	count	9	10	11
Existing oil and gas pipeline ROW crossings[3]	count	4	6	7
Existing 345 kV transmission line crossings	count	1	1	1
Existing 69 kV transmission line crossings	count	2	2	2
Communication towers within 1,000 feet of the centerline	count	-	-	-
Pivot Irrigation crossings within 500 feet of the centerline	count	2	-	-
Engineering and Geotechnical Considerations				
Angle Structures (4 to 10°)	count	2	1	2
Angle Structures (10 to 30°)	count	5	3	6
Angle Structures (30 to 60°)	count	8	16	12
Angle Structures (60 to 90°)	count	8	4	4
Total Angle Structures greater than 10°	count	**21**	**23**	**22**
Rights-of-Way Parallel				
Existing 345 kV transmission lines paralleled	miles	0.7	0.7	7.8
Existing 69 kV transmission lines paralleled	miles	9.6	7.0	7.0
State or Local Road paralleled	miles	0.5	-	-
Infrastructure Parallel (% of total)	percent	**31%**	**21%**	**42%**
Parcel Boundary paralleled	miles	9.4	11.1	8.3
Total length paralleled (% of total)	percent	**58%**	**52%**	**66%**

[3] Some existing oil and gas pipeline ROWs contain multiple pipelines.

5.3.2 ACCESS ROUTES

Permanent access routes are not anticipated for the Project. Access to routes across agricultural fields could be challenging if weather causes wet conditions, as could access to routes that parallel existing transmission lines. In some cases, existing dirt access routes and local roadways may require improvements to accommodate construction equipment. Permanent and temporary earth disturbance may require erosion and sedimentation control plans, National Pollutant Discharge Elimination System permits, and other permits with federal, state, and local jurisdictions.

Alternative Routes Comparison

Proximity to existing roads is important for construction access and future maintenance. Adjacent roads throughout the Study Area also offer suitable solutions to access transmission structures for all routes. Along with roads, large agricultural properties within the northern, western, and southern portions of the Study Area have several dirt accesses to fields for plowing. Generally, all three Alternative Routes traverse areas with suitable access, as they all parallel parcel boundaries for over 24% of their respective routes. As mentioned later in Section 5.3.3, there are advantages to paralleling existing transmission lines and using existing access routes. Alternative Routes A and C both parallel transmission lines for at least 30% of their respective routes. Overall, from an access route perspective, Alternative Route C is more suitable as it parallels transmission lines and agricultural property boundaries for the greatest extent of its route.

5.3.3 EXISTING UTILITY RIGHTS-OF-WAY

Resource Characteristics

Existing utility ROWs are considered an opportunity when routing and siting new linear utility infrastructure. Paralleling existing linear utilities consolidates utility corridors, logically placing a new land use feature in close alignment with an existing similar land use feature, thereby avoiding the fragmentation of existing land uses and sensitive habitats. In addition, paralleling existing transmission lines can reduce the overall impact of the new transmission line on sensitive viewsheds (e.g., historic sites and outdoor recreational areas) and airfield flight zones, since any impacts of the new line are considered with respect to the impacts of the existing line. In these areas, the impacts of the new line are not considered new impacts in otherwise unimpacted areas; instead, they are considered incremental to existing impacts.

Section lines and property boundaries are preferred demarcations similar to existing infrastructure. The Routing Team aligned routes along section/parcel boundaries in the absence of, or as an alternative to, parallel alignments along existing linear infrastructure if existing land use would be more impacted by the Project otherwise. This was most relevant in farmed areas, where farming operations extend to the edge of the property boundary. All Alternative Routes

parallel existing electric transmission lines, pipelines, or section/parcel boundaries for some portion of their length (see **Table 8**).

Alternative Routes Comparison

Engineering constraints (discussed more in **Section 5.3.1**), often require consideration from multiple perspectives as some impacts may be offset by other benefits. For example, crossings over/under transmission or distribution lines and pipelines can require specialized construction techniques and scheduled outages on the existing lines. At the same time, paralleling existing infrastructure like existing transmission lines and roads can also reduce access route construction needs and can reduce overall ROW acquisition. The primary linear infrastructure features recognized as siting opportunities include the existing Moberly – Mexico 69 kV Transmission Line and Thomas Hill – McCredie 345 kV Transmission Line. All three Alternative Routes parallel the existing 69 kV transmission line along a shared corridor for 7 miles of their respective routes. Alternative Route A parallels the 69 kV transmission line an additional 1.6 miles. In the southern portion of the Study Area, Routes A and B continue mostly greenfield towards McCredie Substation while Route C predominately parallels the existing 345 kV Transmission Line for approximately 7.8 miles.

While parallel opportunities were limited, the Routing Team identified road ROW as a paralleling consideration. Route A parallels road ROW for 0.5 mile of its route. Alternative Routes B and C do not parallel roads.

Overall, Alternative Route C parallels existing transmission lines for the greatest length among all Alternative Routes, but it also has the most existing homes within close proximity. Alternative Routes A and B also parallel a large percentage of existing linear infrastructure. In areas where paralleling existing linear features was not possible, the Routing Team attempted to parallel section/parcel boundaries. Alternative Route B parallels parcel boundaries for over 31% of its route, avoiding impacts to residences located adjacent to existing transmission lines (see **Section 5.2.2**). For this reason, Alternative Route B is preferred because it minimizes impacts to the existing landscape and environment.

6 IDENTIFICATION OF THE PROPOSED ROUTE

As stated in the introductory sections, the goal in selecting a suitable route for the Project is to minimize impacts on the natural, cultural, and human environment while avoiding circuitous routes, extreme costs, and non-standard design requirements. It is not possible to optimally minimize all potential impacts at all times. There are often inherent tradeoffs in potential impacts with every routing decision. For example, in central Missouri much of the landscape is either actively cultivated agricultural fields, forested areas, or scattered residential areas. A route that has the greatest proximity from homes would likely have more impact on agriculture and a greater quantity of forest clearing than a route that avoided those resources. Thus, an underlying goal inherent to a routing study is to reach a reasonable balance between minimizing potential impacts on one resource and increasing the potential impacts on another.

The following section presents the rationale for selection of the Proposed Route, which is the route that the Routing Team considered to best minimize impacts of the Project overall. The rationale is derived from the accumulation of the routing decisions made throughout the process, the knowledge and experience of the Routing Team, comments from the public and regulatory agencies, and comparative analysis of potential impacts presented in Section 5.

Alternative Route A

Advantages

- Shortest overall length (34.4 miles)
- Fewest structure angles greater than 10 degrees (21)
- No barns, outbuildings, or silos within the ROW (0, same as B)
- Fewest county or local roads crossed (18)
- Fewest existing oil and gas pipelines crossed (9)

Disadvantages

- Crosses the edge of two center pivot irrigation systems (2)
- Most parcels crossed (139) and most landowners crossed (103)
- Greatest acreage of non-riverine wetlands within ROW (19)
- Greatest acreage within FEMA-designated floodplain (43.4)
- Greatest acreage of tree clearing required within ROW (131.8)

Alternative Route B

Advantages

- Fewest heavy angles greater than 60 degrees (4, same as C)
- Fewest residences within 250 feet (1) and 500 feet (1) of the centerline
- No center pivot irrigation crossings (0, same as C)
- Fewest small parcels (<10 acres) crossed (3)
- Fewest total parcels crossed (125, tied with C)
- Greatest length parallel to parcel boundaries (11.1 miles)
- Fewest streams crossed (40)
- Least riverine (5.1 acres) and non-riverine (7.7 acres) wetlands within ROW
- Least acreage within FEMA floodplains (23.6)
- Least acreage of tree clearing within ROW (90.2)

Disadvantages

- Greatest overall length (35.8 miles)
- Shortest length parallel to existing 345 kV lines (0.7 miles, same as A)
- Shortest overall percentage of existing transmission line parallel (21%)
- Most structure angles >10 degrees (23)

Alternative Route C

Advantages

- No center pivot irrigation crossings (0, same as B)
- Fewest total parcels crossed (125, tied with B)
- Fewest total landowners crossed (84)
- Greatest length parallel to existing 345 kV transmission lines (7.8 miles)
- Greatest percentage of length parallel to existing transmission lines (66%)
- Fewest waterbodies crossed (2)

Disadvantages

- Most residences within 250 feet (4) and 500 feet (7) of the centerline
- Most small parcels (<10 acres) crossed (5)

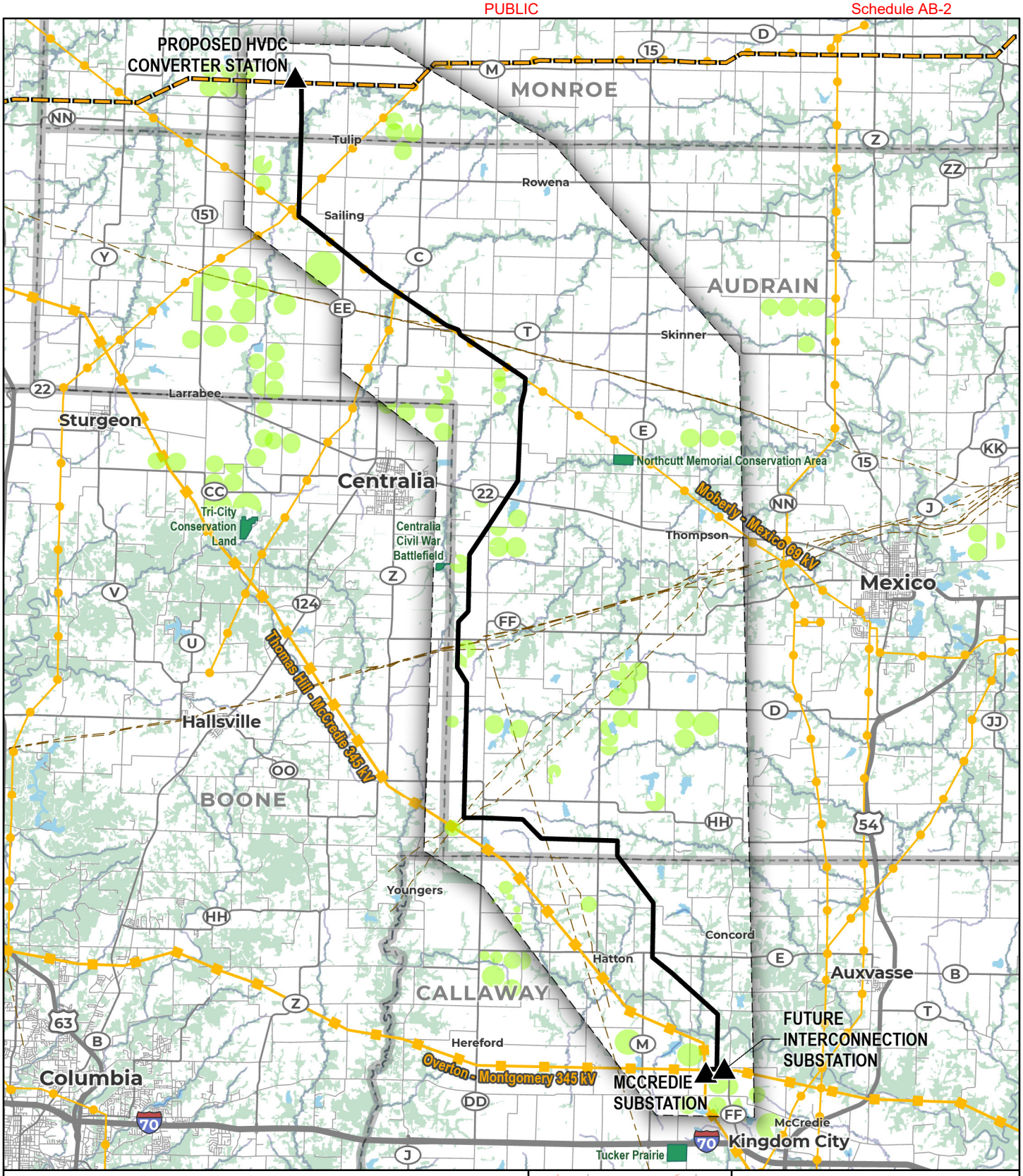
- Shortest length parallel to parcel boundaries (8.3 miles)
- Most gas pipeline crossings (11)
- Most streams crossed (51) and most named streams crossed (19)
- Most riverine wetlands within ROW (6.6 acres)

The Routing Team recommends **Alternative Route B** as the Proposed Route for the Project (**Map 8**). This route meets the overall goal of minimizing impacts on the natural, human, and historic resources, while making the best use of aligning with existing divisions of land by paralleling parcel boundaries, field lines, and existing infrastructure.

The selection of **Alternative Route B** is reasonable and sound for the following reasons:

1. Development of the Alternative Routes integrated input from government agencies, local officials, and the general public into route development, analysis, and selection

2. It optimally minimizes the overall effect of the Project on the natural and human environment while avoiding circuitous routes, unreasonable costs, and special design requirements.



Map 8
Proposed Route

Invenergy Transmission

wsp

0 1 2 3 4 5 Miles

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Route Selection Study
Addendum Appendices
Appendix A through Appendix B

August 2022

Prepared for:
Tiger Connector
An Invenergy Transmission Project

Prepared by:

WSP USA INC

300 Wyandotte Street
Kansas City, MO 64105

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Appendix A: Routing Team

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Member	Affiliation	Title	Specific Role
Henry Abrams	Invenergy Transmission	Project Engineer, Renewable Electrical Engineering	Engineering and siting support
Jason Brown	Invenergy Transmission	Director of Land and Community Affairs	Public outreach
Margaret Campbell	Invenergy Transmission	Senior Analyst, Transmission Public Affairs	Public outreach
Kevin Chandler	Invenergy Transmission	Director, Transmission Business Development	Project director, project development, public outreach, and siting support
Gunnar Dickey	Invenergy Transmission	Associate, Transmission Development	Project development and siting support
Brad Fine	Invenergy Transmission	Manager, Transmission Development	Public outreach and siting support
Cristian Hernandez	Invenergy Transmission	Associate, Transmission Development	Project development and siting support
Dia Kuykendall	Invenergy Transmission	Director of Public Affairs	Public outreach
Brad Pnazek	Invenergy Transmission	Vice President, Transmission Development	Project development, siting support, public outreach
Ryan Raichelson	Invenergy Transmission	Senior Analyst	Project development and siting support
Jen Stelzleni	Invenergy Transmission	Senior Manager, Environmental Compliance & Strategy	Environmental lead and siting support
Aaron White, PE	Invenergy Transmission	Senior Transmission Engineering Manager, Electrical Engineering	Engineering and siting support
Patrick Whitty	Invenergy Transmission	Senior Vice President, Invenergy Transmission	Project director, siting support, public outreach
Aaron Baker	Clout Public Affairs	Vice President	Public Outreach
Greg Smith	CLS	Lead Land Representative	Public outreach
Adam White	CLS	Director of Utilities	Public outreach
Ron Gillett	Invenergy Transmission	Field Representative-Community Relations	Public outreach
Jack Cardetti	Tightline Public Affairs	President	Media, public outreach

Member	Affiliation	Title	Specific Role
Chris Deffenbaugh	HDR	Strategic Communications Section Manager (MO/KS)	Public outreach
Katie Hatfield Edstrom	HDR	Strategic Communications Section Manager (IL/IN/MI)	Public outreach lead and siting support
Maggie LaMar	HDR	Senior Communications Coordinator	Public outreach and siting support
Cindy Largent	HDR	Real Estate Services Agent	Public outreach
Todd Muehlich	HDR	Senior Real Estate Services Agent	Public outreach
Andrew Burke	WSP	Senior Lead Consultant	Siting lead and public outreach
Miranda Bush	WSP	Senior Consultant	Siting support
Linda Green	WSP	GIS Analyst	Siting support and public outreach
Jay Puckett	WSP	Associate Vice President, Geospatial Technology	Siting lead and public outreach

Appendix B: Data Sources

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Category	Definition	Data Source	Last Updated
Aerial Photography			
National Agricultural Imagery	Missouri National Agricultural Imagery Program 2020	The National Agricultural Imagery Program (NAIP) obtains aerial imagery during agricultural growing seasons. The most current imagery for the State of Missouri when the project began was taken in 2020. Imagery is collected at the spatial resolution of 0.6 square meters and with the spectral resolution as natural color.	2020
ESRI World Imagery	Seamless high-resolution imagery basemap	ESRI hosts a continuous worldwide imagery layer compiled from various commercial imagery providers, state and local governments, and the GIS user community. Imagery in the vicinity of the project was collected between 2016-2019 and is typically available at a spatial resolution of up to 0.5 square meters.	2016-2019
Natural Resources			
Hydrology			
Streams	National Hydrography Dataset flowlines	A statewide subset of the National Hydrography Dataset (NHD) was downloaded from the United States Geological Survey (USGS). Feature classes used for calculations included canal/ditch, stream/river (intermittent and perennial), artificial path, and any named features. A member of the Routing Team verified each stream/river crossing point using 2020 NAIP imagery.	2022
Water bodies	National Hydrography Dataset waterbodies	A statewide subset of the NHD was downloaded from USGS.	2022
Wetlands	National Wetlands Inventory	National Wetland Inventory (NWI) data were downloaded from the U.S. Fish and Wildlife Service's (USFWS) website.	2022
Floodplains	100 and 500-year floodplains	The Federal Emergency Management Agency (FEMA) Map Service Center provides digital downloads of its National Flood Hazard Layer. Floodplain data was used to approximate the length of floodplains crossed by the project.	July 2022

Category	Definition	Data Source	Last Updated
Protected and Public Lands			
Public and Conservation Lands	Local, private, state, and federally owned conservation lands and easements	This data layer represents features from a wide variety of sources, including the USGS Protected Areas Database (PADUS v2.1); U.S. Army Corps of Engineers; National Resource Conservation Service (NRCS); USFWS; U.S. Forest Service; the Nature Conservancy; National Conservation Easement Database; Missouri Department of Natural Resources; Missouri Department of Conservation; Missouri Spatial Data Information Service, and parcel boundaries provided by Audrain, Monroe, and Callaway Counties.	July 2022
Sensitive Species and Habitat			
Gray bat, Indiana bat, and Northern long-eared bat Habitat	Potential habitat crossed by route	USFWS publishes a list of federally listed threatened, endangered, proposed, and candidate species by county. Because all Study Area counties are listed as potential habitat for all three endangered bat species (Gray bat, Indiana bat, and Northern long-eared bat), habitat for these species was calculated using forest areas as determined by the Photo-Interpreted Land Cover dataset.	2022
Important Bird Areas	Notable bird habitat areas and flyways	The Nature Conservancy – Illinois Chapter provided data showing areas identified as Important Bird Areas in Illinois. Important Bird Areas provide crucial habitat for species of conservation concern and avian species vulnerable due to their limited range or high congregation density.	2022

Category	Definition	Data Source	Last Updated
Soils and Land Use			
Karst		Data depicting regions of karst topography were acquired from USGS (via the National Atlas Map).	2015
Photo-Interpreted Land Cover	Land cover classification based on aerial imagery interpretation	The 2020 NAIP imagery was used to identify simplified land cover, classified into forested areas, agriculture, grassland/pasture, developed areas, and residential areas.	2020
Human Environment			
Residences	Residences within 250, 300, and 500feet	Building footprints were collected from Bing's building footprints layer and were classified into structure types, including but not limited to residences, outbuildings, commercial buildings, schools, and places of worship. Classifications were initially based on aerial photo interpretation using the NAIP 2020 imagery, and structure types were later verified through field reconnaissance and information provided by landowners at public meetings.	July 2022
Schools, Places of Worship, Cemeteries	Features within 1,000 feet of route	The locations ofplaces of worship, schools, and cemeteries were derived from the USGS Geographic Names Information System (GNIS) and augmented through high resolution aerial photo interpretation, field reconnaissance, and public outreach efforts. The GNIS database serves as the federal government's repository of information regarding feature name spellings and applications for features in United States.	July 2022
Parcels	Tax parcel boundaries	The routing team contacted counties in the Study Area (Monroe, Audrain, and Callaway) and purchased parcel data from the county or their designated parcel data manager. Purchased parcel data included digital files identifying parcel boundaries and owner name, mailing address, parcel address (if available), parcel identification number, and legal description.	July 2022

Category	Definition	Data Source	Last Updated
Pivot Irrigation Systems	Pivots impacted	Pivot irrigation systems were digitized using high resolution aerial image interpretation. Members of the public were also encouraged to provide information about existing or planned pivot irrigation systems on their land, and this data aided in digitizing and verifying pivot locations. A pivot is considered potentially impacted when a potential route crosses more than 800 feet of irrigated area in a single span.	July 2022
Household Density	Households per square mile	Housing density was derived from the U.S. Census Bureau's 2020 Decennial Census data and calculated by dividing the number of households in each census block by the area in square miles of each census block. Classified household density ranges (0-5, 6-10, 11-20, 12-40, and 40+ households per square mile) were established in the 2014 Missouri Route Selection Study and generally indicate the difficulty of routing a transmission line that avoids residences through a given area.	2020
Energy Infrastructure			
Transmission Lines	Centerlines, ownership, and voltages of existing electric transmission lines	Information on existing transmission lines was collected from Platts Transmission Lines geospatial data layer and the Homeland Infrastructure Foundation-Level Data (HIFLD) electric transmission lines dataset . The information was augmented through aerial photo interpretation and field review.	May 2022
Oil and Gas Pipelines	Approximate centerlines of existing interstate pipelines	Major natural gas and oil pipeline information was digitized from the National Pipeline Mapping System (NPMS) online viewer. NPMS limits the scale of the public data viewer for security reasons, so all pipeline locations are considered approximate until detailed engineering surveys can be completed. Locations of local or intrastate pipelines were determined based on information provided by landowners, aerial photo interpretation, and pipeline markers visible from public rights of way.	July 2022
Transportation			

Category	Definition	Data Source	Last Updated
Major and Local Roads	Interstates, U.S. Highways, State Highways and Routes, Local Roads	Roads data was downloaded from the Missouri DOT website.	2020
Airport and Heliport Notification Zones	Airport points and Federal Aviation Administration Notification Zone	The location of airports and heliports was gathered from Federal Aviation Administration databases, aerial photograph interpretation, field reconnaissance, public input, and navigational charts. An approximation of the air navigation obstruction zone was developed based on the Code of Federal Regulations (CFR) Title 14 Part 77, (Aeronautics and Space, Objects affecting navigable airspace). This approximation was calculated based on aerial interpretation of runway length, the average height of the proposed transmission towers, and approach zone formulas for airports and heliports in the CFR. Note: this is a rough approximation performed based on aerial photo interpretation without the inclusion of topographic effects or precise knowledge of runway length.	May 2022
Historic Resources			
Historic and Archaeological Sites		The Illinois State Historic Preservation Office provided shapefiles showing locations of sites and districts listed on the National Register of Historic Places and a geodatabase with spatial and tabular data for archaeological sites across the state.	February 2022