Spire STL Pipeline Project

Resource Report 2
Water Use and Quality

FERC Docket No. CP17-40-_ _ _

Amendment to FERC Application
April 2017

Public

RESOURCE REPORT 2 - WATER USE AND QUALITY	
SUMMARY OF FILING INFORMATION	
Information	**Found in**
1. Identify all perennial surface waterbodies crossed by the proposed project and their water quality classification - Title 18 Code of Federal Regulations (CFR) part (§) 380.12(d)(1)	Sections 2.2.1, 2.2.2, and Table 2.2-2.
2. Identify all waterbody crossings that may have contaminated waters or sediments - 18 CFR § 380.12(d)(1)	Sections 2.2.2.1, 2.2.2.2, and Table 2.2-2.
3. Identify watershed areas, designated surface water protection areas, and sensitive waterbodies crossed by the proposed project - 18 CFR § 380.12(d)(1)	Sections 2.2.2.3, 2.2.2.4, and Table 2.2-3.
4. Provide a table (based on National Wetlands Inventory [NWI] maps if delineations have not been done) identifying all wetlands, by milepost and length, crossed by the proposed project (including abandoned pipeline), and the total acreage and acreage of each wetland type that would be affected by construction - 18 CFR § 380.12(d)(1,4)	Section 2.3.1, Table 2.3-1, Table 2.3-2, and Appendix 1-B.
5. Discuss construction and restoration methods proposed for crossing wetlands, and compare them to staff's Wetland and Waterbody Construction and Mitigation Procedures - 18 CFR § 380.12(d)(2)	Section 2.3.2.3 and Table 2.3-1.
6. Describe the proposed waterbody construction, impact mitigation, and restoration methods to be used to cross surface waters and compare to the staff's Wetland and Waterbody Construction and Mitigation Procedures - 18 CFR § 380.12(d)(2)	Section 2.2.6.1 and Table 2.2-2.
7. Provide original NWI maps or the appropriate state wetland maps, if NWI maps are not available, that show all proposed facilities and include milepost locations for proposed pipeline routes - 18 CFR § 380.12(d)(4)	Appendix 2-G.
8. Identify all U.S. Environmental Protection Agency - or state-designated aquifers crossed - 18 CFR § 380.12(d)(9)	Section 2.1.1.

RESOURCE REPORT 2 - WATER USE AND QUALITY	
INFORMATION RECOMMENDED OR OFTEN MISSING	
Information	**Found in**
1. Identify proposed mitigation for impacts on groundwater resources.	Sections 2.1.3.1 and 2.1.3.2.
2. Discuss the potential for blasting to affect water wells, springs, and wetlands, and associated mitigation.	Sections 2.1.2 and 2.2.2.4.
3. Identify all sources of water required for construction [e.g. hydrostatic testing, dust suppression, horizontal directional drills (HDD)], the quantity of water required, and methods for withdrawal. Identify the treatment of discharge, discharge volumes, rates, locations, and any waste products generated.	Section 2.2.4.
4. Identify operational water requirements for proposed liquefied natural gas facilities, including the operational use, source(s), and volumes	Not Applicable.
5. If underground storage of natural gas is proposed, identify how water produced from the storage field will be disposed.	Not Applicable.
6. If salt caverns are proposed for storage of natural gas, identify the source locations, the quantity of water required, the method and rate of water withdrawal, and disposal locations and methods.	Not Applicable.
7. Provide a site-specific construction plan for each proposed HDD crossing in accordance with section V.B.6.d of the Federal Energy Regulatory Commission's Wetland and Waterbody Construction and Mitigation Procedures.	Appendix 2-D.
9. Identify mitigation measures to avoid impacts on springs; especially those used for drinking water or livestock.	Section 2.1.2.
10. Identify mitigation measures to ensure that public or private water supplies are returned to their former capacity or replaced in the event of damage resulting from construction.	Sections 2.1.2, 2.1.3.1, 2.1.3.2 and Appendix 2-A.
11. In addition to identifying perennial surface waterbodies crossed or affected by the project, also identify intermittent and ephemeral waterbodies.	Section 2.2.1, Table 2.2-2, Appendix 1-B.

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RESOURCE REPORT 2 - WATER USE AND QUALITY	
INFORMATION RECOMMENDED OR OFTEN MISSING	
Information	**Found in**
12. Show the locations of wetlands and waterbodies relative to the construction and permanent rights-of-way and additional temporary workspaces on mile posted alignment sheets or aerial photography	Appendix 1-B.
13. If wetlands would be filled or permanently lost or altered, describe proposed measures to compensate for permanent wetland losses. Include copies of any compensatory mitigation plans and discuss the status of agency consultations/approvals.	Section 2.3.3.
14. Describe measures to avoid or minimize impacts on forested wetlands. If impacts are unavoidable, describe proposed measures to restore forested wetlands following construction.	Sections 2.3.2.3 and 2.3.3.
15. Describe techniques to be used to minimize turbidity and sedimentation impacts associated with offshore trenching, if applicable.	Not applicable.

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2-A Spill Prevention, Control, and Countermeasure Plan

2-B HDD Contingency Plan

2-C Incomplete Environmental Survey Status Mapping

2-D Site-Specific Waterbody Drawings

2-E 100-Year Flood Zones Crossed by the Project

2-F Wetland Delineation and Stream Identification Report

2-G NWI Mapping

Acronyms and Abbreviations

ATWS	Additional temporary workspace
bgs	below ground surface
BMP	best management practices
CFR	Code of Federal Regulations
CWS	Community Water Supply
E&SCP	Erosion and Sediment Control Plan
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FUSRAP	Formerly Utilized Sites Remedial Action Program
gpd	gallons per day
gpm	gallons per minute
HDD	horizontal directional drill
IAWC	Illinois American Water Company
IEPA	Illinois Environmental Protection Agency
ISGS	Illinois State Geological Survey
MDNR	Missouri Department of Natural Resources
MLV	mainline valve
MP	milepost
NHD	National Hydrography Data
NPDES	National Pollutant Discharge Elimination System
NSQS	National Sediment Quality Survey
NWI	National Wetlands Inventory
PCB	Polychlorinated Biphenyl
PEM	palustrine emergent
PFO	palustrine forested
PSS	palustrine scrub shrub
PHMSA	Pipeline and Hazardous Materials Safety Administration
Plan	FERC’s Upland Erosion Control, Revegetation, and Maintenance Plan
Procedures	FERC’s Wetland and Waterbody Construction and Mitigation Procedures

Project	Spire STL Pipeline Project
REX	Rockies Express Pipeline LLC
SPCC Plan	Spill Prevention, Control, and Countermeasure Plan
Spire	Spire STL Pipeline LLC
UNT	Unnamed Tributary
WS	temporary workspace
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

Water Use and Quality

This resource report provides information on the groundwater, surface water, and wetland resources for the Spire STL Pipeline LLC (“Spire”) Spire STL Pipeline Project (“Project”) within Illinois and Missouri. Section 2.1 provides information on groundwater resources including aquifers, karst features, and water wells. Section 2.2 provides information on surface water resources including rivers and streams and general surface water use and quality. Section 2.3 provides information on wetland resources. Potential impacts to groundwater, surface water, and wetland resources are discussed as well as various avoidance and mitigation measures aimed to reduce impacts by the Project.

2.1 Groundwater Resources

2.1.1 Existing Resources

Section 2.1.1 describes the general information on aquifers and karst in Illinois and Missouri. No sole-source aquifers are located within one mile of the Project (USEPA 2016), and the Project has been designed to have minimal impacts on groundwater.

2.1.1.1 Illinois Aquifers

There are three principal aquifer types in Illinois. These are generally categorized as sand and gravel aquifers within the unconsolidated geologic materials overlying the bedrock; shallow bedrock aquifers lying within approximately 500 feet of land surface; and deep bedrock aquifers lying at depths greater than 500 feet of land surface (Illinois State Water Survey 2016). The 24-inch pipeline along the Illinois portion of the Project overlies the Pennsylvanian, Mississippian, Silurian-Devonian, and Cambrian-Ordovician Aquifer systems. They consist primarily of consolidated sediments and are under confined conditions. Many surficial aquifer systems overlay the Pennsylvania and Mississippian Aquifer systems, which generally consist of sand and gravel at or near the land surface or surficial deposits generally less than 100 feet thick.

Pennsylvanian Aquifer

The Pennsylvanian Aquifers in western Illinois typically yield from less than one to 100 gallons per minute (“gpm”). The depth to the top of the Pennsylvanian rocks can be less than 100 feet deep within the Project area. The Pennsylvanian aquifers commonly are used for water supplies in areas where they are buried beneath less than 100 feet of Quaternary deposits. Large volumes of water stored in surficial aquifer systems serve to replenish groundwater withdrawn from wells completed in the Pennsylvanian aquifers. Near southern parts of Illinois, the depth to saltwater decreases, the Pennsylvania rocks thicken, and only 10 percent of the Pennsylvanian rocks contains freshwater. The reported yields of wells are from less than one to more than 100 gpm (Lloyd et al. 1995).

Fresh groundwater withdrawals from the Pennsylvania aquifers are relatively small, and during 1985 they were less than four percent of the total withdrawals in Illinois. According to the United States Geological Survey ("USGS"), approximately two percent of the groundwater withdrawn in Illinois is used for agricultural purposes, four percent is used for public and domestic water supply, and one percent is used for commercial, industrial, or energy generation purposes (Maupin et al. 2014).

Mississippian Aquifer

The Mississippian aquifer is overlaid with many surficial aquifers, as well as the Pennsylvanian aquifer. The quality of the groundwater in surficial aquifers in Illinois is such that the water is generally adequate or can be treated and made adequate for most uses. However in some places in Illinois, nitrate concentrations are larger than the maximum levels for drinking water and are possibly due to contamination. Almost all the Mississippian rocks are considered to be aquifers in western Illinois and are generally used for water supply where they are less than 200 feet below land surface, where more water can be obtained from them than from the overlying surficial aquifer system. Recharge to the Mississippian aquifers occur primarily by water that percolates downward through the overlying deposits and Pennsylvanian rocks (Lloyd et al. 1995).

Fresh groundwater withdrawals from the Mississippian aquifers during 1985 were less than three percent of the total groundwater withdrawn in Illinois. The most prevalent groundwater quality concerns in areas crossed by the proposed Project in Illinois consist of oil, gas, coal, and agricultural activities. Thousands of oil and gas wells are located throughout Illinois, with most being in the southern one-third of the state. Brine waste impoundments have been associated with many of the production wells and salinity has increased in nearby water supply wells. Coal production has resulted in surface-mined areas that may also be a threat to shallow aquifers, and acid mine drainage also may be a threat to groundwater quality. Agriculture is of major economic importance within the state, but the use of fertilizers, herbicides, and insecticides applied over large areas potentially contaminate recharge areas. (Clarke et al. 1986).

Silurian-Devonian Aquifer

In western and northwestern Illinois where the Silurian-Devonian aquifer is covered by Mississippian rocks, the extent of freshwater beneath the younger rocks is greater. The aquifer is most commonly used for water supply where it is overlain by less than 200 feet of Quaternary deposits. It is recharged from the overlying surficial aquifer system in areas where water levels in the surficial aquifer system are higher than those in the Silurian-Devonian aquifer (Lloyd et al. 1995).

The yields of wells completed in the Silurian-Devonian aquifer range from less than five to more than 1,000 gpm. However chloride concentrations might be greater than 250 milligrams per liter where the aquifer is overlain by Devonian, Mississippian, or Pennsylvanian shales in Southwestern Illinois. The withdrawals from the Silurian-Devonian aquifer were about 15 percent of the total groundwater withdrawn in Illinois. Public supply was the largest use category in Illinois (Lloyd et al. 1995).

Cambrian-Ordovician Aquifer

The Cambrian-Ordovician aquifer system is buried beneath the Silurian and Devonian rocks. It consists of three principal aquifers, St. Peter-Prairie du Chien-Jordan, Ironton-Galesville, and the Mount Simon, which are of consolidated rocks. The bulk of the Project crosses the St. Peter-Prairie du Chien-Jordan aquifer. The average altitude of the top of the aquifer is about 250 feet above sea level in the area where the aquifer contains fresh water. The thickness of the aquifer averages 400 feet in areas where the aquifer contains fresh water. Before substantial volumes of groundwater were withdrawn from the Cambrian-Ordovician aquifer system, water levels in the St. Peter-Prairie du Chien-Jordan aquifer are estimated to have ranged about 500 feet above sea level along the Mississippi River in West-central Illinois (Lloyd et al. 1995).

Most of the data on the quality of water from the Cambrian-Ordovician aquifer system is from northern Illinois, where wells are open to more than one aquifer system. Toward southwestern Illinois where the aquifers are deeply buried, the water changes to a sodium bicarbonate chloride type; still further down gradient the water changes to a sodium chloride type, and sulfate is one of the dominant dissolved constituents of the water in the aquifer system. Thus, the Cambrian-Ordovician aquifer system is relied on for large groundwater supplies in northern Illinois (Lloyd et al. 1995).

Sole Source Aquifers

The Mahomet Valley Aquifer is the only United States Environmental Protection Agency ("USEPA") designated Sole Source Aquifer located within Illinois (USEPA 2016). No impacts are anticipated to the aquifer, since the Project area is approximately 30 miles south of the designated boundary. No known state-designated primary aquifers are located in the Project area in Illinois [Illinois Environmental Protection Agency ("IEPA") 2016a].

2.1.1.2 Missouri Aquifers

Within the Project areas in Missouri, groundwater is developed from the surficial aquifer system, the Mississippian Aquifer, and the Ozark Plateaus aquifer system. The uppermost aquifers in the area are unconsolidated sand and gravel of the surficial aquifer system, which is divided into stream-valley alluvial aquifers and glacial-drift aquifers. The Ozark Plateaus aquifer system consists of three aquifers: the Springfield plateau aquifer, the Ozark aquifer, and the St. Francois aquifer, which are in consolidated rocks (Miller et al. 1997).

Surficial Aquifer System

In many places in northern Missouri, bedrock contains slightly saline to saline water, and surficial aquifers are the only sources of fresh groundwater. Alluvial deposits along the Mississippi and Missouri Rivers as well as glacial drift deposits form an important stream-valley aquifer system.

- Missouri River Valley: The alluvial material of stream-valley aquifers average about 90 feet in thickness but can be as much as 160 feet thick in the vicinity of the Project. The saturated thickness of the aquifer averages about 80 feet. Reported yields of the wells in the aquifers range from less than 100 to about 3,000 gpm. Millions of gallons per day ("gpd") of water are withdrawn from the stream-valley aquifers. Public supply was the largest use for withdrawal, followed by industrial, mining, thermoelectric power, and agricultural uses. The remainder of the water withdrawn was used for domestic and commercial purposes (Miller et al. 1997).

- Mississippi River Valley: Part of the Mississippi River Valley Alluvial aquifer is located in the bootheel of Missouri and is the principal source of irrigation water. The thickness of the Mississippi River Valley alluvial aquifer ranges from a featheredge along the ridge to more than 250 feet near the Mississippi River and generally increases to the southeast. Wells typically yield 1,000 gpm. The water in the Mississippi River Valley alluvial aquifer is mostly unconfined and aquifer water levels rise and fall in response to changes in stream water levels. The aquifer discharges to a network of agricultural drainage ditches and into major streams. The chemical quality of the water in the aquifer generally meets the standards recommended for public water supplies by the USEPA; excessive concentration of iron and manganese have been reported. The water can also contain concentrations of pesticides and nutrients as a result of agricultural activities. Withdrawals of freshwater from the Mississippi River Valley alluvial aquifer total million gpd. Agricultural practices were the main use for withdrawal, followed by public supply, industrial, mining, thermoelectric power, domestic, and commercial uses (Miller et al. 1997).
- Glacial Drift Aquifers: In Missouri, the maximum southern extent of glacial ice and glacial drift deposits was about the present location of the Missouri River. Water generally is obtained from sand beds that range from 20 to 40 feet in thickness. Yields of wells in the aquifer are highly variable and range from less than 10 to about 1,000 gpm. Water in the aquifer is suitable for most uses. The water is hard and commonly is a calcium bicarbonate type but in many places in Missouri it is a sodium sulfate type. The source of sulfate is dissolution of gypsum in areas where the high-sulfate water in underlying rock leak upwards (Miller et al. 1997).

Mississippian Aquifer

The Mississippian aquifer is the uppermost aquifer in northern Missouri. The aquifer extends over all of the Missouri River except for small areas near the Mississippi and the Missouri Rivers where the rocks that compose the aquifer have been removed by erosion. The aquifer is thinnest near these areas and averages about 200 feet, but can exceed 400 feet in depth in Northwestern Missouri. Recharge to the aquifer is mostly from precipitation that falls on areas where the aquifer is exposed at the land surface or is overlain by a thin blanket of younger rocks. The aquifer contains freshwater only in the eastern one-third of its extent. The very saline water is thought to have entered the Mississippian aquifer either by upward leakage from the underlying Cambrian-Ordovician aquifer or by the discharge of eastward moving saline water.

Ozark Plateau Aquifer System

The portion of the Project that crosses the Ozark Plateau aquifer system crosses the Ozark aquifer. North of the Missouri River, rocks that are equivalent to the Ozark aquifer are called the Cambrian-Ordovician aquifer. The Cambrian-Ordovician aquifer averages about 1,200 feet deep within the Project area and contains freshwater only in a small area in the southern part of the aquifer (Miller et al. 1997).

Total fresh groundwater withdrawals from the Ozark Plateau aquifer system during 1990 were 330 million gpd. Forty-two percent were withdrawn for agricultural purposes, 27 percent was used for public supply, 16 percent was used for industrial, mining, and thermoelectric power, and 15 percent was withdrawn for domestic and commercial supplies (Miller et al. 1997).

2.1.1.3 Groundwater Resources at HDD Crossings

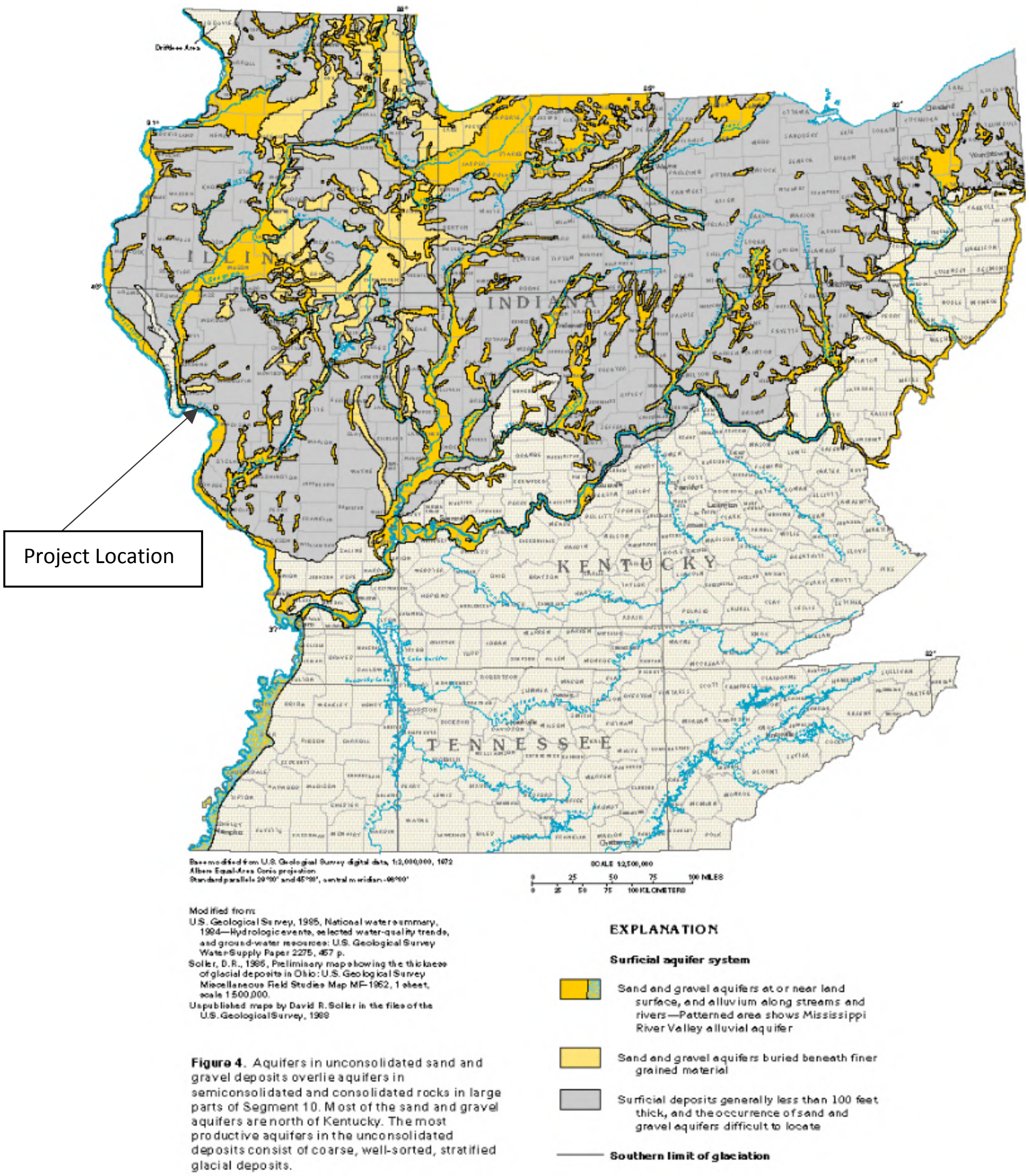
Four HDD crossings are proposed for the Project: the Mississippi River and Missouri River on the 24-inch pipeline, and Coldwater Creek and Spanish Lake Park on the North County Extension. Each of the HDD areas were assessed for groundwater resources at the crossings. As displayed in Figures 2.1-1 and 2.1.-2, surficial aquifer systems (stream and valley alluvium and glacial drift aquifers) are located at the Project's Mississippi River and Missouri River HDD crossings. The groundwater in the surficial aquifer systems may be either locally unconfined, semi-confined, or confined in locations, due to variability in sediment size distribution and associated permeability. The surficial geology at the Coldwater Creek and Spanish Lake Park on the North County Extension HDD crossings consist of loess, which due to its fine-grained composition would not be anticipated to act as a productive aquifer, in comparison to the stream and valley alluvium and glacial drift deposits. The Mississippian aquifer, located below the surficial aquifers and loess layer, may be overlain by a Pennsylvanian shale confining unit and is underlain by a Mississippian shale and/or dolomite confining unit (Miller et al. 1997).

In Missouri, the alluvium material of stream-valley aquifers average about 90 feet in thickness but can be as much as 160 feet thick in the vicinity of the Project; glacial drift aquifers of the area have a typical depth of 100 to 200 feet but is greater than 300 feet in some of eastern Missouri (Miller et al. 1997). In Illinois, the surficial aquifer system is generally less than 100 feet thick, with difficulty locating sand and gravel aquifers (Lloyd et al. 1995). Public data available online from the MDNR (2016a), including groundwater depth data and well logs, was utilized to review potential groundwater depths at the Project's HDD crossings; however, groundwater levels fluctuate due to weather and/or seasonal influences. For actual groundwater depths and subsurface conditions encountered during Spire's geotechnical investigations, the reports are available as Resource Report 6, Appendix 6-B.

At the Mississippi River HDD crossing, groundwater depth based on MDNR contour data at the 24-inch pipeline location (MP 45.3 to 46.2) is between 20 to 30 feet below ground surface ("bgs") within the alluvium layer. The planned drill depth will extend to a minimum of 80 feet below the riverbed within bedrock. Public groundwater depth data was not available for the Illinois portion of this HDD; however, the Project area on Figure 2.1-1 is within an area of alluvium along the Mississippi River valley. The nearest well log data available is for well log identification number (ID #) 024852, located at Portage Des Sioux, approximately 2.5 miles to the southeast of the HDD. This well was drilled within the alluvium layer to a depth of 116 feet and has a post-construction static water level of 17 feet. Based on the well log, there was not a confining layer noted in the alluvium layer.

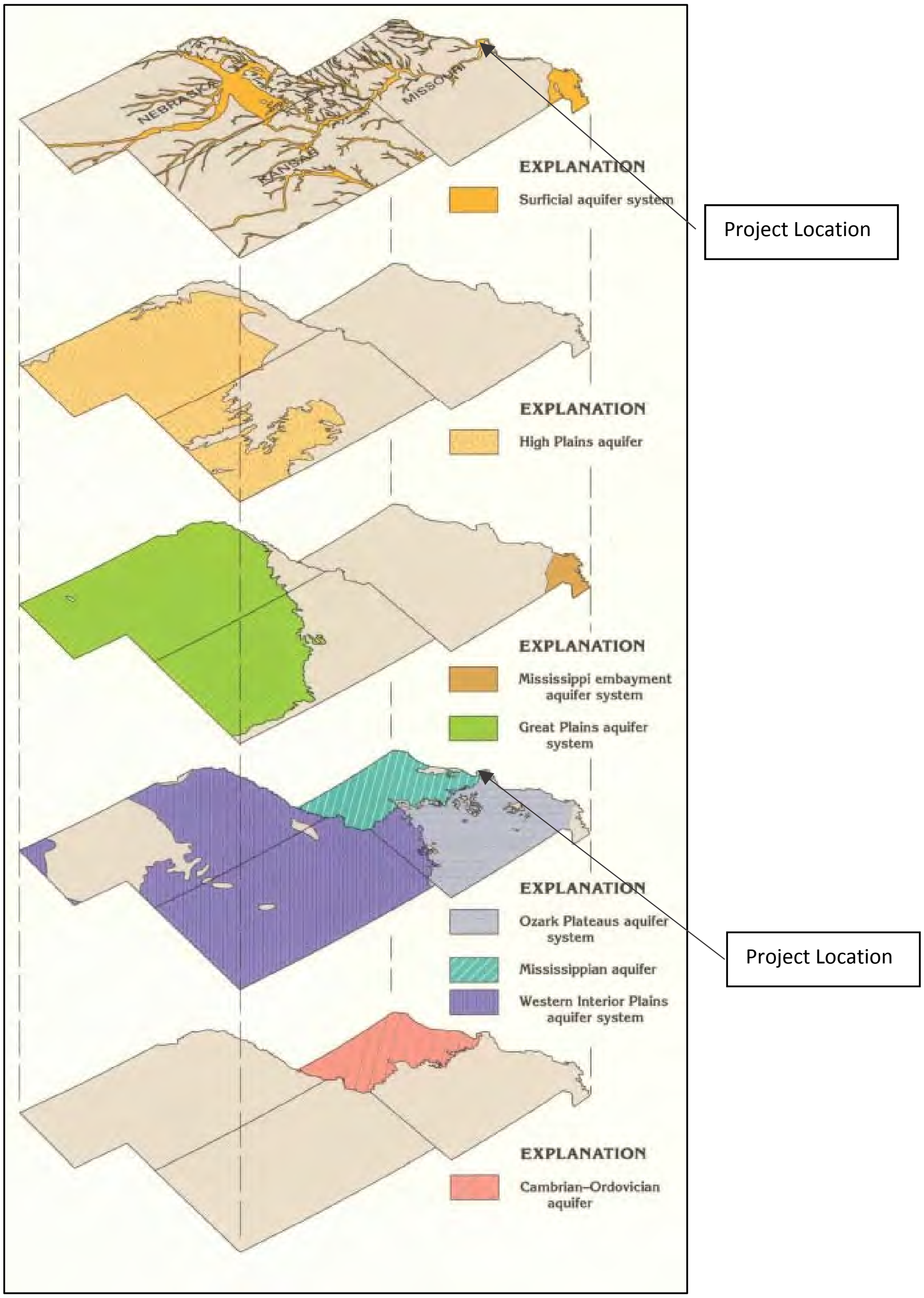
At the Missouri River HDD crossing, groundwater depth at the 24-inch pipeline (MP 57.7 to 58.4) is between 50 to 70 feet bgs, within the alluvium layer. The planned drill depth will extend to a minimum of 80 feet below the riverbed within bedrock. From MP 57.8 to 58.4, groundwater is between 60 to 70 feet bgs, where the surficial geology transitions from alluvium to loess. The nearest well log data is approximately 240 feet to the west of the HDD. Well ID# 018276 was completed to a depth of 560 feet, with bedrock encountered at 120 feet and water noted at 110 feet. This well has a post-construction static water level of 20 feet, which differs from the MDNR groundwater depth data. Fine grained layers (i.e., shale) within the bedrock would be anticipated to act as confining or semi-confining layers.

Figure 2.1-1. Surficial Aquifer System near Project in Illinois



Source: Lloyd et al. 1995.

Figure 2.1-2. Aquifers near Project in Missouri



Source: Miller et al. 1997.

At the Coldwater Creek crossing, groundwater at the North County Extension (MP 1.6 to 2.3) is between 50 to 60 feet bgs. The surficial geology consists of loess, which transitions to alluvium at the creek, then back to loess. The planned drill depth will extend to a minimum of 80 feet below creek bottom. The nearest well log data is 262 feet to the south of the HDD. Well ID # 026312 was completed to a depth of 450 feet, with bedrock encountered at 35 feet. Fine grained layers (i.e., shale) within the bedrock would be anticipated to act as confining or semi-confining layers.

At the Spanish Lake Park crossing, groundwater at the North County Extension (MP 3.8 to 4.5) is between 40 to 50 feet bgs. Loess is present at the surface. The planned drill depth will extend to a minimum of 80 feet below the lake bottom. The nearest well log data is 835 feet to the south of the HDD. Well ID # 025716 was completed to a depth of 480 feet, with bedrock encountered at 120 feet. Fine grained layers (i.e., shale) within the bedrock would be anticipated to act as confining or semi-confining layers.

In summary, the planned pipeline trenches are not anticipated to intercept the primary groundwater aquifers, which are deeper than the trenches. Trenchless (HDD) crossings will exceed these trench depths and likely encounter groundwater. However, these HDD activities are not expected to have an impact on local groundwater quality due to the relatively narrow diameter of the boreholes and short duration of activities. Long-term aquifer recharge and groundwater quality are not anticipated to be affected by pipeline construction or subsequent operations as a majority of the pipeline right-of-way will revert to pre-existing agricultural conditions.

2.1.1.4 Karst

As discussed in Resource Report 6, Section 6.4.4, karst is a landform that develops on or in limestone, dolomite, or gypsum by dissolution, and is characterized by the presence of features such as sinkholes, underground (or internal) drainage through solution-enlarged fractures (joints), and caves. Public data was reviewed for Illinois and Missouri for the possibility of karst features along the proposed Project and are described herein.

A Karst Mitigation Plan is provided in Resource Report 6, Appendix 6-A, and describes the general measures to be implemented by Spire to ensure that correct measures for construction in karst formations are applied during construction of the Project. Section 2.1.3, Groundwater Impacts and Mitigation, and Resource Report 6, Table 6.4-2, also discuss Spire's planned mitigation measures in the event karst features are encountered.

<u>**Illinois**</u>

Data obtained from The Illinois State Geological Survey ("ISGS") (2015) indicate that there are several karst areas crossed by the pipeline centerline and also located within a one-mile buffer of the pipeline centerline. Discussed in Resource Report 6, Figure 6.4-3 illustrates mapped karst terrain data within the Project area and Table 6.4-2 discusses the possibility of karst (and planned mitigation measures) along the Project route near MP 13.5 and 43.1. Most of the hazards are small karst features (sinkholes) that, if encountered during construction, can either be avoided by small adjustments to the Project right-of-way or can be mitigated as described in the Karst Mitigation Plan.

Spire has proposed locations of workspaces associated with the horizontal directional drill ("HDD") crossing of the Mississippi River and conducted geotechnical boring at these locations to determine the geology and feasibility of the drills. Geotechnical reports can be found in Resource Report 6, Appendix 6-B. The plan and profile of the proposed river crossing is depicted in Appendix 2-D, Site Specific Waterbody Drawings. Geotechnical boring test determined that no karst features were present in the HDD workspaces.

Missouri

The Geosciences Technical Resource Assessment Tool from the Missouri Department of Natural Resources ("MDNR") Missouri Geological Survey indicate sinkholes located within the Project area, specifically south of the Missouri River crossing (MDNR 2016a). Sinkhole areas identified at the Project are associated within areas of an active quarry. These areas show the ability to hold surface water, thus it is not anticipated that karst will be encountered at the depth of the pipeline trench. Resource Report 6, Figure 6.4-3 illustrates mapped karst terrain data identified within the Project area.

Spire has proposed locations of workspaces associated with the HDD crossing of the Missouri River and conducted geotechnical boring at these locations to determine the geology and feasibility of the drills. Geotechnical reports can be found in Resource Report 6, Appendix 6-B. The plan and profile of the proposed river crossing is depicted in Appendix 2-D, Site Specific Waterbody Drawings. Geotechnical boring test determined that no karst features were present in the HDD workspaces. A portion of the geotechnical work has been conducted at the Coldwater Creek and Spanish Lake Park HDD crossing locations where survey access has been granted; remaining geotechnical work will be conducted as landowner permission is obtained.

2.1.2 Public and Private Wells

Spire utilized groundwater data from the IEPA, the ISGS (2015), the MDNR (2008a, and the field to obtain information on public and private wells located within 150 feet of the Project area. Table 2.1-1 provides information on private water supply wells and springs within 150 feet of the Project construction areas. Seven private wells are located within 150 feet of the proposed Project through Greene and Jersey Counties, Illinois. No private wells were located within 150 feet of the proposed Project in Scott County, Illinois, or in St. Charles and St. Louis Counties, Missouri. And, no springs were present at the Project area.

In Illinois, no designated community water supply ("CWS") wells, water supply lakes, or IEPA regulated recharge areas were identified within 150 feet of the 24-inch pipeline Project in Illinois (IEPA 2016b). There were also no protected watersheds or locally zoned aquifer protection areas located within the immediate Project area in Illinois (IEPA 2016b). In Missouri, however, a public drinking water groundwater well was located 1,450 feet from the Project area in St. Charles County, Missouri (MDNR 2008). Section 2.2.2.4, Water Protection Areas, contains information on this public source water area where the proposed route crosses a 0.5-mile radius buffer to the Portage Des Sioux Water Plant.

Table 2.1-1. Water Wells and Springs within 150 Feet of the Project Construction Areas

Facility and County, State [1]	Approximate MP	Well Number[2]	Use	Approximate Distance from Temporary Workspace (feet)	Approximate Distance from Pipeline Centerline (feet)
24-Inch Pipeline					
Greene County, Illinois	9.0	Unknown[3]	Private Water[4]	0	33
Greene County, Illinois	9.0	Unknown[3]	Private Water[4]	0	33
Greene County, Illinois	13.9	120612057400	Private Water	117	172
Greene County, Illinois	28.7	120612043300	Private Water	123	203
Greene County, Illinois	29.4	120612043600	Private Water	68	103
Jersey County, Illinois	36.5R	Unknown[3]	N/A[5]	126	161
Jersey County, Illinois	38.6	120830020800	Private Water	104	184
North County Extension					
St. Louis County, Missouri	0.0	Unknown[3]	N/A[5]	85	120
St. Louis County, Missouri	4.0	Unknown	Private Water	45	80
Access Roads					
Greene County, Illinois	24.9R	120612054900	Private Water	144	430

Notes:

1 Facilities not listed in this table do not have water supply wells within 150 feet of the Project. Additional water supply wells and springs may be identified during field survey and discussions with landowners.

2 Public well data from ISGS (2015) and MDNR (2008a).

3 Based on field survey data.

4 Based on landowner communications, the well may or may not be in use.

5 N/A - Not Available.

Spire does not intend to blast in close proximity to private and public water wells. Additional information regarding blasting activities can be found in Resource Report 6, Table 6.2-1, where Spire identified two locations where blasting may be required: MP 44.9 in Jersey County, Illinois, and MP 58.2 to 58.6 in St. Louis County, Missouri. Neither location have wells located within 150 feet of the construction area. Additionally, no municipal water mains were located in the vicinity of these Project areas.

2.1.3 Groundwater Impacts and Mitigation

2.1.3.1 Impacts

Construction, operation, and maintenance of the proposed facilities are not expected to have long-term impacts on groundwater resources. Adherence to the various plans mentioned in Section 2.1.3.2 during construction and restoration is expected to prevent or mitigate impacts to aquifers, wells, and karst features.

As discussed in Resource Report 1, Table 1.3-1, the proposed pipeline will be buried a minimum of three to five feet using standard open trench construction methods. The major groundwater resources are deeper than the trenches and pipeline placement. Trenchless (HDD) crossings will exceed these trench depths; however, these activities are not expected to have an impact on groundwater quality due to the relatively narrow diameter of the boreholes. Long-term aquifer recharge will not be affected by pipeline construction or subsequent operations as a majority of the pipeline right-of-way will revert to pre-existing agricultural conditions.

Pipeline construction activities may have minor, temporary impacts on groundwater resources where shallow aquifers are in proximity of the proposed facilities. These impacts may include increased turbidity, groundwater table fluctuations, short-term disruption of recharge, and localized flow along the pipeline trench or contamination from a spill or leak of hazardous substances. Prior to construction, wells within 150 feet of the construction area are to be staked. While no impacts are anticipated to private wells, should it be necessary, Spire will take measures to protect drinking water wells within 150 feet of the construction area. Spire is continuing to work with landowners regarding private water wells and springs within 150 feet of the Project to help minimize potential impacts.

If karst areas are encountered, stormwater will be diverted upland from the excavated karst areas utilizing approved erosion and control methods. If surface waters are present near the karst excavation, then water will be flumed to minimize the potential for storm water entering the void. Sand bags or similar materials would be utilized to withhold water from entering the excavation, and water levels will be monitored to determine whether it is entering the excavation.

Mitigation measures regarding private wells and karst features are discussed in Section 2.1.3.2.

2.1.3.2 Avoidance and Mitigation

Most potential groundwater impacts will be avoided or minimized due to the use of the standard construction methods and mitigation measures described in the Federal Energy Regulatory Commission's (FERC's) *Upland Erosion Control, Revegetation, and Maintenance Plan* ("Plan") and *Wetland and Waterbody Construction and Mitigation Procedures* ("Procedures") (FERC 2013a and 2013b). Area hydrology will also be preserved with the implementation of the following Plans:

- Karst Mitigation Plan provided in Resource Report 6, Appendix 6-A;
- Spill Prevention, Control, and Countermeasure ("SPCC") Plan in Appendix 2-A; and
- Erosion and Sediment Control Plans ("E&SCPs") developed prior to construction and during local permitting efforts.

As discussed in Section 2.1.1.3, small karst features, if encountered, can be avoided by small adjustments to the Project right-of-way or can be mitigated as described in the Karst Mitigation Plan. The Karst Mitigation Plan describes preventive measures such as personnel training and awareness, inspection monitoring and surveillance, construction phase procedures, and any remediation and post-construction monitoring processes should karst be found.

The Spill Prevention, Control, and Countermeasure Plan (SPCC Plan) describes preventive measures such as personnel training, equipment inspection, and refueling procedures to reduce the likelihood of spills (e.g., fuel storage areas will be located at least 200 feet from active private water wells and at least 400 feet from community and municipal water wells). It also includes mitigation measures, such as containment and cleanup, to reduce potential impacts should a spill occur.

Project-specific E&SCPs will reduce potential for adverse impacts to stormwater runoff during construction. Erosion control devices will be outlined in E&SCPs which will incorporate FERC's Plan and state and local regulations. When regulations or guidance information from multiple sources apply, the more stringent will be utilized in development of the E&SCPs.

Spire will also offer to landowners to conduct a pre-construction evaluation on active wells within 150 feet of the proposed Project workspaces. If requested by the landowner and feasible at the time of sampling, the well may be tested for yield and water quality. Upon request by a landowner who had a pre-construction test, a post-construction test may be performed. Spire will document any landowner choosing to opt out of pre-construction evaluation. Landowners participating in the testing program will be contacted by a Spire representative, and a qualified independent contractor will perform the testing. To maintain responsiveness to the concerns of affected landowners, Spire will evaluate landowner complaints or damage associated with construction.

If contaminated groundwater is encountered during construction, Spire will notify the affected landowner and coordinate with the appropriate federal and state agencies in accordance with applicable notification requirements. In the unlikely event that private landowner wells are damaged by Spire during construction, Spire will negotiate a settlement with the landowner that may include repair or replacement. Spire plans to provide adequate temporary accommodations or a temporary water supply to affected homeowners while their well is repaired or replaced in the event that no other potable water source is readily available.

While no blasting is anticipated near wells, state-specific Blasting Management Plans will be developed by Spire's Construction Contractor for the Project if it is determined that blasting is necessary, in order to minimize the potential for blasting-related adverse impacts. Specific blasting procedures are provided in Resource Reports 1 and 6. Wells within 200 feet of any newly proposed blasting area would be tested for water quantity and quality prior to and after construction by a qualified independent laboratory as granted permission by landowners. And, any property damage as a direct result from blasting will be repaired or replaced.

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2.2 Surface Water Resources

The Project crosses four major hydrologic watersheds upon reviewing hydrologic unit codes ("HUC") at the 4th level (United States Department of Agriculture Natural Resources Conservation Service "USDA-NRCS" 2016a): Lower Illinois (HUC 0713), Upper Mississippi-Salt (HUC 0711), Lower Missouri (HUC 1030), and Upper Mississippi-Kaskaskia-Meramec (HUC 0714).

The 24-inch pipeline route crosses the Lower Illinois watershed from MP 0.0 to MP 42.3, the Upper Mississippi-Salt watershed from MP 42.3 to MP 50.4, and the Lower Missouri watershed from MP 50.4 to its destination at the Laclede/Lange Delivery Station. The North County Extension is within the Lower Missouri watershed from MP 0.0 to MP 5.9 and the Upper Mississippi-Kaskaskia-Meramec watershed from MP 5.9 to the Chain of Rocks Station.

2.2.1 Existing Resources

Spire performed a desktop review of National Wetland Inventory ("NWI") mapping and National Hydrography Datasets ("NHD") and aerial photography to identify potential waterbodies in the Project area. Field surveys were initiated in September 2016 to identify water resources within the Project study area (an approximate 300-foot corridor) and were completed on accessible properties in 2016. A second round of surveys was conducted including newly accessible survey areas, route revisions, and the addition of the North County Extension. Due to continuing survey permission, field surveys have not been completed along the entire Project. The surveys identified waterbodies and wetlands crossed or otherwise impacted by the Project. For the areas not yet field surveyed within the Project areas, desktop inventory is provided from NWI and NHD mapping.

Spire is providing a package to the federal and state agencies (where applicable) in April 2017, to report features surveyed from December 2016 to March 3, 2017, as a supplement to its permit applications filed in January 2017. Data collected after March 3, 2017 is currently being processed and will be submitted to the federal and state agencies in a supplemental filing at a later date.

Table 2.2-1 identifies the areas with limited field survey access as of April 2017, either due to denied survey permissions, landowner conditions, or route revisions. Appendix 2-C, Incomplete Environmental Survey Status Mapping, provides map sheets corresponding with the table's "Pending Survey" areas.

A list of waterbodies crossed by the Project, based on desktop and field review, can be found in Table 2.2-2. A total of 105 waterbody segments are crossed by the Project area. Of these waterbodies, 38 were classified as perennial streams, 29 as intermittent streams, and 36 as ephemeral streams. One pond, and one lake adjacent to the Mississippi River, are also crossed by the Project. The locations of waterbodies relative to the construction and permanent rights-of-way and additional temporary workspaces ("ATWS") are contained in Construction Alignment Sheets provided in Resource Report 1, Appendix 1-B.

Waterbodies are categorized as perennial, intermittent, or ephemeral classes, depending on the permanence or duration of flow. Perennial waterbodies typically flow or contain standing water year round, and under normal circumstances are capable of supporting populations of fish and macroinvertebrates. Intermittent waterbodies flow or contain standing water seasonally, are typically dry for part of the year, and do not usually support populations of fish or macroinvertebrates which are directly dependent on water. Ephemeral waterbodies generally contain water only in response to precipitation or spring snowmelt and usually do not support populations of fish or macroinvertebrates. Existing stream conditions were recorded on data forms that incorporate Missouri Stream Mitigation Method assessment factors [United States Army Corps of Engineers ("USACE") et al. 2013].

Table 2.2-1. Incomplete Environmental Survey Status

Facility/County, State	Approximate MP In	Approximate MP Out	Reason for Incomplete Survey[1]	Survey Needed
24-Inch Pipeline				
Greene County, Illinois	30.4	31.1	Pending Survey Data	Centerline
Greene and Jersey Counties, Illinois	32.4	33.8	Pending Survey Permission	Centerline
Jersey County, Illinois	34.4	34.7	Pending Survey Permission	Centerline
Jersey County, Illinois	35.7R	37.1R	Pending Survey Data	Centerline (Reroute)
Jersey County, Illinois	40.3	41.1	Pending Survey Data	Centerline, TAR-016
Jersey County, Illinois	41.8	43.5	Pending Survey Data	Centerline
Jersey County, Illinois	43.9	45.1	Pending Survey Permission	Centerline, TAR-017
St. Charles County, Missouri	51.1	51.1	Pending Survey Permission[2]	Centerline (Railroad Right-of-Way)
St. Charles County, Missouri	54.1	54.5	Pending Survey Data	Centerline
North County Extension				
St. Louis County, Missouri	1.6	1.6	Pending Survey Data	Centerline
St. Louis County, Missouri	2.0	2.3	Pending Survey Permission	Centerline
St. Louis County, Missouri	2.3	2.5	Pending Survey Data	Centerline, TAR-025
St. Louis County, Missouri	2.5	2.6	Pending Survey Permission	Centerline
St. Louis County, Missouri	2.7	3.9	Pending Survey Permission	Centerline/ATWS
St. Louis County, Missouri	3.9	4.8	Pending Survey Data	Centerline, TAR-026, TAR-027
St. Louis County, Missouri	4.9	4.9	Pending Survey Data	Permanent Easement for Cathodic Protection (new)
St. Louis County, Missouri	5.3	5.3	Pending Survey Data	Centerline
St. Louis County, Missouri	6.0	6.0	Pending Survey Data	Chain of Rocks Station
Total Survey Remaining (in miles)[3]	**4.5**			

Notes:

1 Pending Survey Permission - landowners at parcels have not granted survey permission at this time; Pending Survey Data - area has been surveyed and survey data is being processed. Survey data will be provided in a supplemental filing.

2 Railroad right-of-way will be bored under; adjacent workspaces necessary for the crossing were surveyed.

3 Total survey miles remaining includes areas "pending survey permission"; the total does not include "pending survey data" mileage for which survey is already complete.

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Table 2.2-2. Waterbodies Crossed by the Project

Feature ID[1]	MP	Waterbody Name	Flow Regime[2]	Average Bank to Bank (Channel) Width (feet)	Average Water Width (feet)	Pipeline or Access Road Crossing Length (feet)[3]	State Water Quality Classification[4, 5]	County, State	Fishery Type[6]	Impaired Designated Use (Identified Pollutant)[7]	Crossing Method[8]
24-Inch Pipeline											
SIL-JJP-003	1.3	Unnamed Tributary (“UNT”) to Little Sandy Creek	IT	10	2	10	GEN, PFPWS	Scott, Illinois	WWF	No	Dry Ditch Flume
SIL-JJP-147	1.9R	UNT to Little Sandy Creek	E	4	0	4	GEN, PFPWS	Scott, Illinois	WWF	No	Dry Ditch Flume
SIL-CDK-033	2.7	UNT to Little Sandy Creek	P	20	17	9	GEN, PFPWS	Scott, Illinois	WWF	No	Dry Ditch Flume
SIL-JJP-013	3.4	Little Sandy Creek	P	40	15	30	GEN, PFPWS	Scott, Illinois	WWF	No	Dry Ditch Flume
SIL-TMA-010	3.5	UNT to Little Sandy Creek	E	6	0	6	GEN, PFPWS	Scott, Illinois	WWF	No	Dry Ditch Flume
SIL-JJP-017	3.6	UNT to Little Sandy Creek	E	2	0	0	GEN, PFPWS	Greene, Illinois	WWF	No	Workspace Only
SIL-TMA-011	3.8	UNT to Little Sandy Creek	IT	8	1.5	8	GEN, PFPWS	Greene, Illinois	WWF	No	Dry Ditch Flume
SIL-JJP-018	4	UNT to Little Sandy Creek	P	25	6	19	GEN, PFPWS	Greene, Illinois	WWF	No	Dry Ditch Flume
SIL-TMA-016	4.3	UNT to Little Sandy Creek	IT	8	1	0	GEN, PFPWS	Greene, Illinois	WWF	No	Dry Ditch Flume
SIL-TMA-018	4.3	UNT to Little Sandy Creek	P	9	2	9	GEN, PFPWS	Greene, Illinois	WWF	No	Dry Ditch Flume
SIL-TMA-054	4.3	UNT to Little Sandy Creek	E	8	0	0	GEN, PFPWS	Greene, Illinois	WWF	No	Workspace Only
SIL-JJP-026	5.6	UNT to Hurricane Creek	IT	2.5	0	2.5	GEN, PFPWS	Greene, Illinois	WWF	No	Dry Ditch Flume
SIL-JJP-027	5.7	UNT to Hurricane Creek	IT	4	0	4	GEN, PFPWS	Greene, Illinois	WWF	No	Dry Ditch Flume
SIL-CDK-035	6.3	UNT to Hurricane Creek	IT	4	2	0	GEN, PFPWS	Greene, Illinois	WWF	No	Workspace Only
SIL-TMA-020	6.4	Hurricane Creek	P	12	4	25	GEN, PFPWS	Greene, Illinois	WWF	No	Dry Ditch Flume
SIL-TMA-026	8.8	UNT to Seminary Creek	IT	7	2	7	GEN, PFPWS	Greene, Illinois	WWF	No	Dry Ditch Flume
SIL-JJP-031	10.3	UNT to Seminary Creek	E	4	0	0	GEN, PFPWS	Greene, Illinois	WWF	No	Workspace Only
SIL-TMA-021	10.3	UNT to Seminary Creek	P	30	22	28	GEN, PFPWS	Greene, Illinois	WWF	No	Dry Ditch Flume
SIL-TMA-022	10.8	UNT to Seminary Creek	E	4	0	4	GEN, PFPWS	Greene, Illinois	WWF	No	Dry Ditch Flume
SIL-TMA-024	11.3	UNT to Seminary Creek	E	4	0	4	GEN, PFPWS	Greene, Illinois	WWF	No	Dry Ditch Flume
SIL-TMA-031	13.2	UNT to Apple Creek	P	15	12	14	GEN, PFPWS	Greene, Illinois	WWF	No	Dry Ditch Flume
SIL-TMA-033	13.9	Apple Creek	P	67	35	67	GEN, PFPWS	Greene, Illinois	WWF	Aquatic Life (Dissolved Oxygen) Primary Contact Recreation (Fecal Coliform)	Dry Ditch Flume
SIL-TMA-034	14.1	Apple Creek	P	50	35	0	GEN, PFPWS	Greene, Illinois	WWF	Aquatic Life (Dissolved Oxygen) Primary Contact Recreation (Fecal Coliform)	Workspace Only
SIL-TMA-035	17.1	UNT to Coates Creek	P	3	2	0	GEN, PFPWS	Greene, Illinois	WWF	No	Workspace Only
SIL-TMA-036	17.6	UNT to Coates Creek	P	5	3	5	GEN, PFPWS	Greene, Illinois	WWF	No	Dry Ditch Flume
SIL-JJP-143	18.7 R	Coates Creek	P	15	4	13	GEN, PFPWS	Greene, Illinois	WWF	No	Dry Ditch Flume
SIL-TMA-042	19.1	UNT to Coates Creek	P	6	3.5	6	GEN, PFPWS	Greene, Illinois	WWF	No	Dry Ditch Flume
SIL-JJP-100	19.1	UNT to Coates Creek	E	4	0	0	GEN, PFPWS	Greene, Illinois	WWF	No	Workspace Only
SIL-JJP-110	20.8	UNT to Link Branch	P	7	2.5	7	GEN, PFPWS	Greene, Illinois	WWF	No	Dry Ditch Flume

Table 2.2-2. Waterbodies Crossed by the Project (Continued)

Feature ID[1]	MP	Waterbody Name	Flow Regime[2]	Average Bank to Bank (Channel) Width (feet)	Average Water Width (feet)	Pipeline or Access Road Crossing Length (feet)[3]	State Water Quality Classification[4, 5]	County, State	Fishery Type[6]	Impaired Designated Use (Identified Pollutant)[7]	Crossing Method[8]
24-Inch Pipeline (continued)											
SIL-JJP-111	20.9	UNT to Link Branch	E	5	0	0	GEN, PFPWS	Greene, Illinois	WWF	No	Workspace Only
SIL-TMA-051	20.9	UNT to Link Branch	IT	6	2	6	GEN, PFPWS	Greene, Illinois	WWF	No	Dry Ditch Flume
SIL-TMA-078	22.4	UNT to Link Branch	IT	2	1.5	2	GEN, PFPWS	Greene, Illinois	WWF	No	Dry Ditch Flume
SIL-CDK-016	23.5	UNT to Macoupin Creek	IT	9	4	9	GEN, PFPWS	Greene, Illinois	WWF	No	Dry Ditch Flume
SIL-JJP-148	25.3R	Macoupin Creek	P	145	0	145	GEN, PFPWS	Greene, Illinois	WWF	No	Dry Ditch Flume
SIL-JJP-141	25.3R	UNT to Macoupin Creek	E	4	2	4	GEN, PFPWS	Greene, Illinois	WWF	No	Dry Ditch Flume
SIL-JJP-104	25.8R	UNT to Macoupin Creek	P	8	3	8	GEN, PFPWS	Greene, Illinois	WWF	No	Dry Ditch Flume
SIL-JJP-145	26.7	UNT to Macoupin Creek	P	4	N/A	4	GEN, PFPWS	Greene, Illinois	WWF	No	Dry Ditch Flume
SIL-DFW-002	31.6	UNT to Wines Branch	IT	3.5	1	3.5	GEN, PFPWS	Jersey, Illinois	WWF	No	Dry Ditch Flume
SIL-DFW-001	31.6	Wines Branch	P	25	3.5	13	GEN, PFPWS	Jersey, Illinois	WWF	No	Dry Ditch Flume
NHD-761	33.7	UNT to Otter Creek	IT	N/A	N/A	N/A	GEN, PFPWS	Jersey, Illinois	WWF	No	Dry Ditch Flume
SIL-CDK-012	35.2R	UNT to Otter Creek	P	23	12	34	GEN, PFPWS	Jersey, Illinois	WWF	No	Dry Ditch Flume
SIL-JJP-117	35.2R	UNT to Otter Creek	E	6	0	6	GEN, PFPWS	Jersey, Illinois	WWF	No	Dry Ditch Flume
SIL-TMA-058	35.5R	UNT to Otter Creek	P	8	4	8	GEN, PFPWS	Jersey, Illinois	WWF	No	Dry Ditch Flume
NHD-969	36.6R	Otter Creek	P	N/A	N/A	N/A	GEN, PFPWS	Jersey, Illinois	WWF	Aquatic Life (Dissolved Oxygen)	Dry Ditch Flume
SIL-JJP-136	38.9	UNT to South Fork Otter Creek	E	4	0	4	GEN, PFPWS	Jersey, Illinois	WWF	No	Dry Ditch Flume
SIL-TMA-074	39	UNT to South Fork Otter Creek	P	5	2.5	5	GEN, PFPWS	Jersey, Illinois	WWF	No	Dry Ditch Flume
SIL-TMA-073	39	UNT to South Fork Otter Creek	E	4	0	4	GEN, PFPWS	Jersey, Illinois	WWF	No	Dry Ditch Flume
SIL-JJP-134	39.2	UNT to South Fork Otter Creek	P	8	1	8	GEN, PFPWS	Jersey, Illinois	WWF	No	Dry Ditch Flume
SIL-JJP-131	39.4	UNT to South Fork Otter Creek	E	4	0	0	GEN, PFPWS	Jersey, Illinois	WWF	No	Workspace Only
SIL-JJP-132	39.4	UNT to South Fork Otter Creek	E	4	0	0	GEN, PFPWS	Jersey, Illinois	WWF	No	Workspace Only
SIL-JJP-130	39.4	UNT to South Fork Otter Creek	P	8	1	8	GEN, PFPWS	Jersey, Illinois	WWF	No	Dry Ditch Flume
SIL-TMA-072	39.5	UNT to South Fork Otter Creek	E	3	0	3	GEN, PFPWS	Jersey, Illinois	WWF	No	Dry Ditch Flume
SIL-TMA-070	39.6	UNT to South Fork Otter Creek	E	5	0	5	GEN, PFPWS	Jersey, Illinois	WWF	No	Dry Ditch Flume
SIL-JJP-127	39.7	UNT to South Fork Otter Creek	E	4	0	4	GEN, PFPWS	Jersey, Illinois	WWF	No	Dry Ditch Flume
SIL-TMA-066	39.8R	UNT to South Fork Otter Creek	P	12	6	13	GEN, PFPWS	Jersey, Illinois	WWF	No	Dry Ditch Flume
NHD-849	40.9	UNT to South Fork Otter Creek	IT	N/A	N/A	N/A	GEN, PFPWS	Jersey, Illinois	WWF	No	Dry Ditch Flume
NHD-850	41	UNT to South Fork Otter Creek	IT	N/A	N/A	N/A	GEN, PFPWS	Jersey, Illinois	WWF	No	Dry Ditch Flume
SIL-CDK-001	41.5	UNT to South Fork Otter Creek	P	25	3	32	GEN, PFPWS	Jersey, Illinois	WWF	No	Dry Ditch Flume
SIL-CDK-002	41.5	UNT to South Fork Otter Creek	IT	4	2	4	GEN, PFPWS	Jersey, Illinois	WWF	No	Dry Ditch Flume
SIL-CDK-003	41.6	UNT to South Fork Otter Creek	E	5	0	5	GEN, PFPWS	Jersey, Illinois	WWF	No	Dry Ditch Flume
NHD-869	42	UNT to Otter Creek	IT	N/A	N/A	N/A	GEN, PFPWS	Jersey, Illinois	WWF	No	Dry Ditch Flume
NHD-874	42.5	UNT to Mill Creek	IT	N/A	N/A	N/A	GEN, PFPWS	Jersey, Illinois	WWF	No	Dry Ditch Flume
NHD-902	44.2	UNT to Mississippi River	IT	N/A	N/A	N/A	GEN, PFPWS	Jersey, Illinois	WWF	No	Dry Ditch Flume

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Table 2.2-2. Waterbodies Crossed by the Project (Continued)

Feature ID[1]	MP	Waterbody Name	Flow Regime[2]	Average Bank to Bank (Channel) Width (feet)	Average Water Width (feet)	Pipeline or Access Road Crossing Length (feet)[3]	State Water Quality Classification[4, 5]	County, State	Fishery Type[6]	Impaired Designated Use (Identified Pollutant)[7]	Crossing Method[8]
24-Inch Pipeline (continued)											
NHD-908	44.5	UNT to Mississippi River	IT	N/A	N/A	N/A	GEN, PFPWS	Jersey, Illinois	WWF	No	Dry Ditch Flume
NHD-913	45	UNT to Mississippi River	IT	N/A	N/A	N/A	GEN, PFPWS	Jersey, Illinois	WWF	No	Dry Ditch Flume
NHD-915	45.1	UNT to Mississippi River	IT	N/A	N/A	N/A	GEN, PFPWS	Jersey, Illinois	WWF	No	Workspace
NHD-917	45.2	UNT to Mississippi River	IT	N/A	N/A	N/A	GEN, PFPWS	Jersey, Illinois	WWF	No	HDD
NHD-921	45.3	Mississippi River	P	N/A	3,020*	N/A	Illinois: GEN, PFPWS Missouri: LWW, AQL, WBC-Category A, SCR, DWS, IND	Jersey, Illinois St. Charles, Missouri	WWF WWF	Illinois: Fish Consumption [Polychlorinated Biphenyls ("PCBs") and Mercury], Primary Contact Recreation (Fecal Coliform) Missouri: Category B (*E. coli*)	HDD
SMO-WJW-001, NHD-924	46	Luesse Lake	P	350*	350*	N/A	AQL, WBC - Category B, SCR, LWW, IRR	St. Charles, Missouri	WWF	No	HDD
SMO-TMA-008	46.3	UNT to Mississippi River	E	2	0	0	AQL, WBC - Category B, SCR, LWW, IRR	St. Charles, Missouri	WWF	No	Workspace Only
SMO-JJP-030	46.5	UNT to Mississippi River	E	3	0	0	AQL, WBC - Category B, SCR, LWW, IRR	St. Charles, Missouri	WWF	No	Workspace Only
SMO-TMA-011	46.7	UNT to Mississippi River	E	2	0	0	AQL, WBC - Category B, SCR, LWW, IRR	St. Charles, Missouri	WWF	No	Workspace Only
SMO-JJP-004	47R	UNT to Mississippi River	E	2	0	2	AQL, WBC - Category B, SCR, LWW, IRR	St. Charles, Missouri	WWF	No	Dry Ditch Flume
SMO-JJP-003	47.7R	UNT to Mississippi River	E	4	0	4	AQL, WBC - Category B, SCR, LWW, IRR	St. Charles, Missouri	WWF	No	Dry Ditch Flume
SMO-TMA-006	47.8R	UNT to Mississippi River	P	60	20	60	AQL, WBC - Category B, SCR, LWW, IRR	St. Charles, Missouri	WWF	No	Dry Ditch Flume
SMO-JJP-001	48.5	UNT to Mississippi River	E	4	0	4	AQL, WBC - Category B, SCR, LWW, IRR	St. Charles, Missouri	WWF	No	Dry Ditch Flume
SMO-TMA-009	49.6	UNT to Mississippi River	E	6	0	6	AQL, WBC - Category B, SCR, LWW, IRR	St. Charles, Missouri	WWF	No	Dry Ditch Flume
SMO-TMA-005	52	UNT to Missouri River	E	4	0	4	AQL, WBC - Category B, SCR, LWW, IRR	St. Charles, Missouri	WWF	No	Dry Ditch Flume
SMO-TMA-004	52.1	UNT to Missouri River	E	3	0	3	AQL, WBC - Category B, SCR, LWW, IRR	St. Charles, Missouri	WWF	No	Dry Ditch Flume
SMO-TMA-003	52.2	UNT to Missouri River	E	3	0	2	AQL, WBC - Category B, SCR, LWW, IRR	St. Charles, Missouri	WWF	No	Dry Ditch Flume
SMO-TMA-002	52.3	UNT to Missouri River	E	2	0	2	AQL, WBC - Category B, SCR, LWW, IRR	St. Charles, Missouri	WWF	No	Dry Ditch Flume
PMO-TMA-001	54.5	None	Pond	N/A	N/A	73	N/A	St. Charles, Missouri	WWF	No	Dry Ditch Flume
SMO-TMA-001	57.9	Missouri River (oxbow)	P	175*	165*	345*	AQL, WBC - Category B, SCR, LWW, IRR	St. Charles, Missouri	WWF	No	HDD
SMO-CDK-001	58.2	Missouri River	P	1,335*	1,300*	1,320*	IRR, LWW, AQL, WBC - Category B, SCR, DWS, IND	St. Louis, Missouri	WWF	WBC-Category B (*E. coli*)	HDD
North County Extension											
SMO-JJP-023	0.6	UNT to Missouri River	E	4	0	0	AQL, WBC - Category B, SCR, LWW, IRR	St. Louis, Missouri	WWF	No	Workspace Only
SMO-JJP-022	0.9	UNT to Missouri River	P	6	2	6	AQL, WBC - Category B, SCR, LWW, IRR	St. Louis, Missouri	WWF	No	Dry Ditch Flume
SMO-JJP-024	1.1	UNT to Missouri River	E	4	0	4	AQL, WBC - Category B, SCR, LWW, IRR	St. Louis, Missouri	WWF	No	Dry Ditch Flume
SMO-JJP-022	1.1 - 1.2	UNT to Missouri River	P	6	2	35	AQL, WBC - Category B, SCR, LWW, IRR	St. Louis, Missouri	WWF	No	Dry Ditch Flume
SMO-JJP-026	1.2	UNT to Missouri River	E	6	0	6	AQL, WBC - Category B, SCR, LWW, IRR	St. Louis, Missouri	WWF	No	Dry Ditch Flume
SMO-JJP-027	1.2	UNT to Missouri River	E	6	1	6	AQL, WBC - Category B, SCR, LWW, IRR	St. Louis, Missouri	WWF	No	Dry Ditch Flume
SMO-JJP-020	1.9	Coldwater Creek	P	125	80	N/A	LWW, AQL, WBC - Category B, IND[9]	St. Louis, Missouri	WWF	AQL (Chloride) and WBC-Category B, SCR (*E. coli*)	HDD

Table 2.2-2. Waterbodies Crossed by the Project (Continued)

Feature ID[1]	MP	Waterbody Name	Flow Regime[2]	Average Bank to Bank (Channel) Width (feet)	Average Water Width (feet)	Pipeline or Access Road Crossing Length (feet)[3]	State Water Quality Classification[4, 5]	County, State	Fishery Type[6]	Impaired Designated Use (Identified Pollutant)[7]	Crossing Method[8]
North County Extension (continued)											
SMO-JJP-032	2	UNT to Coldwater Creek	P	15	4	14	AQL, WBC - Category B, SCR, LWW, IRR	St. Louis, Missouri	WWF	No	HDD
NHD-955	2.9	UNT to Coldwater Creek	IT	N/A	N/A	N/A	AQL, WBC - Category B, SCR, LWW, IRR	St. Louis, Missouri	WWF	No	Dry Ditch Flume
NHD-962	3.4	UNT to Coldwater Creek	IT	N/A	N/A	N/A	AQL, WBC - Category B, SCR, LWW, IRR	St. Louis, Missouri	WWF	No	Dry Ditch Flume
SMO-JJP-015	5.3	UNT to Mississippi River	P	14	5	14	AQL, WBC - Category B, SCR, LWW, IRR	St. Louis, Missouri	WWF	No	Dry Ditch Flume
SMO-JJP-012	5.5	UNT to Mississippi River	P	35	5	40	AQL, WBC - Category B, SCR, LWW, IRR	St. Louis, Missouri	WWF	No	Dry Ditch Flume
SMO-DFW-015	5.9	UNT to Watkins Creek	P	4	2.3	0	AQL, WBC - Category B, SCR, LWW, IRR	St. Louis, Missouri	WWF	No	Workspace Only
SMO-JJP-007	5.9	UNT to Watkins Creek	IT	6	0	0	AQL, WBC - Category B, SCR, LWW, IRR	St. Louis, Missouri	WWF	No	Workspace Only
Laclede/Lange Delivery											
SMO-DFW-002	0	UNT to Missouri River	E	6	0	0	N/A	St. Louis, Missouri	WWF	No	Workspace Only[10]
Access Roads											
SIL-TMA-049	24.8R	UNT to Macoupin Creek	IT	5	1.5	5	GEN, PFPWS	Greene, Illinois	WWF	No	TAR-012 - Existing Road/Stream Culverted
SIL-JJP-104	25.8R	UNT to Macoupin Creek	P	8	3	0	GEN, PFPWS	Greene, Illinois	WWF	No	TAR-018 - Workspace Only
SIL-JJP-103	26.1	UNT to Macoupin Creek	IT	4	0.5	4	GEN, PFPWS	Greene, Illinois	WWF	No	TAR-014 - Existing Road/Stream Culverted
SIL-TMA-044	26.1	UNT to Macoupin Creek	IT	7	4	7	GEN, PFPWS	Greene, Illinois	WWF	No	TAR-014 - Existing Road/Stream Culverted
SIL-CDK-029	36.6R	UNT to Otter Creek	IT	5	3	5	GEN, PFPWS	Jersey, Illinois	WWF	No	TAR-015 - Existing Access/Stream Culverted
SMO-JJP-002	46.9R	UNT to Mississippi River	E	5	0.2	0	AQL, WBC - Category B, SCR, LWW, IRR	St. Charles, Missouri	WWF	No	PAR-018 - Workspace Only

Notes:

1 Map Designation - the unique code designated to the waterbodies identified during the field surveys. A unique identifier was also assigned to NHD data that was used to supplement field delineations on properties without survey permissions or in areas that are pending studies. Project facilities not listed do not impact streams.

2 Flow regime based on USGS topographic mapping and onsite field review. IT - Intermittent; E - Ephemeral; and P - Perennial.

3 Crossing width is the bank-to-bank width of stream at the pipeline or access road centerline crossing unless noted otherwise. N/A-Not applicable indicates that these waterbodies are desktop identified and therefore no crossing lengths are currently known.

4 Water quality standards are contained in 35 IAC Section 302. Water use designation and site-specific water quality standards are contained in 35 IAC Section 303. General Use Waters (GEN) - Except as otherwise specifically provided, all waters of the State (Illinois) must meet the general use standards of Subpart B of Part 302. The General Use standards will protect the State's (Illinois) water for aquatic life (except as provided in Section 302.213), wildlife, agricultural use, secondary contact use and most industrial uses and ensure the aesthetic quality of the State's (Illinois) aquatic environment. Public and Food Processing Water Supplies (PFPWS) - Except as otherwise specifically provided and in addition to the general use standards of Subpart B, Part 302, waters of the State shall meet the public and food processing water supply standards of Subpart C, Part 302, at any point at which water is withdrawn for treatment and distribution as potable supply for food processing.

5 Water quality classifications in Missouri are contained in 10 CSR 20-7.031. Last revised January 29, 2014 (MDNR 2014). Codes for the designated uses are as follows: IRR - Irrigation, LWW - Livestock & Wildlife Watering, AQL - Protection of Warm Water Aquatic Life and Human Health-Fish Consumption, SCR - Secondary Contact Recreation, DWS - Drinking Water Supply, WBC - Whole Body Contact Recreation, IND - Industrial.

6 Initial consultation with the IEPA have indicated that all waters of Illinois are considered general use waters and no waters of the state are designated as cold water fisheries (IEPA 2016d). Water Quality Standards Table C of Missouri 10CSR20.7 lists Waters Designated for Cold-Water Fisheries (MDNR 2014). Luesse Lake is contained within the Mississippi River valley and was designated by the NWI layer as a L1UBHH - Lacustrine, Limnetic, Unconsolidated Bottom.

7 State impaired waters have been defined by the Section 303(d) lists for Illinois (IEPA 2016c) and Missouri (MDNR 2016d).

8 With the exception of those listed as HDD, Spire will assume a dry ditch flume crossing method unless the feature has no discernable flow at the time of construction. Conventional open cut method will be employed, where allowable, if the feature is dry.

9 Classified by the MDNR as a Metropolitan No-Discharge Stream, located in Chapter 7 10 CSR 20-7.031 of the Clean Water Commission created by the MDNR. Last revised January 29, 2014 (MDNR 2014).

10 Feature avoided by final facility design as shown in Resource Report 1, Appendix 1-F.

* Measured using aerial photography (2016).

Five perennial waterbodies equal to or greater than 100 feet wide were identified within the Project area: Macoupin Creek, the Mississippi River, the Missouri River, an oxbow of the Missouri River, and Coldwater Creek. As described in Table 2.2-2, waterbody features greater than 100 feet wide (Feature IDs: NDH-921, SMO-CDK-001, SMO-TMA-001, SMO-JJP-020), along with their adjacent waters (Feature IDs: NHD-915, NHD-924/NWI-505/SMO-WJW-001, SMO-JJP-032), are proposed to be crossed using the HDD method; therefore, no direct impact to the rivers is anticipated. Site-specific, cross-section drawings of these HDD crossings are depicted in Appendix 2-D. Spire has also provided a HDD Contingency Plan in Appendix 2-B.

The Macoupin Creek crossing was adjusted to the west since January 2017 (now Feature ID: SIL-JJP-148). The 145-foot crossing is currently proposed to be crossed by the flume method. Spire evaluated the use of trenchless crossing methods at Macoupin Creek, and it was determined unfeasible due to location of adjacent wetlands and unsuitable bore sites (e.g., surveyed wetlands in the area, potential need for groundwater pumping at deep bore sites due to the stream's high banks) which could result in additional wetland and water impacts. The site-specific crossing of Macoupin Creek is provided in Appendix 2-D.

General construction methods at waterbodies are discussed in Section 2.2.6.

2.2.2 Water Quality

2.2.2.1 Contaminated Sediments

Spire searched the IEPA, IDNR, and MDNR databases for potential contaminated streams and sites. The primary potential sources of sediment contamination in the Project area are agricultural fields containing fertilizers and pesticides, leachate from feed lots and leeching fields, or natural background geologic sources. The USEPA's National Sediment Quality Survey ("NSQS") was examined to generally characterize potential contamination of aquatic bed sediment found throughout the Project area.

According to the NSQS reports, the Macoupin Watershed (HUC 8 - 07130012) was identified as an area of probable concern for sediment contamination (USEPA 2004a); however, the stream segment within the Project area (Macoupin Creek, HUC 10 - 0713001206) is not present on the IEPA total maximum daily load report (IEPA 2007), nor is segment 0713001206 listed for suspended solids on the current 303(d) list (IEPA 2016c). Thus, no crossing restrictions are anticipated. The Project's crossing of Macoupin Creek will be flumed and trenched, and Spire will minimize downstream sedimentation by utilizing instream construction methods and establishing erosion and sediment controls per FERC's Plan and Procedures, applicable state and local regulations and guidance documents, and Project-specific E&SCPs.

The Project crosses Coldwater Creek within the metropolitan no-discharge stream reach as found in 10CSR 20-7.031, Table F (MDNR 2014). Due to the stream's designation, no direct impacts are permitted without obtaining an Individual 401 water quality certification from the MDNR; Spire obtained the Individual 401 water quality certification for the crossing of Coldwater Creek in November 2016, which is valid through the completion of construction. However, due to the Project modification to cross Coldwater Creek utilizing HDD techniques, an individual 401 water quality certification is no longer required. Spire also coordinated with the USACE Formerly Utilized Sites Remedial Action Program ("FUSRAP") regarding crossing Coldwater Creek with an open cut method.

The USACE FUSRAP indicated that their current sampling efforts are revealing the sources of contaminants have been removed upstream and there is an unlikely possibility for contaminants to migrate. The USACE FUSRAP reviewed Spire's open cut crossing plan and proposed soil disturbance areas and determined that there is not contamination or a pathway for future contamination at the crossing location (Prebianca 2016a, 2016b, and Rankins 2016). Spire consulted with the USACE FUSRAP regarding the proposed crossing method change at Coldwater Creek. The USACE FUSRAP confirmed there were no concerns for the crossing or any need for utility support there (Rankins 2017). Copies of the correspondence are provided in Resource Report 1, Appendix 1-C.

The USEPA's List of Sediment Sites with Substantial Contamination was also examined for Superfund sites within the Project area. The West Lake Landfill Superfund Site is a USEPA Superfund Site located in Bridgeton, Missouri consisting of several inactive landfills, including the West Lake Landfill and Bridgeton Landfill. The Project is located approximately 11.4 miles northeast of these landfills and therefore no issues of contamination are expected during construction. No superfund sites are located within one mile of the Project area (USEPA 2015).

2.2.2.2 Impaired Waters

A review of statewide 303(d) Impaired Waters (IEPA 2016c and MDNR 2016d) identified several waterbodies crossed by the Project in Illinois and Missouri that are designated as impaired. Under Section 303(d) of the 1972 Clean Water Act, states, territories, and authorized tribes are required to develop a list of waters which do not meet or are not expected to meet applicable water quality standards. The proposed Project crosses several streams in Illinois and Missouri listed on the respective 2016 List of Impaired Waterbodies for the 303(d) program as listed in Table 2.2-2, including Apple Creek, Macoupin Creek, and the Mississippi River in Illinois, and the Mississippi River, Missouri River, and Coldwater Creek in Missouri.

In Illinois, Apple Creek is impaired for aquatic life due to dissolved oxygen, Macoupin Creek is impaired for primary contact recreation due to fecal coliform, and the Mississippi River is impaired for primary contact recreation and fish consumption for mercury, PCB, and fecal coliform. In Missouri, the Mississippi River is impaired for water body contact recreation for *Escherichia coli* (*E. coli*). Other listed streams in Missouri include the Missouri River, which is impaired for water contact recreation due to the presence of *E. coli,* and Coldwater Creek, whose designated uses are impaired for aquatic life, primary water contact recreation, and secondary contact recreation from the presence of chloride and *E. coli*. Coldwater Creek is also listed by the MDNR as a metropolitan no-discharge stream and was previously discussed in Section 2.2.2.1 (Prebianca 2016). The Project does not cross waters impaired by suspended solids, turbidity, or siltation; therefore there are no regulatory restrictions for the crossing of 303(d) listed streams on the Project. Correspondence is provided Resource Report 1, Appendix 1-C.

The IEPA does not specify special requirements for any of the stream crossings in the Project area. However, Missouri will not validate a Section 404 Permit issued on a water that is listed as impaired by inorganic sediment, aquatic habitat alteration, or an unknown impairment. No streams crossed by the Project in Missouri are listed impaired under these designations.

Spire plans to cross all streams in Illinois and in Missouri in accordance with the FERC's Procedures. The potential for impacting the contaminated sediments or creating greater impairment to waterbodies on the Project is minimal. Erosion control devices will be installed to prevent sediment from entering waterbodies from the disturbed Project area. Additional procedures to avoid or mitigate contaminant impacts are provided in the SPCC Plan in Appendix 2-A and state and/or local permitting efforts. Erosion and sediment control best management practices (“BMPs”), such as flume pipe stream bypass methods, immediate streambed and bank stabilization, and installation of sediment barriers, will be established in Project-specific E&SCPs as part of the required regulatory approvals.

2.2.2.3 Designated or Sensitive Surface Waters

Sensitive waterbodies include those designated under Section 305(b) or Section 303(d) of the CWA for domestic use; where fish or other listed species are present; and/or outstanding or exceptional quality waterbodies, waters of recreational importance, protected watershed areas, surface waters that have important riparian areas, and rivers on the designated rivers inventory.

No known wild trout streams, high quality waters, waterbodies listed as outstanding or exceptional quality, or state or federal wilds and scenic rivers occur within the Project area [IEPA 2016d, MDNR 2016b, MDNR 2014, and the United States Fish and Wildlife Service (“USFWS”) 2016].

The Mississippi River is listed by the USACE as a Section 10 federally navigable water, a state fish and wildlife designated area, and also contains federally-listed and state-listed threatened and endangered species (IEPA 2016b, USACE 2016a, and USFWS 2013). The Missouri River is also designated as a critical resource for federally-listed and state-listed threatened and endangered species and as a Section 10 federally navigable water (USACE 2016b and USFWS 2013).

Spire is crossing both rivers by the HDD method to protect these sensitive waters. Although trenchless methods are adopted to avoid impacts on water quality with no disturbance to streams’ bank, channel, and bottom, a potential for an inadvertent return of drilling mud may occur, and the release could result in a plume extending from the discharge point downstream. Sections 2.2.6.3 and 2.2.6.5, discusses the HDD crossing method and Spire’s action plans for inadvertent releases.

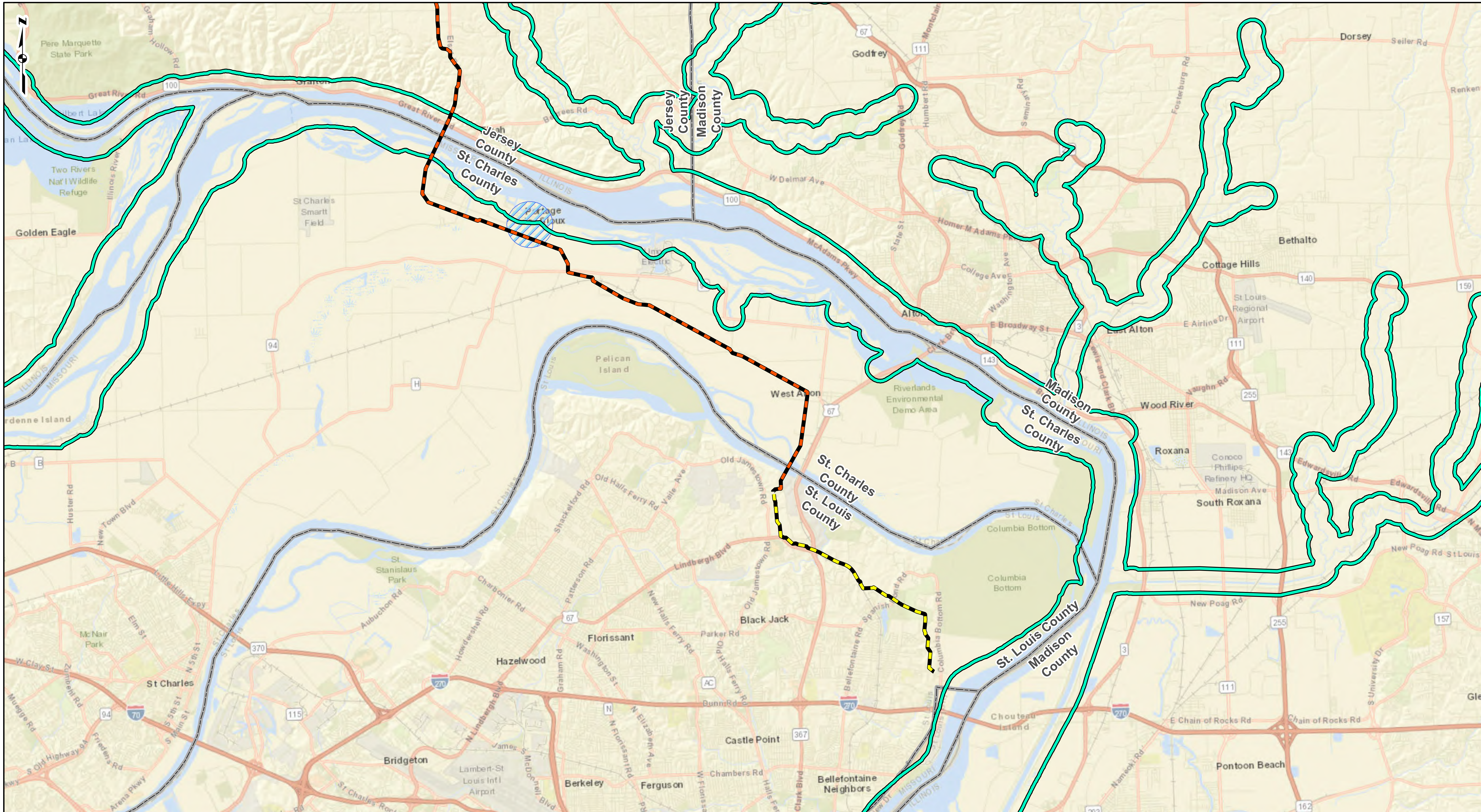
2.2.2.4 Water Protection Areas

Mississippi River

The Mississippi River is designated by Illinois and Missouri’s respective 303(d) lists as a drinking or public water supply (IEPA 2016c) (MDNR 2016d). Table 2.2-3 identifies two public water protection areas in the vicinity of the Project near the Mississippi River: the Mississippi River Water Supply Intake Protection Area (IEPA 2016b) and the Portage Des Sioux Water Plant (MDNR 2008a) source water area. Figure 2.2-1 identifies the location of the public water protection areas.

Missouri River

According to the MDNR’s Section 305(b) list, the Missouri River is listed as a drinking water supply (MDNR 2016d). No public drinking water pumping and booster station, tanks, active water wells, water intakes or springs, supply districts, or intake watersheds for lakes or rivers were identified within the immediate Project area or three miles downstream of the waters in Missouri (MDNR 2016a).



PROJECT LOCATION

JERSEY COUNTY, ILLINOIS AND ST. CHARLES AND ST. LOUIS COUNTIES, MISSOURI

REFERENCE: WORLD STREET MAP, 2016, ESRI, HERE, DELORME, USGS, INTERMAP, INCREMENT P, NRCAN, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), ESRI (THAILAND), MAPMYINDIA, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY, ACCESSED 03/2017.

LEGEND

- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
- COUNTY BOUNDARY
- MISSISSIPPI RIVER WATER INTAKE PROTECTION AREA
- PORTAGE DES SIOUX PUBLIC WATER PLANT 0.5 MILE BUFFER

0 1 2 4 Miles

FIGURE 2.2-1
SOURCE WATER PROTECTION AREAS MAP

gai consultants

SPIRE STL PIPELINE PROJECT

spire

DRAWN BY: PMH
DATE: 3/27/2017
CHECKED: EFJ
APPROVED: LMF

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Table 2.2-3. Public Water Supply Protection Areas Crossed by the Project

City/County, State	Approximate MPs	Public Water Supply	Distance/Direction of Water Supply from Project Facilities (miles)	Project Facilities Upstream/Downstream of Withdrawals
24-Inch Pipeline				
Granite City and Alton City, Illinois	44.8 to 45.9	Mississippi River Water Supply Intake Protection Area, operated by Illinois American Water Company	9.0 miles downstream of HDD	Mississippi River HDD Crossing Upstream of Intake
St. Charles County, Missouri	N of 49.2	Portage Des Sioux Water Plant (Public Water Supply Well, Water Treatment, and Water Tank)	2.5 miles downstream of HDD; 0.2-mile north of construction right-of-way	Mississippi River HDD Crossing Upstream of the Public Water Well

Note:

[1] Facilities not listed do not impact public water supplies. North County Extension does not cross water supply protection areas.

The Mississippi River Water Supply Intake Protection Area, designated by the IEPA, is sourced from the Illinois American Water Company ("IAWC") divisions in Granite City and Alton City. No water supply intakes were located three miles downstream of the Mississippi River crossing in Illinois (IEPA 2016b). No adverse impacts are anticipated for the Mississippi River Water Supply Intake Protection Area as the IAWC intake location is located approximately nine miles downstream of the Project's HDD location. Copies of correspondence are provided in Resource Report 1, Appendix 1-C.

MDNR (2008b) uses a 0.5-mile radius to initially assess source water areas around public wells. The proposed centerline for the 24-inch pipeline in St. Charles County, Missouri crosses within their established buffer for the Portage Des Sioux Water Plant. According to MDNR (2008a) data layers, the Portage Des Sioux Public Water Plant contains a public drinking water well, water treatment plant, and water tank (tower). The water well was drilled in 1967 to a depth of 116 feet in the alluvium layer of the Mississippi River. While the well is located 2.5 miles downstream of the HDD crossing of the Mississippi River, construction workspace associated with the 24-inch pipeline is located approximately 1,450 feet south of the well. Upland pipeline construction is proposed through this area south of Portage Des Sioux in which the pipe is buried a minimum of five feet below surface at agricultural fields or seven feet below surface at floodplains, and no blasting is proposed within the county. Recharge to alluvium layers of the river can be received from infiltration from the river, from bedrock adjacent to and underlying the alluvium, from precipitation falling upon the floodplain, and from downward leakage of water from streams flowing across the alluvium; however, recharge typically occurs during high flow stages of the river with groundwater movement from bedrock to the alluvium (MDNR 2016c). The Web Soil Survey (USDA-NRCS 2016b) identifies soils ranging from silty clay loam to clay textures within the source water buffer area; clays or silt cap overlying the more permeable sands and gravels will restrict or retard infiltration of surface water to alluvial aquifers (MDNR 2016c). No adverse impacts are anticipated given the distance from the well; depth of the well; and pipeline construction methods, depths, and soils proposed in the buffer area. Spire has consulted with the MDNR Wellhead Protection Program and MDNR Public Drinking Water Branch to see if any restrictions occur at the 0.5-mile radius source protection buffer area. The Wellhead Protection Program stated their program does not have restrictions for pipeline/utility development in regards to public source waters/wells as they only handle domestic wells and give guidance to contact the Public Drinking Water Branch at MDNR (Rollins 2016). Spire has communicated general project information to the MDNR Public Drinking Water Branch (Baker and Jaafari 2017) and will continue to discuss the proposed Project plans with their department regarding the Portage Des Sioux Water Plant buffer area and the two HDD crossings. In February 2017, the MDNR Public Drinking Water Branch (Tomlin 2017) and the City of Portage Des Sioux (Warner 2017) confirmed no local or state regulations or zoning ordinances occur at the half-mile buffer protection area. Copies of correspondence are provided in Resource 1, Appendix 1-C.

Spire developed a HDD Contingency Plan for the crossing of the Mississippi and Missouri Rivers, Coldwater Creek, and Spanish Lake Park as a FERC requirement in accordance with Section V.B.6.d of the FERC's Procedures (IEPA 2016b). Spire consulted the IEPA regarding the Mississippi River Water Protection Area intake protection area; IEPA confirmed that there are no crossing restrictions associated with the area (Cook 2016); and as mentioned previously, Spire will follow up with the MDNR Public Drinking Water Branch to address specifics of the crossing. Copies of correspondence are provided in Resource 1, Appendix 1-C.

2.2.3 Floodplains

Table 2.2-4 lists the 100-Year Federal Emergency Management Agency ("FEMA") flood zones crossed by the Project with corresponding mapping provided in Appendix 2-E. Crossing methods to be used within each flood zone is provided in the table, and additional details are provided as site-specific cross-section drawings in Appendix 2-D. Spire is proposing to provide a minimum depth of cover of seven feet at floodplains; the HDD crossings at floodplains, as discussed in Section 2.2.6.3, are at depths much greater and well below river bottoms. The proposed cover will generally provide adequate scour protection from high flows and flooding. Prior to construction, field observations will be conducted to determine stability of the banks and appropriate bank stabilization techniques.

2.2.3.1 Illinois

Portions of the 24-inch pipeline will be located within the FEMA 100-year flood zones of Apple Creek and Macoupin Creek in Greene County, Illinois, and Otter Creek and the Mississippi River in Jersey County, Illinois. Temporary impacts within the FEMA 100-year flood zones are unavoidable due to the long linear nature of the floodplain and the proposed Project route. Construction of the pipeline throughout these areas will not result in placement of any permanent fill above existing grade within the flood zones.

Spire will prepare and submit required documentation for County Floodplain Development Permits for the portions of the proposed pipeline and associated construction right-of-way, access roads, and ATWS located within the FEMA 100-year flood zones in Jersey County and Greene County, Illinois. Spire anticipates to submit applications for floodplain permits in early October 2017.

Table 2.2-4. 100-Year Flood Zones Crossed by the Project

Flood Zone Crossed (by MP)	Waterbody Associated with Flood Zone	County, State	Crossing Method	Permanent Above Ground Structures in Flood Zone
24-Inch Pipeline				
13.8 - 14.4	Apple Creek	Greene County, Illinois	Proposed upland and wetland open trenching; Dry Ditch Flume of stream	No
25.0R - 25.1R	UNT to Macoupin Creek	Greene County, Illinois	Dry Ditch Flume	No
25.2R - 25.6R	Macoupin Creek	Greene County, Illinois	Proposed upland and wetland open trenching; Dry Ditch Flume of stream	No
36.5R - 36.7R	Otter Creek	Jersey County, Illinois	Proposed upland and wetland open trenching; Dry Ditch Flume of stream	No
45.0 - 47.1R	Mississippi River[1]	Jersey County, Illinois and St. Charles County, Missouri	Proposed upland and wetland open trenching; HDD of river and adjacent wetlands/waters	Yes, MLV at MP 46.2
47.4R - 57.8[2]	Mississippi and Missouri Rivers	St. Charles County, Missouri	Proposed upland and wetland open trenching; Dry Ditch Flume of streams crossed within this portion	No
57.8 - 58.3	Missouri River[1]	St. Charles and St. Louis Counties, Missouri	HDD of river and adjacent wetlands/waters	No
North County Extension				
1.9 - 2.0	Coldwater Creek[1]	St. Louis County, Missouri	HDD	No
Chain of Rocks Station				
N/A[3]	Mississippi River	St. Louis County, Missouri	N/A[4]	Fence/gravel

Notes:

1 Regulated floodway also crossed.

2 Milepost range provided for large floodplain between the two rivers.

3 N/A - Not Applicable, station has no mileposts. Approximately 1,100 feet within the flood zone.

4 N/A - Not Applicable as a crossing; station design is discussed in Section 2.2.3.2.

2.2.3.2 Missouri

A portion of the 24-inch pipeline will be located within the FEMA 100-year flood zone and FEMA regulatory floodway of the Mississippi River, Missouri River, and tributaries to the Missouri River, including Coldwater Creek. This includes the crossing of the Mississippi River and the crossing of the Missouri River, as well as the proposed 24-inch pipeline alignment across the floodplain from approximately MP 45.0 through MP 58.1. Construction of the pipeline through these floodplains and floodway areas will be crossed using HDD, where feasible. However elsewhere, temporary impacts within the FEMA flood zones are unavoidable due to the long linear nature of the floodplain and the route of the Project.

As currently proposed along the 24-inch pipeline route, the HDD workspaces for the Mississippi River HDD crossing are within the FEMA 100-year flood zone, and the HDD workspace on the south side of the river in St. Charles

County is also partially within the regulated floodway. The permanent aboveground mainline valve ("MLV") also at this HDD workspace area (at approximately MP 46.2) is just outside of the regulated floodway, though still within the FEMA 100-year flood zone. At the Missouri River HDD crossing, the HDD workspace on the north side of the river in St. Charles County is within the FEMA 100-year flood zone and the regulated floodway, however, the HDD workspace on the south side of the river is outside of both the 100-year flood zone and floodway.

The proposed Chain of Rocks Station on the North County Extension in St. Louis County is partially located within the limits of the Mississippi River FEMA 100-year flood zone, though not within the regulated floodway. A small area (less than 0.05 acre) will be fenced and permanently graveled within the LGC previously disturbed right-of-way adjacent to the existing Enable Mississippi River Transmission, LLC Chain of Rocks Station; the fenced and graveled area is within the limits of the floodplain.

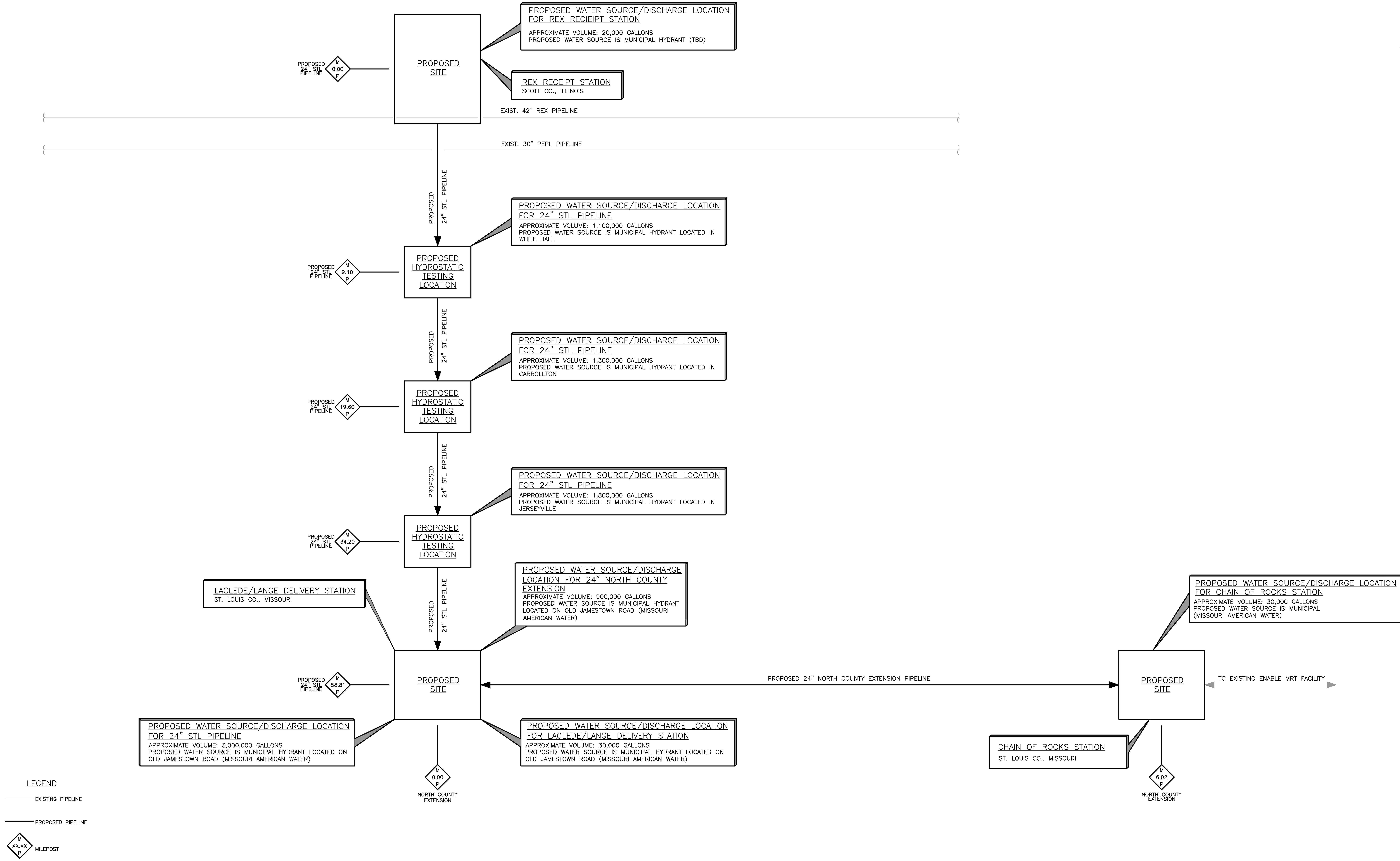
Spire will prepare and submit required documentation for Floodplain Development Permits for the portions of the proposed pipeline (and associated construction right-of-way, valve and meter stations, access roads, and ATWS) located within the FEMA 100-year flood zones and a No-Rise Certification (for regulatory floodway crossings) to St. Louis County, St. Charles County, and the City of West Alton. Spire anticipates to submit applications for floodplain permits in early October 2017. If necessary, Spire will perform a hydrologic and hydraulic analysis as part of the permit submittals.

2.2.4 Water Use

2.2.4.1 Hydrostatic Testing Water Use

The Project will be hydrostatically tested to ensure that it is capable of safely operating at the design pressure. Spire plans to source water necessary for hydrostatic testing from municipal water supply. Table 2.2-5 and Figure 2.2-2 display the anticipated water quantities for hydrostatic testing per pipeline test segment as well as the proposed discharge location. Spire is working out agreements with local municipalities to identify specific municipal water withdrawal locations, rates, and amounts. No water treatment (chemicals or inhibitors) are necessary during or after the hydrostatic testing.

Hydrostatic testing will occur at test segments by MP. In accordance with Pipeline and Hazardous Materials Safety Administration ("PHMSA") requirements, each segment will be capped and filled with water and pressurized for a minimum of eight hours prior to the pipeline being placed in service. Any leaks or unexplained pressure losses detected during this process are subsequently repaired and retested. As hydrostatic testing completes at a segment, the test water may be pumped to the next segment for testing or the water may be discharged in accordance with state permitting requirements. Test water will be discharged through an energy-dissipating device. Once a pipeline segment has been successfully tested and dried, the test cap and manifold will be removed and the pipe will be connected to the remainder of the pipeline.



2	04/2017	MAP	FERC AMENDMENT FILING	DGG	JEW
Rev	Date	Drawn	Description	Ch'k'd	App'd

Prepared By: MOTT MACDONALD

Prepared For: Spire STL Pipeline

Designed	MAP	Eng check	MAP
Drawn	MAP	Coordination	MAP
Dwg check	DGG	Approved	JEW
Scale at ARCH D: NONE	Status	Rev: 2	Security

Project Number: 372453 | B/O | Total

Drawing Number: HYDRO-001

Title:
SPIRE STL PIPELINE PROJECT
SPIRE 24-INCH PIPELINE AND 24-INCH NORTH COUNTY EXTENSION PIPELINES
HYDROSTATIC TEST PLAN
OVERALL SCHEMATIC

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Table 2.2-5. Hydrostatic Test Water Segments, Volumes, Sources, and Discharge Locations

Pipeline Test Segments		Approximate Volume (gallons)	Water Source	Discharge Location (MP)
Begin MP	End MP			
24-Inch Pipeline				
0.00	9.10	1,100,000	Municipal Hydrant	9.10
9.10	19.60	1,300,000	Municipal Hydrant	19.60
19.60	34.20	1,800,000	Municipal Hydrant	34.20
34.20	58.81	3,000,000	Municipal Hydrant	58.81
REX Receipt Station				
0.00		30,000	Municipal Hydrant	0.00
Laclede/Lange Delivery Station				
58.81		30,000	Municipal Hydrant	58.81
North County Extension				
0.00	6.02	900,000	Municipal Hydrant	0.00
Chain of Rocks Station				
6.02		30,000	Municipal Hydrant	6.02

2.2.4.2 HDD Drilling Water Use

As previously discussed, the HDD crossing method is proposed at the Mississippi and Missouri Rivers, Coldwater Creek and Spanish Lake Park. Potential water sources and estimated volumes necessary for each HDD installation are identified in Table 2.2-6. In sum, approximately 4.5 million gallons of water are estimated for HDD drilling at the Project. Spire's water withdrawals are being developed to ensure quantities do not surpass allowable quantities as permitted. Spire will apply for the appropriate water withdrawal and water disposal permits using a preliminary plan based on estimated water volumes and withdrawal timing needs for construction.

HDD waste water disposal locations will identified by a Spire HDD contractor prior to construction; disposal of all fluids and cuttings will be transported and disposed of at an appropriate disposal facility approved by Spire.

2.2.4.3 Dust Suppression Water Use

Water required for dust suppression will be obtained from municipal sources. As previously mentioned, Spire is working out agreements with local municipalities regarding water use.

Table 2.2-6. HDD Water Usage Estimates

HDD Location	Estimated Water Usage (gallons)[1]	Water Source
24-Inch Pipeline		
Mississippi River	2,800,000	Mississippi River or Municipal Water
Missouri River	1,600,000	Missouri River or Municipal Water
North County Extension		
Coldwater Creek	70,000	Municipal Water
Spanish Lake Park	70,000	Municipal Water

Note:

1 Approximate water volume required for executing the drill (pilot bore, reaming, swab, and pull-back operations) and for buoyancy control during construction. The listed quantities are conservative estimates and may vary based on site-specific conditions.

2.2.5 Construction Permits

Spire will obtain the necessary federal and state permits for water usage and construction at regulated waters and will conduct waterbody crossings in accordance with FERC Procedures, the USACE, and state requirements. A summary of permits and approvals associated with the proposed construction and operation of the Project is provided in Resource Report 1, Table 1.6-1. In addition, Spire anticipates obtaining permits to conduct the HDD crossings of the Mississippi and Missouri Rivers, Coldwater Creek, and Spanish Lake Park.

Floodplain development permits from Greene County, Illinois; Jersey County, Illinois; St. Louis County, Missouri; St. Charles County, Missouri; and the City of West Alton, Missouri will also be obtained.

In Illinois and Missouri, oil and gas activities are exempt from submitting for National Pollutant Discharge Elimination System ("NPDES") Construction Stormwater Permit provided that FERC Plan and Procedures and state BMPs are incorporated into construction activities. As previously mentioned, Project-specific E&SCPs will be developed using the more stringent of state and local regulations and/or FERC's Plan and Procedures.

Copies of correspondence are provided in Resource Report 1, Appendix 1-C.

2.2.6 Waterbody Construction and Mitigation Procedures

2.2.6.1 Construction

The Project, as proposed, will not cause permanent impacts on any surface waterbodies. Construction at waterbodies will be conducted in accordance with applicable state and local regulations and guidance manuals and the FERC's Procedures, unless variances are requested by Spire and approved by the FERC. Spire intends to implement the FERC's Procedures as a minimum standard for crossing and restoring waterbodies affected by the Project. Construction methods at waterbodies will vary with the characteristics of the waterbody encountered and will be consistent with permit conditions that will be outlined in the regulatory permit approvals as well as the Plan and Procedures which contain BMPs intended to reduce ground disturbance, minimize erosion and sediment runoff, and promote revegetation within the construction area.

Spire plans to utilize the dry ditch flume method at stream crossings, and the HDD method at river crossings. In accordance with FERC Procedures, waterbody flow will be maintained at all times during construction; where allowable, any crossings that are dry or frozen and not flowing may utilize open cut/conventional lay construction methods. Construction methods are described in Sections 2.2.6.1 to 2.2.6.3.

Spire proposes to limit waterbody impacts by reducing the construction right-of-way width to 75 feet at the waterbody crossings as displayed in Resource Report 8, Appendix 8-A.

Per the USACE's 2017 Nationwide Permit for Missouri, a new water quality certification specific condition was added for Nationwide 12 permits, requiring individual water quality certification review for new utility lines when the Project crosses more than one stream and result in greater than 500 linear feet and/or 0.5-acre of impact, except for directional boring crossings (Stout 2017); and, the permittee must not excavate from or discharge into the listed waters on the Missouri Combined Stream Spawning List during the specified seasonal restrictions (USACE 2017). No streams crossed by the Project within St. Charles or St. Louis Counties, Missouri, are listed on the spawning list, and no streams crossed by the Project are designated within the one mile buffer receiving waters for the listed streams. Spire has been in communication with the IEPA (Twait 2016a and 2016b), MDNR (Irwin 2016), and Missouri Department of Conservation (Beres 2017) regarding instream construction timing restrictions for warmwater fisheries; the state agencies have indicated there are no timing restrictions in Illinois and Missouri for the Project's waterbody crossings. Communications are provided in Resource Report 1, Appendix 1-C. Timing restrictions that differ from the FERC Procedures developed in consultation with the applicable state agencies is allowed under Section V of the FERC Procedures. Therefore, Spire anticipates that construction can occur at any time of year on the waterbodies crossed by the Project.

2.2.6.2 Dry Ditch Flume Crossing Method

Intermediate waterbodies (between 10 and 100 feet wide) and minor waterbodies (less than 10 feet wide) will be crossed by the dry ditch flume crossing method. Dry ditch flume is an alternative to the open cut method in which water flow is temporarily directed through one or more flume pipes placed over the excavation area. Temporary dams consisting of sand bags, bladders, or other impervious materials are installed upstream and downstream of the proposed crossing and are used to divert water into the flume(s). The use of the flume(s) allows trenching and pipeline installation to occur primarily in dry conditions without significant disruption of water flow.

In waterbodies less than 100 feet wide, pipe will be installed to provide a minimum of five feet of cover from the waterbody bottom to the top of the pipeline, except in consolidated rock, where a minimum of two feet of cover will be required. In waterbodies more than 100 feet wide, pipeline depth of cover will be at least five feet with the exception of a two-foot minimum depth of cover in consolidated rock. Trench spoil will be placed on the bank above the high water mark for use as backfill. Excavated material not required for backfill will be disposed of at an upland site within the Project's limits of disturbance or otherwise disposed of at a commercial disposal facility. Waterbody banks will be returned to pre-construction grade.

2.2.6.3 HDD

The HDD crossing method is typically utilized at wide or sensitive waterbodies to avoid direct impacts on sensitive resources and/or to avoid areas in which constructability by conventional means is not feasible. The HDD method allows for construction across wetland without the excavation of a trench, by drilling a hole significantly below conventional pipeline depth and pulling the pipe through the pre-drilled hole. Waterbodies proposed to be crossed by HDD are associated with the Mississippi and Missouri Rivers, Coldwater Creek, and Spanish Lake Park crossings. Spire conducted geotechnical borings at the river HDD crossing locations to determine the geology and feasibility of the drills. A portion of the geotechnical work has been conducted at the Coldwater Creek and Spanish Lake Park HDD crossing locations where survey access has been granted; remaining geotechnical work will be conducted as landowner permission is obtained.

The HDDs will allow for trenchless construction across the waterbodies and will eliminate planned impacts from construction activities within the waterbodies. Site-specific cross-section drawings of the HDD crossings are depicted in Appendix 2-D. The HDD of the Mississippi River crossing will include an entry/exit locations north of the Mississippi River, and an entry/exit location south of the Mississippi River; the crossing depth will extend to a minimum depth of 80 feet below the riverbed. The Missouri River crossing will include an entry/exit location north of the Missouri River and an entry/exit location south of the Missouri River; the crossing depth will extend to a minimum depth of 80 feet below the riverbed. The Coldwater Creek crossing will include an entry/exit location east and west of the creek; the crossing depth will extend to a minimum depth of 80 feet below the creek bed. The Spanish Lake Park crossing will include an entry/exit location east and west of the park; the crossing depth will extend to a minimum depth of 80 feet below the surface.

2.2.6.4 Open Cut/Conventional Lay

Where a dry ditch crossing method is not specifically required by the Procedures, the waterbody may be crossed using the open cut/conventional lay crossing method should the waterbody have no discernable flow at the time of construction. The process is the same as upland trenching described in Resource Report 1, Section 1.3.1.1, with FERC Procedures, the SPCC Plan, and the E&SCP implemented for excavation placement and proper setbacks.

2.2.6.5 Impacts and Mitigation

Impacts to waterbodies will be minimized through the implementation of measures outlined in the FERC Procedures as well as other federal and state requirements identified during the permitting process.

Measures to avoid and minimize impacts to waters include:

- requiring temporary erosion and sediment control measures installed and maintained along the construction right-of-way;
- installing erosion and sediment control BMPs with the flume pipe stream bypass, immediate streambed and bank stabilization, and installation of sediment barriers;
- implementing the E&SCPs and Local Land Disturbance permitting processes;

- installing erosion and sediment control BMPs (e.g., flume pipe stream bypass, immediate streambed and bank stabilization, and installation of sediment barriers)
- maintaining appropriate water flow downstream of the crossing;
- requiring construction to be completed within specified hourly time frames based on crossing lengths;
- adherence to the state guidelines as opposed to the guidelines found in the FERC's Procedures;
- routinely inspecting construction equipment for leaks and storing fuel and hazardous materials in upland areas at least 100 feet from waterbodies;
- implementing the SPCC Plan to respond quickly to leaks and spills; and
- implementing the HDD Contingency Plan related to inadvertent returns.

At stream crossings, the trench will be excavated immediately prior to pipe installation to limit the duration of construction within the waterbody to 24 hours for crossings less than 10 feet, and 48 hours for crossings between 10 feet and 100 feet. Excavated materials will be stored no less than 10 feet from the edge of the waterbody and temporary erosion control devices will be utilized to prevent the sediment from reentering the waterbody. If a release occurs into the environment, fuels, lubricants or other potentially hazardous materials used during routine construction can temporarily impact aquatic habitats and resources. To minimize these potential impacts, Spire will restrict the storage location and use of hazardous materials according to FERC Procedures. Spire's SPCC Plan incorporates these restrictions to minimize potential for impacts during construction and contains measures to mitigate releases should they occur. Refueling and lubricating of vehicles and/or equipment will occur no closer than 100 feet from a waterbody unless no feasible alternative exists or a greater setback is stipulated by a permitting agency. Spire will also locate ATWS a minimum of 50 feet from waterbody and wetland boundaries unless a reduced setback is requested on a site-specific basis and a modification is approved in accordance with FERC's Procedures. Proposed exceptions to FERC's Plan and Procedures are provided in Resource Report 1, Appendix 1-F.

At HDD crossings, Spire will not clear in between the entry and exit locations of each crossing, which would also minimize disturbance to the ground surface in these areas. Pipe sections long enough to span each HDD crossing will be staged and welded in the construction workspaces. Spire has determined that conditions at the planned HDD river crossing locations are feasible crossing methods after reviewing geotechnical reports. While HDDs are preferred to avoid certain sensitive features, there are still circumstances in which an HDD cannot be successfully completed. The most probable modes of failure during the HDD process include: pilot hole drilling failure, pilot hole enlargement failure, and failure during pipe pullback. A successful HDD crossing will result in no planned impacts on the banks, bed, or water quality of the waterbodies being crossed.

There also exists the possibility for drilling mud to reach the surface as an inadvertent return. To address the unlikely event of an inadvertent return of drilling fluids (water, bentonite clay, and/or polymers) to surface waters or wetlands, Spire will adhere to the HDD Contingency Plan provided in Appendix 2-B to reduce impacts. Spire will temporarily cease drilling operations so the pressure in the hole will reduce and the surface seepage will stop. If seepage occurs in a waterbody, there may be a visible plume whereas minor seepage may be difficult to detect in waterbodies due to possible turbidity of the water and the high specific gravity of bentonite clay drilling fluid. There will be very little drilling fluid pressure to disturb sediments due to the distance that the drilling fluid must travel to reach the surface. In general, it is not environmentally beneficial to try and contain and collect drilling fluid returns in a waterway. Placement of containment structures and attempting to collect drilling fluid within a waterway often result in greater environmental impact than allowing the drilling fluids to dissipate naturally. If seepage is detected in a wetland, corrective measures, if any, will be taken to try to minimize the seepage and it will be monitored and documented. However, drilling activities will not be suspended unless returns create a threat to public health and safety. In the event that the drill head or another portion of the bore hole makes inadvertent contact with the surface in a location not anticipated by the drilling contractor, there is the potential for drilling fluid discharge to surface waters or wetlands, which could result in the smothering of macroinvertebrates and herbaceous plants, reduce food availability to aquatic food webs, and interfere with hydrology.

There is greatest potential for inadvertent returns of drilling fluid at the HDD entry and exit locations. In the contingency planning for the HDD crossing, drilling fluid seepage at the entry and exit locations has been considered and preventative actions have been developed. The entry and exit locations at all HDD crossings have dry land segments where drilling fluid seepage can be easily detected and contained. To contain and control drilling fluid seepage on the land area, Spire's contractor will use typical containment measures (i.e., hay bales, silt fence, sand bags, pumps, and vacuum trucks). It will then be immediately cleaned up from the area and hauled or pumped to one of the storage locations at the closest drilling site.

Spire has conducted geotechnical investigations at the Mississippi and Missouri River crossings to determine the feasibility of conducting an HDD of these rivers. Based on these primary evaluations, the proposed Mississippi River and Missouri River are determined to be feasible with a high probability of successful completion.

The HDD installation on the rivers is anticipated to encounter a sequence of soils consisting of layers of soft to medium stiff clayey silt, loose rock fragments (gravel), medium dense silty sand, and silt overlying bedrock materials consisting of predominantly limestone and shale with various layers of mudstone, siltstone and sandstone. To avoid potential risks associate with loss of drilling fluids through the soft soils identified on either drill location, temporary conductor casing has been incorporated into the design. It is the intent of this casing pipe to be installed from the ground surface and seated into the bedrock below eliminating risks associated with loss of drilling fluids to the soil environment. The bedrock materials observed on both drills are ideally suited for an HDD installation, having rock quality designations characterized as fair to excellent. No zones of poor to very poor rock quality, that can give rise to excess loss of drilling fluids through fracture and joint networks, were observed in any of the boreholes.

To further alleviate concerns associated with the potential loss of drilling fluids to the overlying environments, drilling fluid pressure calculations were completed in accordance with the USACE's "Guidelines for Installation of Utilities Beneath Corps of Engineers Levees Using Horizontal Directional Drilling." In completing this evaluation, conservative strength parameters (deemed to be lower than actual strengths for individual layers) were assigned to replicate the sequence/layering of soil and bedrock materials. A factor of safety of two, consistent with that required by USACE was applied to the values calculated based on the cavity expansion values to derive the allowable drilling fluid pressures for this crossing. This allowable drilling fluid pressure was then compared with the drilling fluid pressure required to facilitate the HDD processes. For both river crossings, the allowable drilling fluid pressure was found to be significantly higher than the required drilling fluid pressure for the installation suggesting that hydrofracture or loss of drilling fluids is not anticipated to be an issue with a high degree of certainty for the HDD installations at the Mississippi and Missouri Rivers.

While not anticipated, if an attempted HDD installation is unsuccessful, the proposed HDD alignment could be modified beneath the rivers using the same general location to accommodate an additional HDD attempt, depending on the condition/cause contributing to the original HDD failure. Prior to attempting a second HDD crossing, a risk mitigation workshop shall be held with all parties to determine the cause of the initial failure and any mitigation measures that could be adopted to reduce the risk(s) during the second HDD attempt. If the HDD must be abandoned, the bore hole would be grouted with a cement-based material to fill the void and minimize the potential for a groundwater flow path.

The Mississippi and Missouri River crossings' geotechnical studies have been summarized in a Geotechnical Investigation Report, Appendix 6-B, which was submitted to the FERC in February 2017.

A portion of the geotechnical work has been conducted at the Coldwater Creek and Spanish Lake Park HDD crossing locations where survey access has been granted; remaining geotechnical work will be conducted as landowner permission is obtained.

In the State of Illinois, there are no mitigation requirements for stream impacts, whereas the State of Missouri does mitigate these impacts. Section 2.3.3 discusses the current status of permitting for wetland and waterbody impacts as well as mitigation planning.

Operation of the pipeline facilities is not anticipated to impact groundwater, surface water, or sensitive surface waters and federally-listed and state-listed threatened and endangered species and their habitats.

2.3 Wetlands

As previously mentioned in Section 2.2.1, field surveys were initiated in September 2016 to identify wetlands within the Project study area and were completed on accessible properties in 2016; Table 2.2-1 identifies the areas with limited field survey access. Wetland delineations were conducted in accordance with the *1987 USACE Wetlands Delineation Manual* (Environmental Laboratory 1987) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Midwest Region Version 2.0 (USACE 2012)*. Agricultural land uses have extensively modified local hydrology and land cover at much of the proposed Project area; and due to concerns regarding atypical conditions encountered within agricultural fields, the USACE recommends utilizing the conditions for atypical situations outlined in the Midwest Regional Supplement. These conditions outline the procedure for making a wetland determination when one or more wetland indicators are not present due to natural or human influenced disturbance.

A comprehensive Wetland Delineation and Stream Identification Report is provided in Appendix 2-F with the methods briefly discussed here. Prior to field investigations, Spire performed a desktop review of NWI mapping (provided in Appendix 2-G), USDA-NRCS soil surveys, and aerial photography to identify potential wetlands in the Project area. These areas were generally identified around areas of persistent inundation, irregular shapes of visible saturation in agricultural fields (“wet signatures”), drain-tile outlets, and floodplains.

Field observations were supplemented with an intensive review of existing NWI mapping, USDA-NRCS soils, historical aerial photography (Google Earth), and local landscape topography/morphology to provide a determination of potential wetlands present within the Project study area. Professional judgment was used to determine wetland status in problematic areas identified during the field investigation. Additional soil test pits were also recorded at the areas identified during desktop review as potentially wet. Many of these areas were later confirmed as wetland or upland following the onsite delineations.

Wetlands are classified according to the Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al. 1979), and the National Wetland Plant list (Lichvar 2016) was utilized to assign vegetation a wetland indicator status.

2.3.1 Existing Resources

Table 2.3-1 details the wetlands identified at the Project area. This includes field data where surveys are completed as well as supplemental NWI data where surveys are still pending. Seventy-three wetland features are crossed by the Project. Ten palustrine forested wetlands (“PFO”), one palustrine scrub shrub (“PSS”), five palustrine unconsolidated bottom (“PUB”), one lacustrine limnetic unconsolidated bottom (L1UB), and 56 palustrine emergent (“PEM”) wetlands are impacted by the Project. Five of these wetlands were sourced from NWI mapping where field survey was inaccessible or field survey data is still pending from recent survey. Three PFO wetlands, two PEM wetlands, one lake, and one pond are proposed to be crossed using the HDD method; therefore, no direct impact to these wetlands is anticipated.

PFO wetlands throughout the Project area included species such as silver maple (*Acer saccharinum*), American sycamore (*Platanus occidentalis*), eastern cottonwood (*Populus deltoides*), southern hackberry (*Celtis laevigata*), common hackberry (*Celtis occidentalis*), American elm (*Ulmus americana*), and smooth hedge nettle (*Stachys tenuifolia*).

PSS wetlands throughout the Project area included species such as silver maple, sandbar willow (*Salix interior*), black willow (*Salix nigra*), and American elm.

PEM wetlands throughout the Project area included primarily herbaceous species, such as water hemp (*Amaranthus rudis*), valley redstem (*Ammannia coccinea*), Frank's sedge (*Carex frankii*), *Carex* spp., barnyard grass (*Echinochloa crus-galli*), yerba-de-tajo (*Eclipta prostrata*), rice cut grass (*Leersia oryzoides*), fall panic grass (*Panicum dichotomiflorum*), *Persicaria* spp., reed canary grass (*Phalaris arundinacea*), rough cockleburr (*Xanthium strumarium*), yellow bristlegrass (*Setaria pumila*), and white panicled American aster (*Symphyotrichum lanceolatum*).

Table 2.3-1. Wetlands Crossed by the Project

Wetland ID[1]	Approximate MP	NWI/Cowardin Classification[2]	Source[3]	Approximate Crossing Length (feet)[4]	Area Affected by Permanent Easement (acres)[5]	Area Affected by ATWS (acres)[6]	Area Affected by Construction (acres)[7]	Area Affected by Operation (acres)[8]	Crossing Method[9]
24-Inch Pipeline									
Scott County, Illinois									
WIL-JJP-002	1.1	PEM	FD	0	< 0.01	0.00	< 0.01	0.00	Workspace Only
WIL-TMA-001	2.2	PEM	FD	84	0.09	0.00	0.14	0.00	Open Cut
WIL-TMA-002	3.4	PFO	FD	0	< 0.01	0.00	< 0.01	0.00	Workspace Only
WIL-JJP-005	3.4	PFO	FD	39	0.04	0.00	0.07	0.03	Open Cut
Greene County, Illinois									
WIL-JJP-009	4.4	PEM	FD	0	0.00	0.00	< 0.01	0.00	Workspace Only
WIL-JJP-010	5.1	PEM	FD	0	0.01	0.00	0.01	0.00	Workspace Only
WIL-JJP-012A	5.6	PEM	FD	47	0.04	0.00	0.11	0.00	Open Cut
WIL-JJP-012	5.6	PFO	FD	4	< 0.01	0.00	0.03	< 0.01	Open Cut
WIL-TMA-005	5.7	PEM	FD	11	0.02	0.00	0.02	0.00	Open Cut
WIL-JJP-015B	10.8	PEM	FD	6	0.03	0.00	0.03	0.00	Open Cut
WIL-JJP-015	10.8	PSS	FD	39	0.04	0.00	0.05	0.01	Open Cut
WIL-JJP-015A	10.8	PEM	FD	22	0.03	0.00	0.05	0.00	Open Cut
WIL-JJP-107	13.0	PEM	FD	0	0.01	0.00	0.01	0.00	Workspace Only
WIL-JJP-100A	13.8	PEM	FD	0	0.00	0.00	< 0.01	0.00	Workspace Only
WIL-JJP-100	13.8	PFO	FD	0	0.00	0.00	< 0.01	0.00	Workspace Only
WIL-JJP-101	13.9	PEM	FD	195	0.22	0.00	0.33	0.00	Open Cut
WIL-JJP-101A	13.9	PFO	FD	42	0.05	0.00	0.07	0.03	Open Cut
WIL-JJP-001	13.9	PEM	FD	46	0.06	0.00	0.07	0.00	Open Cut
WIL-TMA-006	14.1	PEM	FD	72	0.06	0.00	0.25	0.00	Open Cut
WIL-TMA-007	14.3	PEM	FD	22	0.03	0.00	0.04	0.00	Open Cut
WIL-TMA-008	14.4	PEM	FD	307	0.33	0.00	0.49	0.00	Open Cut
WIL-TMA-007	14.4	PEM	FD	29	0.03	0.00	0.05	0.00	Open Cut
WIL-TMA-009	17.1	PEM	FD	62	0.07	0.00	0.11	0.00	Open Cut
WIL-TMA-017	24.6R	PEM	FD	14	0.02	0.00	0.02	0.00	Open Cut
WIL-JJP-120	24.9R	PEM	FD	41	0.05	0.00	0.11	0.00	Open Cut
WIL-TMA-014	25R	PEM	FD	153	0.18	0.00	0.31	0.00	Open Cut
WIL-JJP-121	24.9R	PEM	FD	4	0.01	0.00	0.02	0.00	Open Cut

Table 2.3-1. Wetlands Crossed by the Project (Continued)

Wetland ID[1]	Approximate MP	NWI/Cowardin Classification[2]	Source[3]	Approximate Crossing Length (feet)[4]	Area Affected by Permanent Easement (acres)[5]	Area Affected by ATWS (acres)[6]	Area Affected by Construction (acres)[7]	Area Affected by Operation (acres)[8]	Crossing Method[9]
24-Inch Pipeline (Continued)									
Greene County, Illinois (Continued)									
WIL-TMA-021	25.8R	PEM	FD	56	0.07	0.00	0.11	0.00	Open Cut
WIL-TMA-018	26.1	PEM	FD	11	0.01	0.00	0.02	0.00	Open Cut
WIL-JJP-122	26.4	PEM	FD	0	< 0.01	0.00	< 0.01	0.00	Workspace Only
WIL-JJP-123	26.7	PEM	FD	76	0.09	0.00	0.13	0.00	Open Cut
Jersey County, Illinois									
WIL-CDK-010	31.9	PEM	FD	70	0.08	0.00	0.12	0.00	Open Cut
WIL-CDK-007	35.2R	PUB	FD	19	0.08	0.00	0.08	0.00	Open Cut
WIL-CDK-008	35.2R	PEM	FD	8	0.01	0.00	0.02	0.00	Open Cut
WIL-JJP-109	35.5R	PEM	FD	0	0	0.00	< 0.01	0.00	Workspace Only
NWI-205	36.2R	PUBGh	NWI	0	0.02	0.00	0.02	0.00	Workspace Only
WIL-JJP-115	37.2	PEM	FD	28	0.03	0.00	0.05	0.00	Open Cut
WIL-JJP-116	37.2	PEM	FD	9	0.01	0.00	0.03	0.00	Open Cut
WIL-JJP-112	39.1	PEM	FD	0	0	0.00	< 0.01	0.00	Workspace Only
WIL-JJP-113	41.1	PEM	FD	7	0.01	0.00	0.02	0.00	Open Cut
WIL-JJP-114	41.2	PEM	FD	28	0.03	0.00	0.05	0.00	Open Cut
WIL-TMA-028	41.3	PEM	FD	42	0.05	0.00	0.07	0.00	Open Cut
WIL-DFW-002	43.8	PEM	FD	50	0.03	0.00	0.11	0.00	Open Cut
St. Charles County, Missouri									
NWI-105	45.7	PFO1Ah	NWI	377	0.43	0.00	0.00	0.00	HDD[10]
WMO-WJW-001	46.1	PFO	FD	330	0.37	0.00	0.00	0.00	HDD[10]
WMO-JJP-012	49.7	PEM	FD	1,491	1.72	0.54	3.38	0.00	Open Cut
WMO-TMA-010	49.9	PEM	FD	359	0.25	0.01	0.26	0.00	Open Cut
WMO-JJP-010	50.2	PEM	FD	67	0.07	0.00	0.11	0.00	Open Cut
WMO-JJP-007	53.9	PEM	FD	555	0.47	< 0.01	0.60	0.00	Open Cut
WMO-TMA-006	54.8	PEM	FD	235	0.2	0.12	0.55	0.00	Open Cut
WMO-TMA-005A	55.7	PEM	FD	131	0.16	0.00	0.22	0.00	Open Cut
WMO-TMA-005	55.8	PUB	FD	378	0.43	0.00	0.61	0.00	Open Cut
WMO-TMA-005A	55.8	PEM	FD	40	0.02	0.00	0.08	0.00	Open Cut

Table 2.3-1. Wetlands Crossed by the Project (Continued)

Wetland ID[1]	Approximate MP	NWI/Cowardin Classification[2]	Source[3]	Approximate Crossing Length (feet)[4]	Area Affected by Permanent Easement (acres)[5]	Area Affected by ATWS (acres)[6]	Area Affected by Construction (acres)[7]	Area Affected by Operation (acres)[8]	Crossing Method[9]
24-Inch Pipeline (Continued)									
St. Charles County, Missouri (Continued)									
WMO-TMA-005A	55.8	PEM	FD	28	0.05	0.00	0.07	0.00	Open Cut
WMO-JJP-002	56.0	PEM	FD	0	0.10	0.00	0.10	0.00	Workspace Only
WMO-JJP-005	56.8	PEM	FD	62	0.07	0.00	0.11	0.00	Open Cut
WMO-TMA-004	57.2	PEM	FD	39	0.05	0.00	0.07	0.00	Open Cut
WMO-TMA-003A	57.2	PEM	FD	0	0.00	0.09	0.09	0.00	Workspace Only
WMO-TMA-003	57.2	PUB	FD	0	0.00	0.15	0.15	0.00	Workspace Only
WMO-TMA-002	57.4	PEM	FD	0	0.00	0.13	0.13	0.00	Workspace Only
WMO-TMA-001A	57.9	PFO	FD	142	0.16	0.00	0.00	0.00	HDD[10]
WMO-TMA-001	57.9	PEM	FD	36	0.04	0.00	0.00	0.00	HDD[10]
St. Louis County, Missouri									
WMO-CDK-005	58.3	PEM	FD	0	0.00	0.01	0.00	0.00	Workspace Only
WMO-CDK-004	58.4	PEM	FD	60	0.04	0.00	0.04	0.00	Open Cut
WMO-CDK-003	58.4	PEM	FD	0	0.00	0.00	0.02	0.00	Workspace Only
North County Extension									
St. Louis County, Missouri									
WMO-JJP-120	0.4	PEM	FD	0.2	< 0.01	0.00	0.01	0.00	Open Cut
WMO-JJP-120	0.4	PFO	FD	22	0.03	0.00	0.05	0.02	Open Cut
WMO-JJP-120	0.5	PEM	FD	131	0.14	0.00	0.21	0.00	Open Cut
WMO-JJP-120	0.5	PFO	FD	96	0.12	0.00	0.17	0.07	Open Cut
WMO-JJP-122	1.1	PEM	FD	0	0.03	0.00	0.03	0.00	Workspace Only
WMO-JJP-123	1.2	PEM	FD	0	0.02	0.00	0.02	0.00	Workspace Only
WMO-JJP-125	1.8	PEM	FD	37	0.02	0.00	0.00	0.00	HDD[10]
WMO-JJP-119	2.6	PEM	FD	156	0.08	0.00	0.15	0.00	Open Cut
WMO-DFW-002	3.2	PEM	FD	0	0.02	0.00	0.02	0.00	Workspace Only
NWI-204	3.8	PFO1C	NWI	22	0.02	0.01	0.05	0.01	Open Cut
NWI-185	4.0	L1UBHh	NWI	699	0.80	0.00	0.00	0.00	HDD[10]
NWI-186	4.3	PUBGh	NWI	249	0.28	0.00	0.00	0.00	HDD[10]
WMO-DFW-007	6.0	PEM	FD	26	0.03	0.00	0.04	0.00	Open Cut

Table 2.3-1. Wetlands Crossed by the Project (Continued)

Notes:

[1] Map Designation - the unique code designated to the wetlands identified during the field surveys. A unique identifier was also assigned to National Wetland Inventory ("NWI") data that was used to supplement field delineations on properties that lack access permission or in areas that are pending delineation data. Facilities not listed (i.e. staging areas, mainline valve sites, and access roads) do not impact wetlands.

[2] Cowardin classification: PEM - Palustrine Emergent; PFO - Palustrine Forested; PSS - Palustrine Scrub-Shrub; and PUB - Palustrine Unconsolidated Bottom.

[3] FD - Field Delineation. NWI used where field surveys have not been conducted due to lack of access.

[4] Length of Crossing is representative of the centerline crossing length. Where the crossing length is zero, the wetland is crossed by construction workspace but not the pipeline.

[5] Area affected by Permanent Easement is the area of wetlands identified within the 50-foot-wide permanent easement. For example, acreages at HDDs would be visible here but not in the Construction or Operation column where impacts are avoided by the HDD.

[6] Area affected by ATWS is also included within Area Affected by Construction acreages.

[7] Area affected by Construction is the total area of wetland within the construction right-of-way.

[8] Area affected by Operation on PEM wetlands are 0.0 acres as these wetlands will revert back to the same type following construction. Operational impacts on PSS wetlands in this column are based on a 10-foot-wide operational impact that will be converted to herbaceous wetlands due to pipeline maintenance. Operational impacts on PFO wetlands in this column reflect potential for selective thinning of trees within 15 feet of the pipeline (30-foot-wide operational impact) that have roots that could compromise the integrity of the pipeline coating.

[9] Timber mats will be utilized at saturated wetlands for equipment crossings within the construction right-of-way and access roads. Pipeline crossings will be open cut or trenchless (HDD). "Workspace Only" designates those wetlands within the construction workspace though not crossed by centerline and will be avoided where possible or matted for equipment crossing.

[10] Wetland is crossed by the HDD. Spire does not intend to clear vegetation within the permanent right-of-way above the HDD path; therefore impacts to this wetland are not anticipated.

2.3.2 Wetland Construction and Operation Impacts

Spire will utilize two methods to cross wetlands at the Project: open cut/conventional lay and HDD. As described in Section 2.3.1, the HDD crossing method avoids impacts to PFO wetland resources adjacent to the Mississippi River and Missouri River.

With the exception of the two HDD crossings, wetland crossing methods will be determined based on site-specific conditions at the time of construction. Wetlands with soils that can support construction equipment may be crossed using the conventional lay method, whereas at saturated wetlands, Spire will utilize timber mats to preserve the soil structure at wetlands.

2.3.2.1 Open Cut/Conventional Lay

Spire plans to cross wetlands with the open cut/conventional lay method in accordance with all applicable permits and the FERC Procedures. Construction techniques for this method are similar to the open cut method in upland areas, however topsoil segregation techniques will be utilized to facilitate revegetation following the completion of construction activities. Spire will limit topsoil segregation to the trenchline in wetlands. In some cases, site-specific conditions may not support construction equipment, but the area will still be crossed using the open cut method. In these instances, timber mats will be used to minimize disturbances to wetland hydrology and maintain soil structure. Pipeline depth of cover will be at least five feet at wetlands.

2.3.2.2 HDD

As discussed in Section 2.2.6.3., Spire plans to use the HDD crossing method for the Mississippi and Missouri Rivers, Coldwater Creek, and Spanish Lake Park, which includes their adjacent and/or abutting wetland resources. Spire conducted geotechnical boring to determine the geology and feasibility of the drills. The river crossings' geotechnical reports are complete, and geotechnical work at the Coldwater Creek and Spanish Lake Park crossings will be finalized after remaining landowner permission is obtained. HDDs, while the preferred method to avoid impacts to wetlands, still have risks which are thoroughly discussed in Section 2.2.6.5.

2.3.2.3 Wetland Construction and Operation Impacts

Wetlands that are open cut may experience temporary construction impacts such as loss of herbaceous and scrub-shrub vegetation; soil disturbance associated with grading, trenching, and stump removal; sedimentation and turbidity increases; and hydrological profile changes. Impacts to forested wetlands may include long-term conversion to emergent and/or scrub-shrub wetland types through tree removal. No permanent loss of wetlands are expected to occur from the construction of the Project though functional changes to the wetland community may result. Upon the completion of construction, topsoil, contour elevations, and hydrologic patterns will be restored and disturbed areas will be reseeded to promote the re-establishment of native hydrophytic vegetation. Temporary workspace ("TWS") and ATWS will be restored to preconstruction grades and contours reseeded. TWS and ATWS areas will not be maintained for operation of the Project and will be allowed to revert to their preconstruction land use and vegetation cover types. Wetlands that are encompassed as part of a HDD crossing are not anticipated to be directly impacted from construction activities as these features will be avoided.

Spire will protect and minimize potential adverse impacts on wetlands by complying with the applicable permit conditions issued by appropriate regulatory agencies with respect to construction and operation of the Project facilities within wetlands and through implementation of FERC's Procedures. Spire has reduced its construction right-of-way in and around wetlands during construction to 75 feet in accordance with FERC's Procedures; this is depicted in the construction right-of-way typical drawings provided in Resource Report 8, Appendix 8-A. Site-specific exceptions to the FERC Procedures where greater than 75 feet of construction workspace is needed in wetlands are identified in Resource Report 1, Appendix 1-D.

ATWS may also be required in and around wetland areas to facilitate certain crossings. The size of ATWS adjacent to wetlands varies along the length of the Project. ATWS size was dictated by the corresponding adjacent topography and both wetland-related and unrelated Project needs given the limited viable staging options along the Project's route. Where possible, ATWS has been located at least 50 feet from wetlands. Locating ATWS within 50 feet of wetlands is necessary in certain locations to facilitate road and HDD crossings, provide additional spoil storage area, and topsoil segregation. Some ATWS for topsoil segregation in agricultural lands are located within 50 feet of wetlands where the adjacent upland consists of cultivated or rotated cropland as permitted in the FERC Procedures; these are included in Appendix 1-D of Resource Report 1 and indicated as such.

Construction equipment in wetlands will be limited to that essential for clearing the right-of-way, excavating the trench, fabricating and installing the pipeline, backfilling the trench, and restoring the right-of-way. Prior to grading activities, erosion controls will be placed as required along the downslope edge of the construction right-of-way and around ATWS to minimize impacts to adjacent wetlands. Erosion and sediment controls will be properly installed and maintained throughout construction to protect wetlands from sediment that may migrate from disturbed areas during construction. Where there is no reasonable access except through wetlands, non-essential equipment would be allowed if the ground is firm or is stabilized with timber mats to avoid rutting. In order to preserve the existing seedbank and promote revegetation of the wetlands, Spire will segregate the top 12 inches of soil from the area disturbed by trenching activities except in saturated wetlands. Topsoil will be restored back to its original location immediately after backfilling is complete. Seed mixes spread on the restored topsoil for temporary stabilization will include annual rye grass at a rate of 40 pounds per acre (unless standing water is present) or appropriate mixes recommended by permitting agencies. To minimize inadvertent spills of fluids used during construction, any lubricating oils and fuels will be stored in upland areas at least 100 feet from wetland boundaries, whenever possible, or additional materials (such as spill kits) or secondary containment structures will be employed.

The majority of the wetlands impacted by the Project will be restored and will revert to pre-existing conditions after construction has been completed. In accordance with FERC's Procedures, Spire will maintain a mowed corridor through wetlands; keeping this portion of each feature in an herbaceous state to allow for periodic pipeline patrols and operational surveys. PEM wetlands will be restored to pre-construction conditions and no permanent impacts are anticipated to these features. For PSS wetlands, the maintained corridor will be up to 10 feet centered on the pipeline, converting this portion of each feature to PEM wetland types. For PFO wetlands, trees within 15 feet of the pipeline that have roots that could compromise the integrity of the pipeline coating will be selectively removed. Therefore converting a 30-foot corridor in PFO wetlands to PSS or PEM wetland types.

Wetlands that are encompassed between HDD entry and exits locations will not be routinely maintained; therefore, long-term impacts to these features are not anticipated. Table 2.3-2 summarizes the types and acreages of wetlands affected by construction and operation of the Project.

Table 2.3-2. Summary of Wetlands Affected by Construction and Operations

Cowardin and NWI Classification[1]	Length of Each Type Crossed (feet)[2]	Area Affected by Permanent Easement (acres)[3]	Area Affected by ATWS (acres)[4]	Area Affected During Construction (acres)[5, 6]	Area Affected During Operation (acres)[6, 7]
24-Inch Pipeline					
PFO	934	1.07	0.00	0.19	0.07
PSS	39	0.04	0.00	0.05	0.01
PEM	4,603	4.96	0.91	8.78	0.00
PUB	397	0.53	0.15	0.86	0.53
Subtotals[8]	**5,973**	**6.55**	**1.05**	**9.88**	**0.61**
North County Extension					
L1UBHh	699	0.08	0.00	0.00	0.00
PFO	140	0.17	0.01	0.27	0.10
PSS	0	0.00	0.00	0.00	0.00
PEM	350	1.07	0.00	0.50	0.00
PUB	249	0.28	0.00	0.00	0.00
Subtotals[8]	**1,438**	**1.58**	**0.01**	**0.77**	**0.10**
Totals					
Subtotals L1UBHh	**699**	**0.08**	**0.00**	**0.00**	**0.00**
Subtotals PFO	**1,074**	**1.24**	**0.01**	**0.46**	**0.17**
Subtotals PSS	**39**	**0.04**	**0.00**	**0.05**	**0.01**
Subtotals PEM	**4,953**	**6.03**	**0.91**	**9.28**	**0.00**
Subtotals PUB	**646**	**0.81**	**0.15**	**0.86**	**0.53**
Totals[8]	**7,411**	**8.13**	**1.06**	**10.65**	**0.71**

Notes:

1 NWI Wetland Type: PFO - Palustrine Forested; PSS - Palustrine Scrub-Shrub; PEM - Palustrine Emergent; and PUB - Palustrine Unconsolidated Bottom. Facilities not listed do not impact wetlands.

2 The length of the crossing was calculated from field delineated or NWI polygons, rounded to the nearest foot. These may not equal the sum of this column due to rounding.

3 Area affected by Permanent Easement is the area of wetland identified at the 50-foot-wide permanent easement, which includes the permanent easement above the path of the HDD where impacts are avoided.

4 Area at ATWS is also included within Area Affected by Construction acreages.

5 Area affected by construction is the total area of wetland within the construction right-of-way.

6 Excludes wetlands avoided by trenchless crossings (HDDs).

7 Area affected by operation on PEM wetlands are zero acres as these wetlands will revert back to the same type following construction. Operational impacts on PSS wetlands in this column are based on a 10-foot-wide operational impact that will be converted to herbaceous wetlands due to pipeline maintenance. Operational impacts on PFO wetlands in this column reflect potential for selective thinning of trees within 15 feet of the pipeline (30-foot-wide operational impact) that have roots that could compromise the integrity of the pipeline coating.

8 May not equal the sum of the column due to rounding.

2.3.3 Wetland Mitigation Procedures

Following restoration, wetlands will be monitored in accordance with FERC's Procedures and/or in accordance with protocols specified by the applicable permitting agencies. Revegetation of impacted wetlands will be monitored periodically for the first three years following construction. Revegetation will be considered successful when the native vegetation cover is at least 80 percent of either the cover documented for the wetland prior to construction, or at least 80 percent of the cover in adjacent wetland areas that were not disturbed by construction.

Spire has identified all necessary permits and approvals that will be required for construction of the Project through wetlands. These permits, as well as anticipated submittal and receipt dates, are outlined in Resource Report 1. The USACE St. Louis District is the regulating federal agency for impacts to wetlands and the Project. Construction associated with the Project will impact wetlands and waterbodies and is subject to Section 404 of the CWA, therefore Spire has prepared a pre-construction notification package for the USACE for coverage under Nationwide Permit 12-Utility Lines concurrently with the FERC application. In compliance with federal and state regulatory permitting frameworks relative to wetland protection, Spire is developing a Project-specific wetland mitigation plan prior to construction in consultation with the USACE St. Louis District and other regulatory agencies. The mitigation plan will provide measures to compensate for permanent wetland conversion in Illinois and Missouri, and stream-related impacts in Missouri. Spire is coordinating with the USACE and applicable state regulatory agencies for guidance during the development of the proposed mitigation measures and plans. Spire is in communication with mitigation banks in Illinois and Missouri and currently plans to mitigate impacts through the use of mitigation bank credits.

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APPENDIX 2-A

Spill Prevention, Control, and Countermeasure Plan

APPENDIX 2-B

HDD Contingency Plan

Spire STL Pipeline Project

Horizontal Directional Drill Contingency Plan

FERC Docket No. CP17-40-_ _ _

April 2017

Public

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Acronyms and Abbreviations

FERC	Federal Energy Regulatory Commission
HDD	horizontal directional drill
LGC	Laclede Gas Company
Project	Spire STL Pipeline Project
Spire	Spire STL Pipeline LLC

Horizontal Directional Drill Contingency Plan

The following discussions summarize the minimum requirements for dealing with an inadvertent return during horizontal directional drill ("HDD") installations beneath the Mississippi and Missouri Rivers. It also presents a contingency plan in the event of a failed HDD installation. A detailed hydraulic fracture/inadvertent return plan will be developed by the HDD contractor and reviewed by Spire STL Pipeline LLC ("Spire") prior to commencing drilling operations.

1.0 Background Information

Spire is seeking authorization from the Federal Energy Regulatory Commission ("FERC") to construct and operate the proposed Spire STL Pipeline Project ("Project") located in Scott, Greene, and Jersey Counties, Illinois, and St. Charles and St. Louis Counties, Missouri. The proposed Project will consist of approximately 65 miles of new, greenfield, 24-inch-diameter steel pipeline in two segments. The first segment (referred to as the "24-inch pipeline" portion of the Project) will originate at a new interconnect with the Rockies Express Pipeline LLC pipeline in Scott County, Illinois and extend approximately 59 miles through Greene and Jersey Counties in Illinois before crossing the Mississippi River and extending east through St. Charles County, Missouri. The 24-inch pipeline then crosses the Missouri River into St. Louis County, Missouri, and terminates at a new interconnect with Laclede Gas Company ("LGC"). The second segment of new, greenfield pipeline (referred to as the "North County Extension"), will consist of a 24-inch-diameter steel pipeline which will extend approximately six miles from the LGC interconnect through the northern portion of St. Louis County and terminate at a new interconnect with Enable Mississippi River Transmission, LLC and LGC.

Spire proposes to use the HDD method to install the pipeline under the Mississippi River, Missouri River, Coldwater Creek, and Spanish Lake Park. A traditional single drill rig operation is anticipated to be used to complete the Missouri River, Coldwater Creek, and Spanish Lake Park HDD installations. For the Mississippi River, it is anticipated the HDD contractor will use the drill and intersect method to complete the installation due to the need for temporary conductor casings on each end of the HDD alignment (casings will be removed upon completion of pullback operations). The intersect method involves drilling individual pilot bores from each end of the HDD installation and intersecting in a target intersection location established in the bottom horizontal tangent of the HDD profile. Use of the drill and intersect method decreases the flow pathway length for each individual pilot bore. One advantage of this method is a lower required drilling fluid pressure necessary to complete each pilot bore operation.

1.1 HDD Construction Method

HDD is a surface-to-surface installation technique comprised of three primary stages including pilot bore, reaming, and product pipe installation. This method of construction is typically used to install pipelines in areas not amenable for open cut construction, including waterbodies, highways, railroads, runways, environmentally sensitive areas and urban environments. Assuming proper design and good HDD construction practices, the HDD method allows for the installation of pipelines with minimal impacts to the crossing feature(s).

The first stage of the installation process consists of advancing a steerable, rotary drill bit along the design alignment from the drill rig entry location to the exit location. The downhole tooling is matched to the anticipated ground conditions. Soil tooling is typically used in soils and bedrock tooling is used to drill through bedrock materials. As the pilot bore is advanced, a tracking system is used to locate the position and orientation of the assembly to allow for steering inputs required to maintain the design profile and alignment.

The second stage of the installation process is referred to as the reaming stage. This process consists of enlarging the pilot bore to a final diameter necessary to accommodate the product pipe. Depending upon the outer diameter of the product pipe, multiple reaming passes of increasing diameter are typically used to incrementally increase the size of the bore to the final required diameter. The acceptable HDD industry standard for the final bore diameter is generally 1.5 times the outer diameter of the pipe being installed for product pipe diameters less than or equal to 24 inches and 12 inches larger than the outer diameter of the product pipe for product pipe diameters greater than 24 inches. Hence, for the anticipated NPS24 pipeline, the final bore diameter is expected to be 36 inches.

Upon completion of the reaming pass(es), the condition of the HDD bore is assessed by pushing or pulling a barrel or ball reamer with a slightly larger diameter than the product pipe (but less than the final diameter of the bore) through the fully reamed bore from start to finish. This proving step is referred to as a swab pass. The observed drill rig effort during this installation step allows the HDD contractor to evaluate if the bore has been conditioned sufficiently to receive the product pipe.

The final stage of the installation process consists of pulling/installing the fabricated product pipe from the pipe entry location toward the drill rig. A reamer and swivel is placed between the drill pipe within the reamed bore and the pulling head connected to the product pipe. The swivel is used to isolate the torsional stresses from the rotating drill pipe and reamer assembly and prevent rotation of the product pipe during its installation. The reamer used in the pulling assembly is slightly larger than the pipe diameter, but smaller than the final bore diameter. The reamer assembly is used to clear any cuttings that may remain in the bore, reducing installation risks during the product pipe pullback phase of the installation process.

The use of the reamer also allows for fluids to be pumped downhole during pullback to assist with cuttings removal and lubrication of the product pipe string. Large diameter product pipes are typically buoyant when pulled into a drilling fluid filled bore and tend to float to the top of the bore. To counter buoyancy conditions and increased frictional forces, water is often added to the back end of the product pipe to increase the net weight of the product pipe string. Without the use of buoyancy counter measures, risks associated with overstressing of the product pipe and excessive damage to abrasion resistant coatings and corrosion protection due to the increased frictional forces will increase.

Pipe rollers and additional heavy equipment (i.e., cranes, excavators, and/or side booms) are required to assist the pullback process. The rollers and slings on the equipment provide support for the fully fabricated pipe string, help to reduce the amount of friction acting on the tail string (thus reducing the overall amount of force required to pull the pipe into the bore) and also help to position the pipe such that the angle that the pipe enters the bore matches the exit angle of the bore itself. All of these features reduce the bending and tensional stresses applied to the product pipe at the break-over location during installation.

Drilling fluids, consisting of a mixture of water, bentonite, and/or polymers are pumped into the bore during the entire HDD installation process. The exact mixture of fluids is typically determined by the HDD contractor based on the anticipated and actual geotechnical materials encountered within the bore and the performance of the drilling equipment as the drilling process progresses. Polymers are commonly used to modify specific drilling fluid properties that bentonite alone is incapable of providing. The drilling fluids are typically a mixture of freshwater and bentonite (sodium montmorillonite). Bentonite is natural clay usually mined in Wyoming. Bentonite is extremely hydrophilic and can absorb up to 10 times its weight in water. Typically, the drilling fluid contains no more than five percent bentonite (95 percent freshwater).

Drilling fluids perform several functions integral to the success of the installation. These primary functions include:

- cooling, lubricating, and cleaning drilling tools, drill pipe and the product pipe during its installation;
- suspension of cuttings within the drilling fluid to facilitate their removal;
- transport soil/bedrock cuttings from the bore during each phase of the installation process;
- stabilization of the bore against collapse and minimization of raveling of the surrounding soil materials;
- provide a bentonite filter cake along the bore walls to help maintain fluid flow within the drilled bore;
- provide a hydrostatic fluid pressure within the bore to offset ground formation/groundwater pressure; and
- drive downhole tooling (mud motor assemblies) for drilling in bedrock materials.

The HDD contractor maintains drilling fluid performance through sampling, testing, and recording the fluid properties during drilling operations. The HDD contractor also analyzes, adjusts, and maintains the fluids as necessary to afford the most efficient drilling fluid rheology to adapt to various geological conditions.

The drilling fluid is pumped into the bore through the drill pipe. As the drilling fluid exits the down-hole tooling within the bore, it mixes with the soil and/or rock cuttings generated by the down-hole tooling to create "flowable" slurry. This mixture flows through the HDD bore under an induced fluid pressure gradient generated by the injection of additional drilling fluids into the bore.

When the drilling fluids reach the ground surface at either the HDD entry or exit locations, these fluids are either transferred to a separation plant for processing or removed from the site with vacuum trucks (or other means). Separation plants are commonly used on installations where the cost to dispose of the drilling mud and cuttings exceeds the costs to recycle and reuse the fluids.

Controlling and maintaining fluid flow within the HDD bore during all installation stages is critical to the success of an HDD installation. While the HDD method is a proven technology, there are certain impacts that could occur as a result of the drilling such as the inadvertent release of drilling fluid, which is a slurry of bentonite clay and water which is classified as non-toxic to the aquatic environment and is a non-hazardous substance. Drilling fluids that are released typically contain a lower concentration of bentonite when they surface because the bentonite is filtered out as its passes through existing sediments of varying types. All drilling fluid components will be approved by the Owner prior to transportation and use on each HDD installation.

The following sections provide the process of HDD and procedures to be implemented in the case of an inadvertent release of drilling fluid.

1.2 Inadvertent Release Procedures/Contingency Plan

Prior to drilling operations, site-specific HDD procedures will be prepared by the HDD contractor and submitted to Spire for review and approval. Drilling fluid returns (flow of drilling fluids to the HDD entry/exit location) will be continuously monitored visually during the installation.

Lost circulation materials may be introduced to the drilling fluid to help seal off a flow pathway that is allowing for drilling fluid migration away from the HDD bore. All mud products will be approved by the Owner prior to use on-site. Lost circulation materials can include, but are not limited to, sawdust, bentonite chips, ground corn, magma fiber, and/or other manufactured materials.

As a minimum, the HDD Procedures will address the following:

1.2.1 Inadvertent Return Prevention

The drill rig operator will monitor the downhole annular pressure at all times. If the bore pressure is observed to be abnormally high or fluid loss is apparent and a release has occurred, the driller has the following options (or any combination of these options):

- temporarily cease drilling operations and shut down mud pump delivering drilling fluids downhole;
- notify Spire representatives immediately;
- dispatch experienced company personnel to monitor the area in the vicinity of the drilled path;
- restart pump and stroke bore hole in 30 foot (+/-) lengths to restore circulation ("swab" the hole) as many as six times but no fewer than two times;
- introduce additional flow along the borehole starting at the entry/exit using "weeper" subs; and
- modify the drilling mud with a change in viscosity and/or lost circulation additives.

1.2.2 Monitoring of Inadvertent Returns

1.2.2.1 Personnel and Responsibilities

The actions in this Plan are to be implemented by the following personnel:

- Chief Inspector - Spire will designate an HDD Chief Inspector for the Project. The Chief Inspector will have overall authority for construction activities that occur on the Project.
- Environmental Inspector - At least one Environmental Inspector will be designated by Spire to monitor the HDD activities. The Environmental Inspector will have status over all other activity inspectors and will report directly to the HDD Chief Inspector who has overall authority. The Environmental Inspector will have the authority to stop activities that violate the environmental conditions of the FERC Certificate (if applicable), other federal and state permits, or landowner requirements, and to order corrective action.

- HDD Superintendent - The HDD Superintendent will be the senior on-site representative of the HDD contractor and will have the overall responsibility for implementing this Plan on behalf of the HDD contractor. The HDD Superintendent will be familiar with all aspects of the drilling activities, the contents of the Plan, and the conditions of approval under which the activity is permitted to take place. The HDD Superintendent will make a copy of this Plan available at the drill site and will distribute it to the appropriate construction personnel. The HDD Superintendent will ensure that workers are properly trained and familiar with the necessary procedures for response to an inadvertent release.
- HDD Operator - The HDD Operator will be responsible for operating the drilling rig and mud pumps, monitoring circulation back to the entry and exit locations, and monitoring annular pressures during pilot hole drilling. In the event of loss of circulation or higher than expected annular pressures, the HDD Operator must communicate the event to the HDD Superintendent and HDD contractor field crews, as well as the on-site Spire inspection staff. The HDD Operator is responsible for stoppage or changes to the drilling program in the event of observed or anticipated inadvertent returns.
- HDD Contractor Personnel - During HDD installation, field crews will be responsible for monitoring the HDD alignment along with the Spire's field representatives. Field crews, in coordination with the Environmental Inspector, will be responsible for timely notifications and responses to observed releases in accordance with this Plan. The Environmental Inspector ultimately must sign-off on the action plan for mitigating the release.

Prior to drilling, the HDD Superintendent, Chief Inspector, and Spire's Environmental Inspector will verify that the HDD Operator and field crew receive, at minimum, the following site-specific training:

- Project-specific safety training;
- review provisions of this Plan and site-specific permit requirements;
- review location of sensitive environmental resources at the site;
- review drilling procedures for release prevention;
- review the site-specific monitoring requirements;
- review the location and operation of release control equipment and materials; and
- review protocols for reporting observed inadvertent returns.

1.2.2.2 Monitoring and Reporting

Appropriate monitoring and reporting actions will be as follows:

- If the HDD Operator observes an increase in annular fluid pressure or loss of circulation, the Operator will notify the HDD Superintendent and field crews of the event and approximate position of the tooling.
- Where practical, a member of the field crew will visually inspect the ground surface near the position of the cutting head.

- If an inadvertent release is observed:
  - field crew will notify (via handheld radio or cell phone) the HDD Operator;
  - the HDD Operator will temporarily cease pumping of the drilling fluid and notify the HDD Superintendent and Chief Inspector;
  - the Chief Inspector will notify and coordinate a response with the Environmental Inspector;
  - the Environmental Inspector will notify appropriate permit authorities, as necessary, of the event and proposed response and provide required documentation within 24 hours; and
  - the Chief Inspector will prepare a report that summarizes the incident.

1.2.3 Response to Inadvertent Returns

Typically, inadvertent releases are most often detected in an area near the entry or exit locations of the drill alignment when the pilot bore is at shallow depths, above bedrock, and in permeable/porous soils. In these occurrences, the release will be assessed by the HDD Superintendent, Environmental Inspector, and Chief Inspector to determine an estimated volume and footprint of the release. The potential of the release to reach adjacent waterbodies, wetlands, or other types of infrastructure will also be assessed.

The HDD Superintendent will assess the drilling parameters (depth, annular pressures, fluid flow rate, and drill fluid characteristics) and incorporate appropriate changes.

The HDD Superintendent, Environmental Inspector, and Chief Inspector will implement installation of appropriate containment structures and additional response measures. Access for personnel and equipment to the release site is a major factor in determining the methods used for containment and disposal. Typically, containment is achieved by excavating a small sump pit (five cubic yards) at the site of the release and to surround the release with hay bales, silt fence, and/or sand bags. Once contained, the drilling fluid is either collected by vacuum trucks or pumped back to the mud recycle unit or to a location accessible to vacuum trucks. The fluids are then transported either back to the HDD drilling rig or to a disposal site.

If the release is mitigated and controlled, forward progress of the drilling will be approved by the Environmental Inspector in coordination with the HDD Superintendent and Chief Inspector.

The site-specific response will follow the guidelines presented below.

1.2.3.1 Inadvertent Fluid Release at Inaccessible Location

If inadvertent returns are observed surfacing on the ground surface at a location that is inaccessible, the following procedures will be followed:

- contractor will ensure all reasonable measures within the limitations of current technology have been taken to re-establish circulation; and
- continue drilling utilizing a minimal amount of drilling fluid as required to penetrate the formation or to maintain a successful product pull back.

1.2.3.2 Upland Location

- Evaluate the amount of release to determine if containment structures are warranted and will effectively contain the release.
- Promptly implement appropriate containment measures as needed to contain and recover the slurry.
- If the release is within 50 feet of a wetland or waterbody, silt fence and/or hay bales will be installed between the release site and the wetland or waterbody.
- If the release cannot be contained, then the HDD Operator will suspend drilling operations until appropriate containment is in place.
- Remove the fluids using either a vacuum truck or by pumping to a location accessible to a vacuum truck.
- After the HDD installation is complete, perform final clean-up.

1.2.3.3 Wetland Location

Spire's proposed HDD installations are designed to minimize the potential for inadvertent releases to the HDD crossing locations. Although final design is still in progress, Spire expects that the Mississippi and Missouri River crossings will be in soils in the vicinity of the HDD entry and exit locations transitioning to bedrock materials. The bedrock materials are capable of resisting higher drilling fluid pressures than the soils. To further minimize the potential for inadvertent returns, casing will be installed through overburden soils at both ends of the HDD for the Mississippi River. Casing is anticipated at the HDD entry location only for the Missouri River crossing.

Even with these controls in place, if a release of drilling fluids does occur, the following steps will be taken:

- Evaluate the amount of release to determine if containment structures are warranted and will effectively contain the release.
- Promptly implement appropriate containment measures to contain and recover the slurry.
- Efforts to contain and recover slurry in wetlands may result in further disturbance by equipment and personnel and possibly offset the benefit gained in removing the slurry.
- If the amount of the slurry is too small to allow the practical collection from the affected area, the fluid will be diluted with freshwater or allowed to dry and dissipate naturally.
- If the release cannot be controlled or contained, drilling operations will be suspended immediately until appropriate containment is in place.
- Remove the fluids using either a vacuum truck or by pumping to a location accessible to a vacuum truck.
- After the HDD installation is complete, perform final clean-up.

1.2.3.4 Final Clean-Up

After completion of the HDD installation, site-specific clean-up measures will be developed by the Chief Inspector and HDD Superintendent for approval by the Environmental Inspector. Potential for secondary impact from the clean-up process will be evaluated, along with the benefits of clean-up activities.

The following measures are considered appropriate:

- Drilling mud will be removed by hand using shovels, buckets, and soft bristled brooms to minimize damage to existing vegetation.
- Freshwater washes may be employed if deemed beneficial and feasible.
- Containment structures will be pumped out and the ground surface scraped to bare topsoil, thereby minimizing loss of topsoil or damage to adjacent vegetation.
- The recovered drilling fluid will be recycled or disposed of at an approved upland location or disposal facility. No recovered drilling fluid will be disposed of in streams or storm drains.
- All containment structures will be removed.
- Recovered materials will be collected in containers for temporary storage prior to removal from the site.

1.3 Failed HDD Installation

While not anticipated, if an attempted HDD installation is unsuccessful, the proposed HDD alignment could be modified beneath the River using the same general location to accommodate an additional HDD attempt, depending on the condition that resulted in the HDD failure. Prior to attempting a second HDD crossing, a risk mitigation workshop should be held with all parties to determine the cause of the initial failure and any mitigation measures that could be adopted to reduce the risk(s) during the second HDD attempt.

Potential causes that may lead to a failed HDD installation include:

- stuck or damaged product pipe during pullback operations; this risk is mitigated by:
  - completing swab pass or passes to gauge the condition of the HDD bore by evaluating the drill rig effort required to pull tooling through the HDD bore;
  - only commencing pullback operations after verification that the bore is adequately conditioned; and
  - minimizing the amount of downtime associated with delays during pullback operations.
- bore instability/collapse; this risk is mitigated by:
  - designing the HDD profile in favorable ground materials along the alignment that are not amenable to raveling causing collapse of the bore.
- Excess loss of drilling fluids and inability to remove cuttings from the bore; this risk is mitigated by:
  - designing the HDD profile in favorable ground materials along the alignment;

– evaluating the required and allowable drilling fluid pressures for the installation and providing sufficient separation between the required and allowable drilling fluid pressures; and

– incorporating temporary casing pipe to support shallow soils.

If an open HDD bore could not be advanced and abandonment where required, the bore would be grouted with a cement-based material to fill the excavation and minimize risks of a potential groundwater flow pathway.

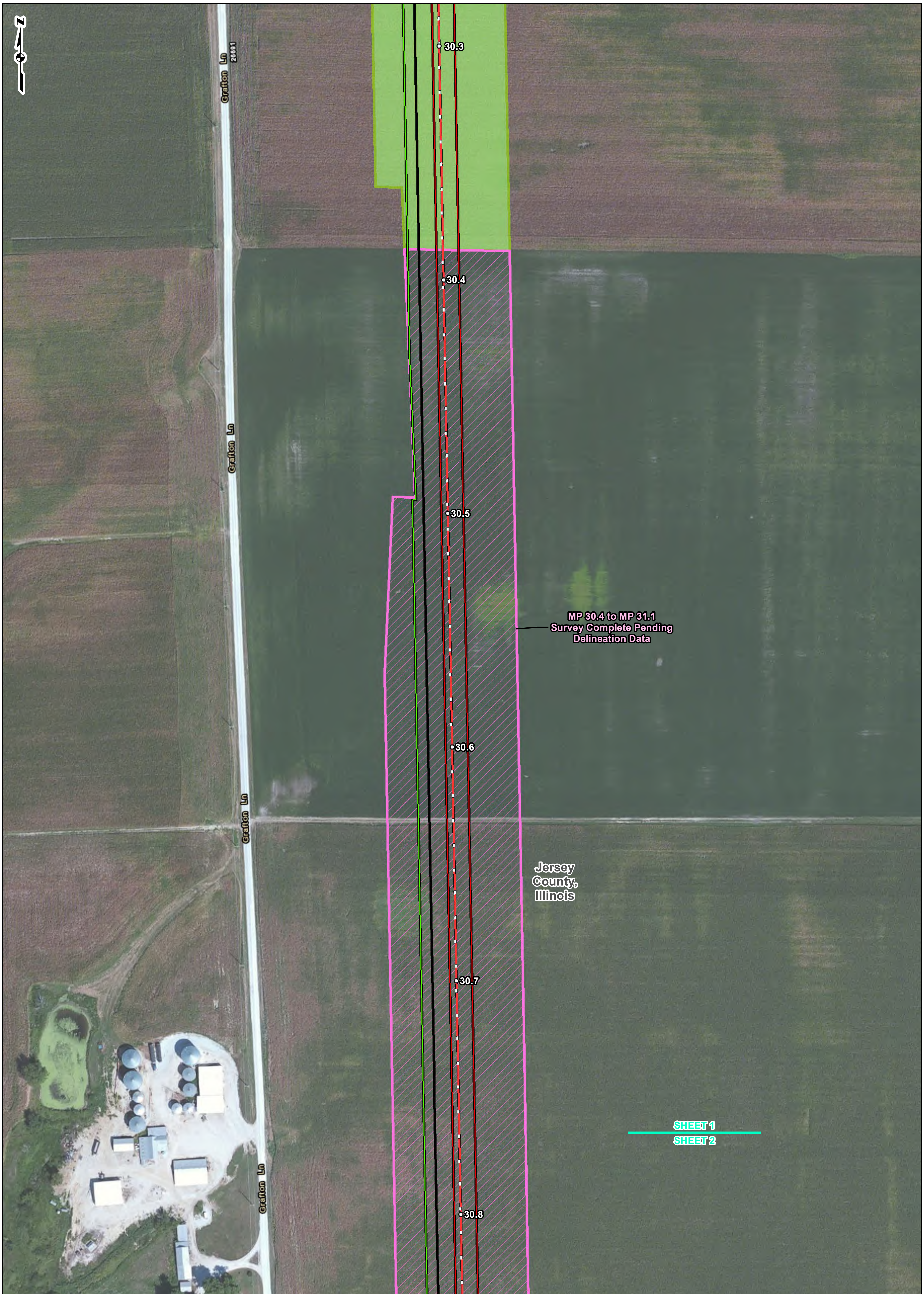
If an HDD installation were completed and the installed pipe was damaged to the point it could not be used for its intend purpose, the inside of the steel product pipe would be grouted with a cement based grout and the annular space around the pipe would be grouted for a distance of approximately 200 feet at each HDD entry and exit location. The above approach is as outlined in the US Army Corps of Engineers' "Guidelines for Installation of Utilities Beneath Corps of Engineers Levees Using Horizontal Directional Drilling" (Latorre et al. 2002) that requires backfilling with grout or bentonite. In addition, any additional requirements set forth in permits acquired for a specific HDD installation will be met in terms of abandonment.

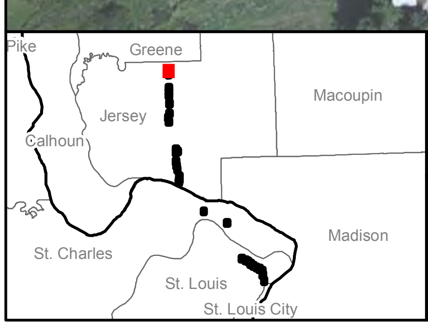
1.4 Reference

Latorre, Carlos A., Wakeley, Lillian D., and Conroy, Patrick J. 2002. *Guidelines for Installation of Utilities Beneath Corps of Engineers Levees Using Horizontal Directional Drilling.* United States Army Corps of Engineers. ERDC/GS LTR-02-9.

APPENDIX 2-C

Incomplete Environmental Survey Status Mapping





REFERENCE:
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- FACILITY
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- SURVEY COMPLETE PENDING DELINEATION DATA
- SURVEY COMPLETED
- COUNTY BOUNDARY
- STATE BOUNDARY

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INCOMPLETE ENVIRONMENTAL SURVEY STATUS MAP
SHEET 1 OF 30

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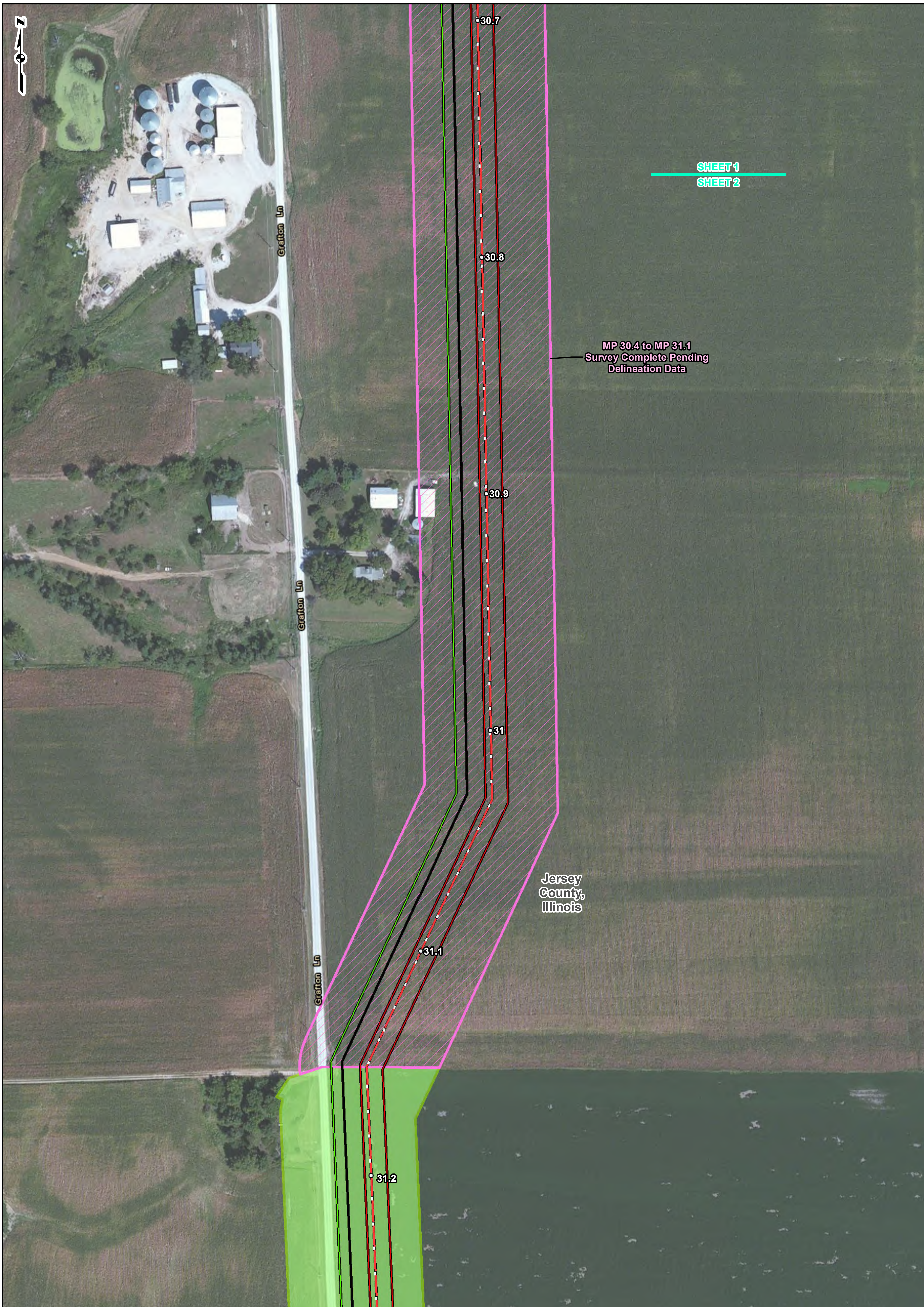

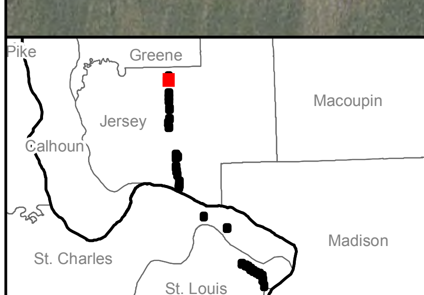

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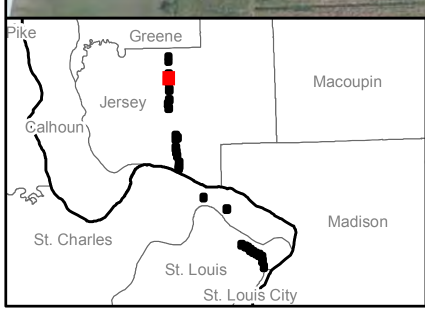

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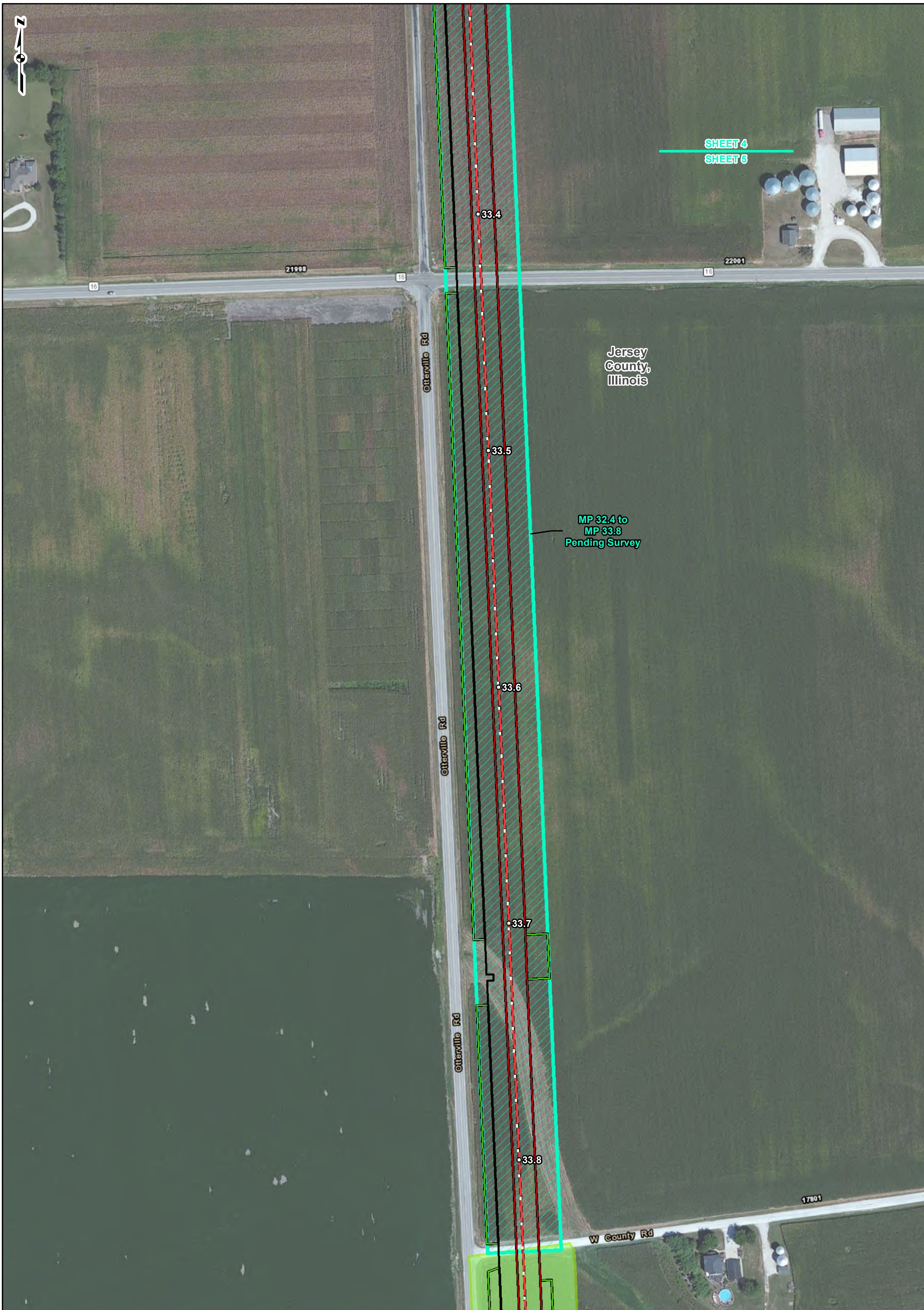

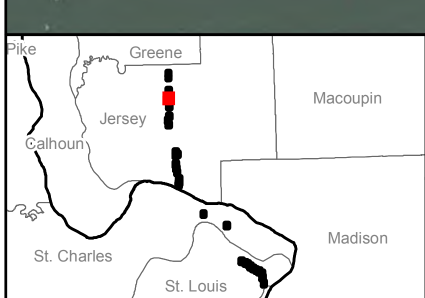

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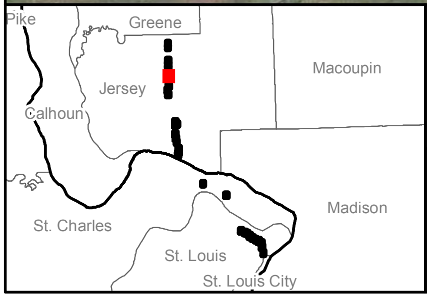

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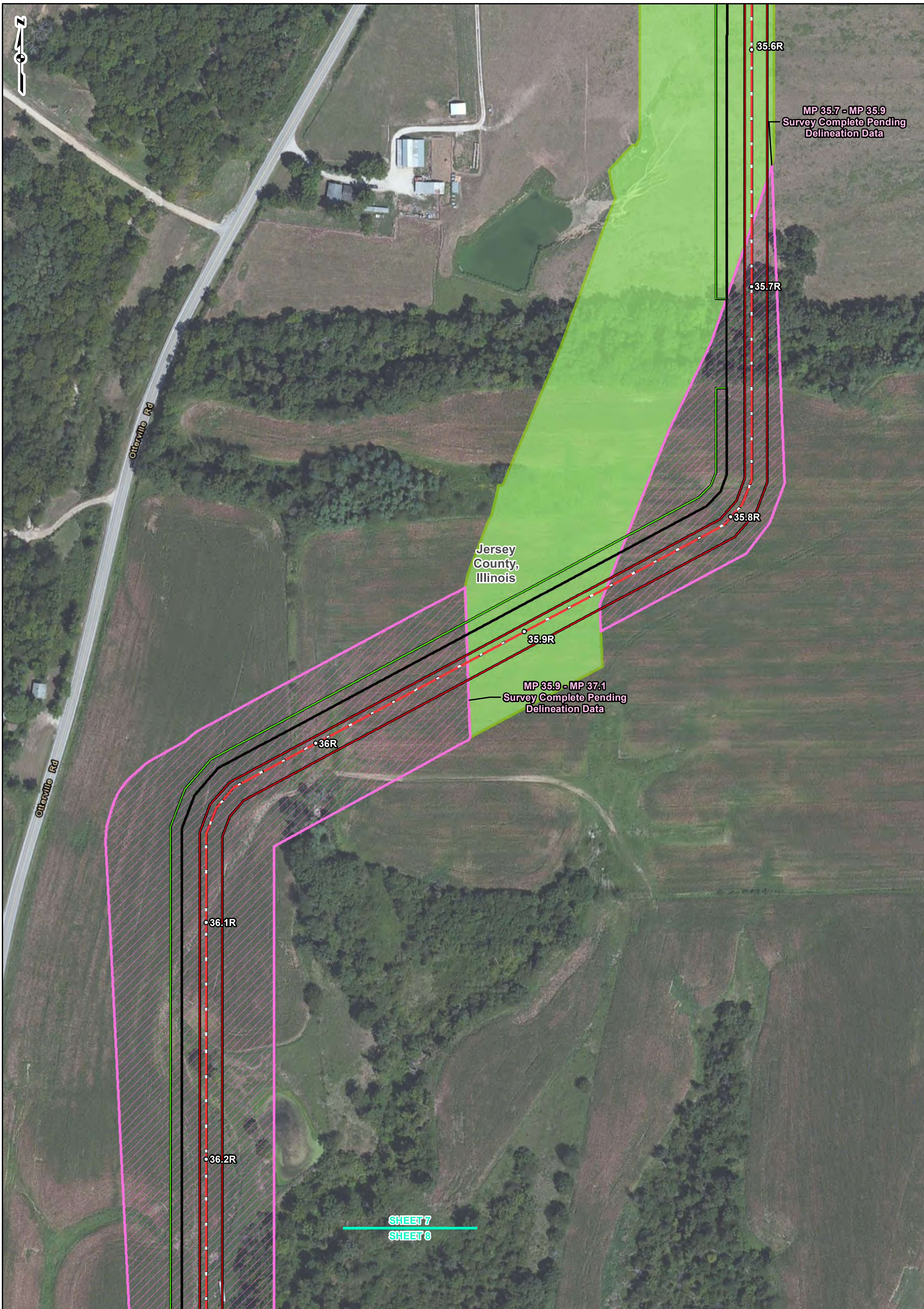

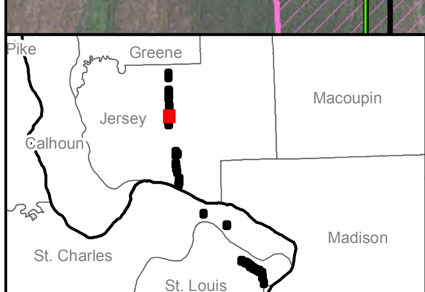

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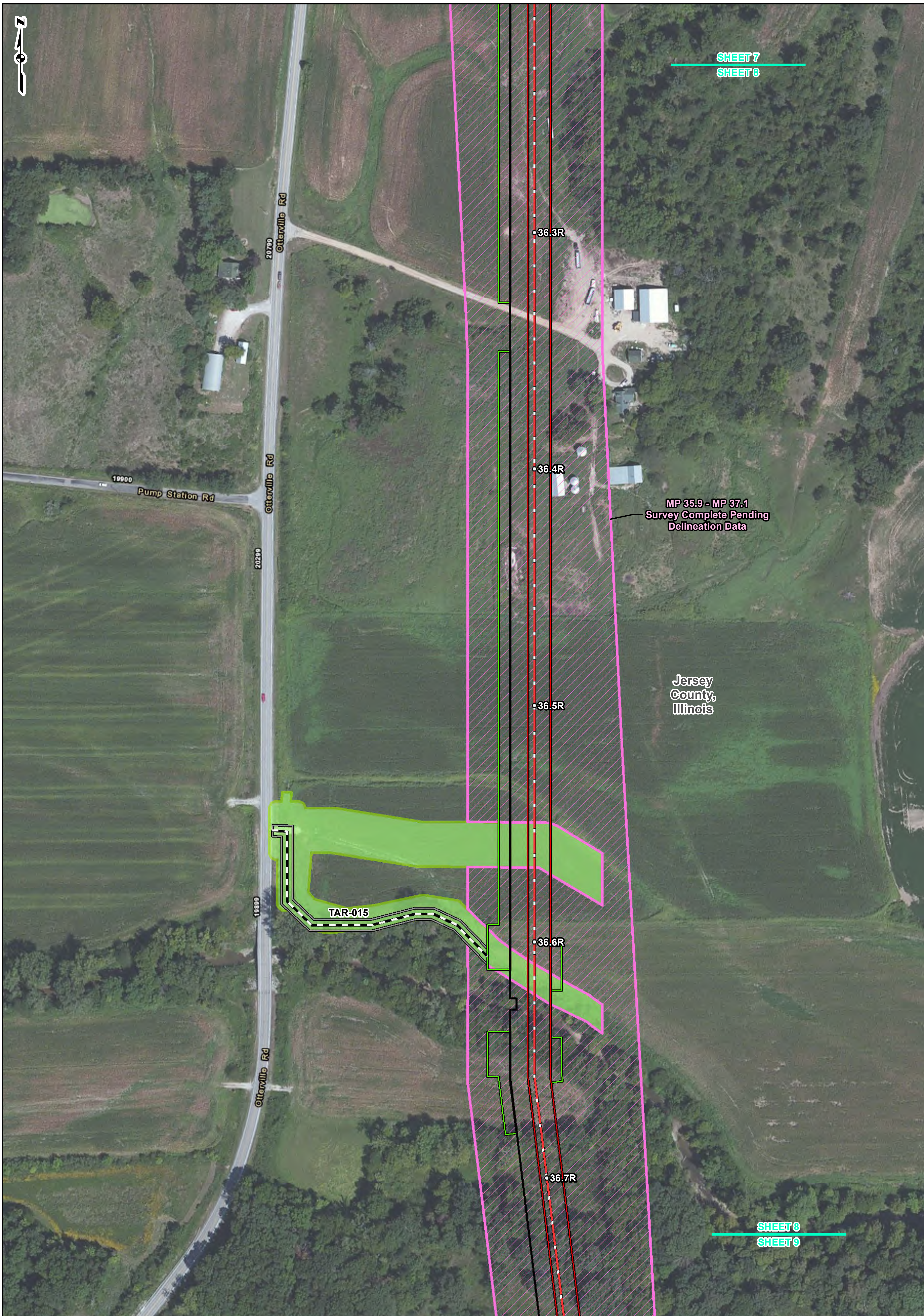

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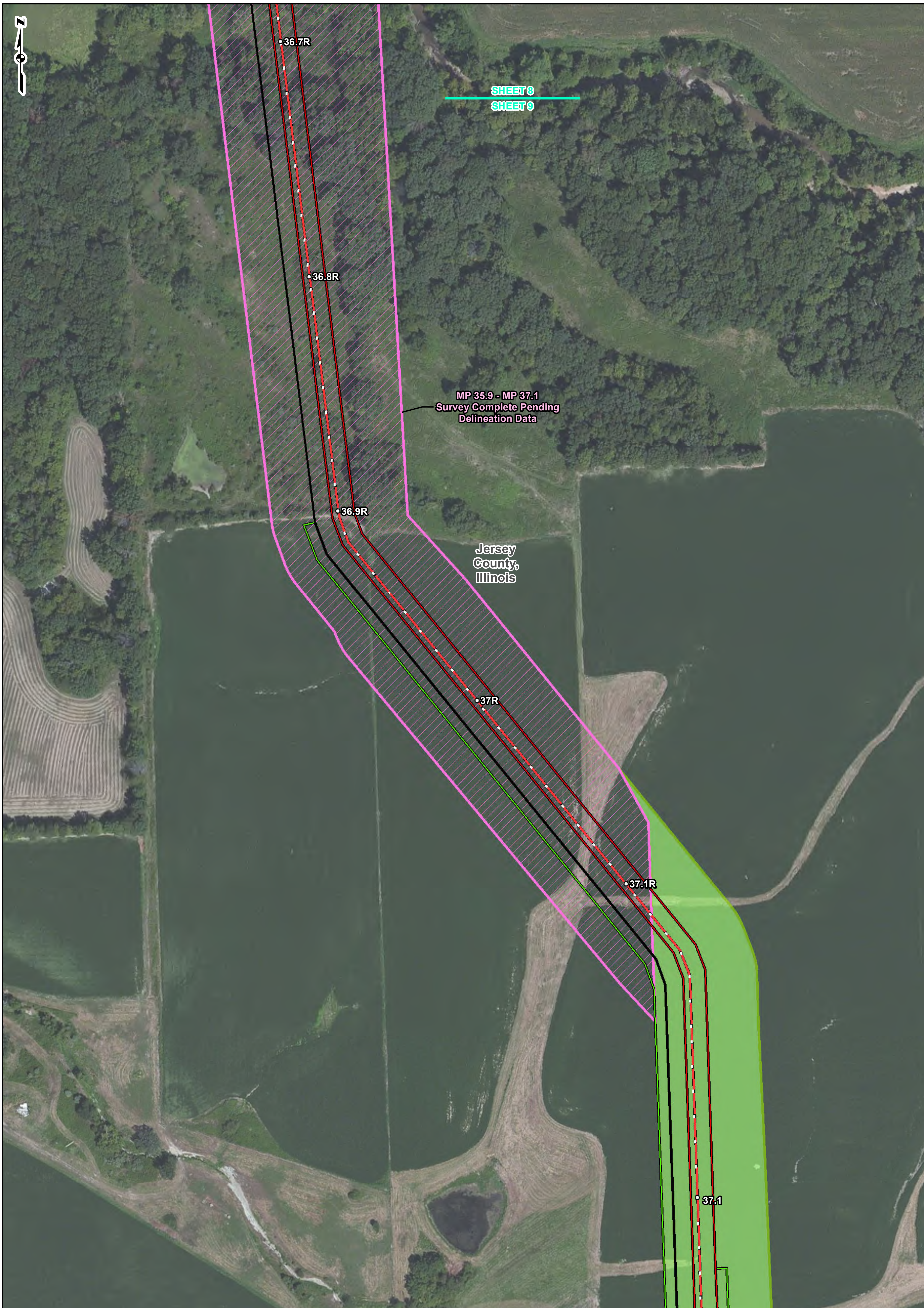

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0 100 200 400 Feet

INCOMPLETE ENVIRONMENTAL SURVEY STATUS MAP
SHEET 9 OF 30

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SPIRE STL PIPELINE PROJECT

spire

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DATE: 4/7/2017
CHECKED: SWW
APPROVED: LMF

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REFERENCE:
ESRI WORLD IMAGERY AND TRANSPORTATION, NAIP, USDA FSA, 2014, ACCESSED 04/2017.

LEGEND

- FACILITY
- MILEPOST
- ACCESS ROAD
- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
- PERMANENT EASEMENT
- CONSTRUCTION WORK AREA
- ATWS
- STAGING AREA
- ACCESS ROAD WORK AREA
- PENDING SURVEY
- SURVEY COMPLETE PENDING DELINEATION DATA
- SURVEY COMPLETED
- COUNTY BOUNDARY
- STATE BOUNDARY

0 100 200 400 Feet

INCOMPLETE ENVIRONMENTAL SURVEY STATUS MAP
SHEET 10 OF 30

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SPIRE STL PIPELINE PROJECT

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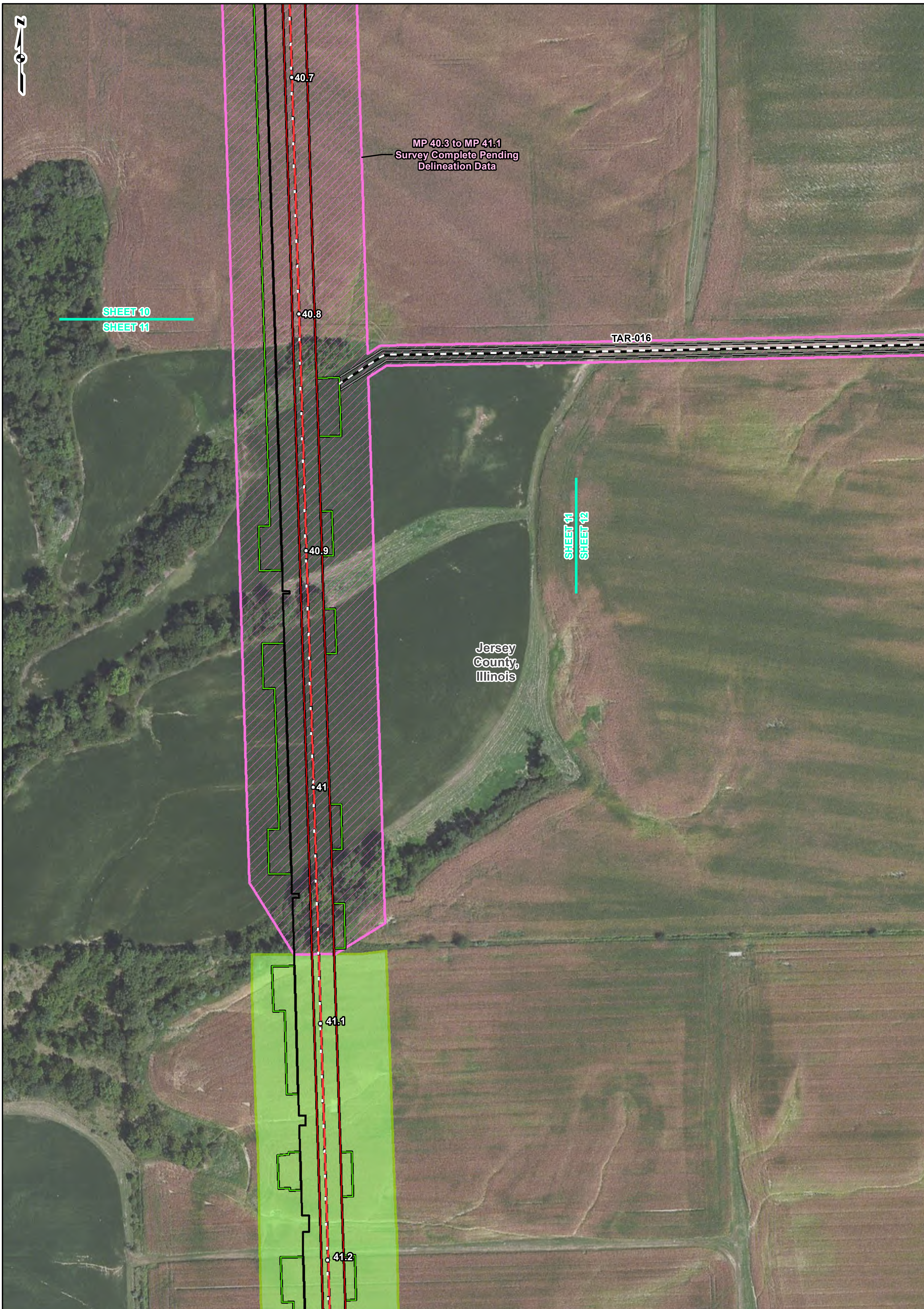

REFERENCE:
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LEGEND

- FACILITY
- MILEPOST
- ACCESS ROAD
- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
- PERMANENT EASEMENT
- CONSTRUCTION WORK AREA
- ATWS
- STAGING AREA
- ACCESS ROAD WORK AREA
- PENDING SURVEY
- SURVEY COMPLETE PENDING DELINEATION DATA
- SURVEY COMPLETED
- COUNTY BOUNDARY
- STATE BOUNDARY

0 100 200 400 Feet

INCOMPLETE ENVIRONMENTAL SURVEY STATUS MAP

SHEET 11 OF 30

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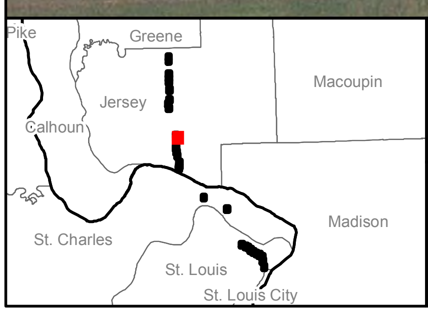

REFERENCE: ESRI WORLD IMAGERY AND TRANSPORTATION, NAIP, USDA FSA, 2014, ACCESSED 04/2017.

LEGEND

- FACILITY
- MILEPOST
- ACCESS ROAD
- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
- PERMANENT EASEMENT
- CONSTRUCTION WORK AREA
- ATWS
- STAGING AREA
- ACCESS ROAD WORK AREA
- PENDING SURVEY
- SURVEY COMPLETE PENDING DELINEATION DATA
- SURVEY COMPLETED
- COUNTY BOUNDARY
- STATE BOUNDARY

0 100 200 400 Feet

INCOMPLETE ENVIRONMENTAL SURVEY STATUS MAP

SHEET 12 OF 30

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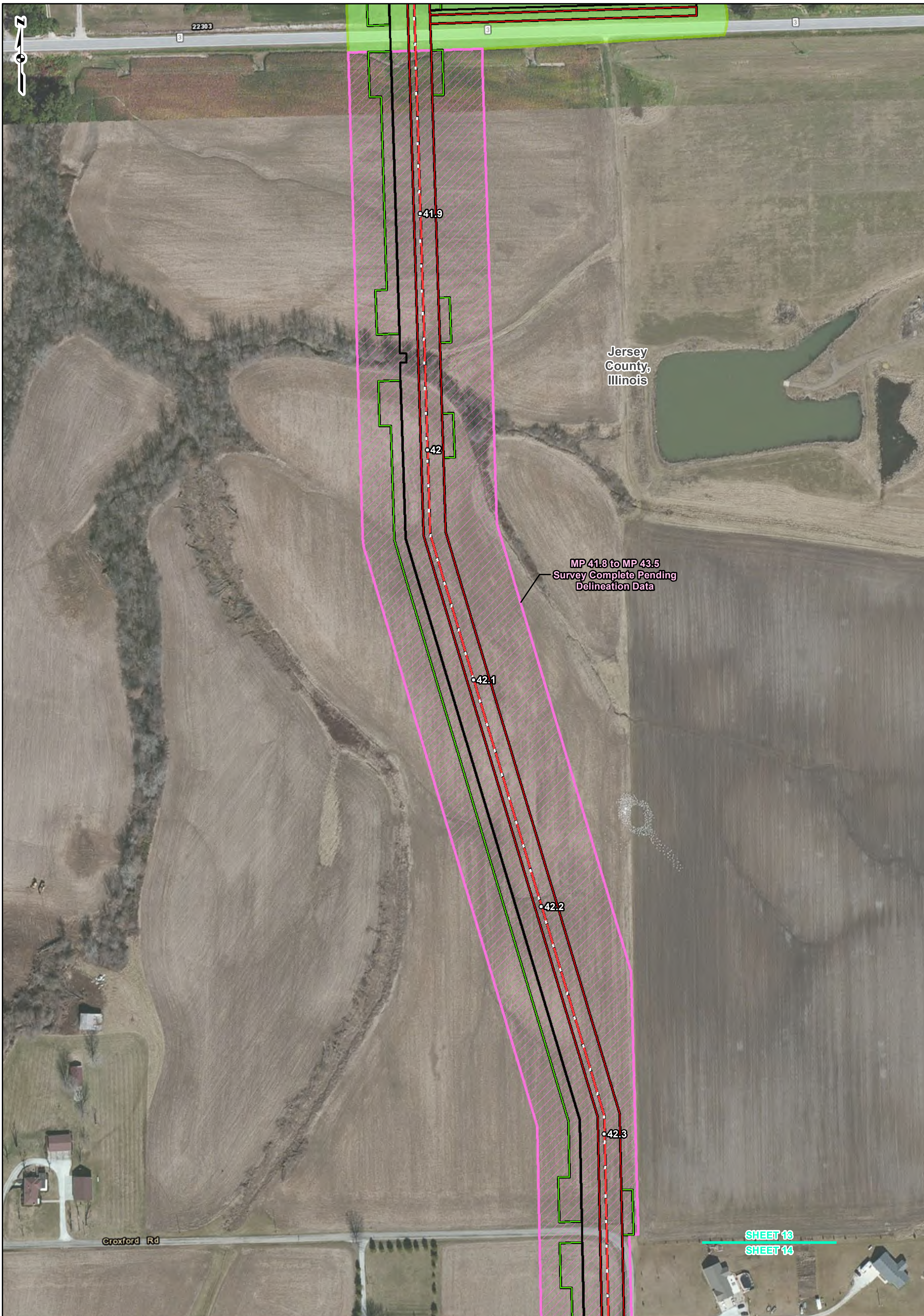

REFERENCE: ESRI WORLD IMAGERY AND TRANSPORTATION, NAIP, USDA FSA, 2014, ACCESSED 04/2017.

LEGEND

- FACILITY
- MILEPOST
- ACCESS ROAD
- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
- PERMANENT EASEMENT
- CONSTRUCTION WORK AREA
- ATWS
- STAGING AREA
- ACCESS ROAD WORK AREA
- PENDING SURVEY
- SURVEY COMPLETE PENDING DELINEATION DATA
- SURVEY COMPLETED
- COUNTY BOUNDARY
- STATE BOUNDARY

0 100 200 400 Feet

INCOMPLETE ENVIRONMENTAL SURVEY STATUS MAP
SHEET 13 OF 30

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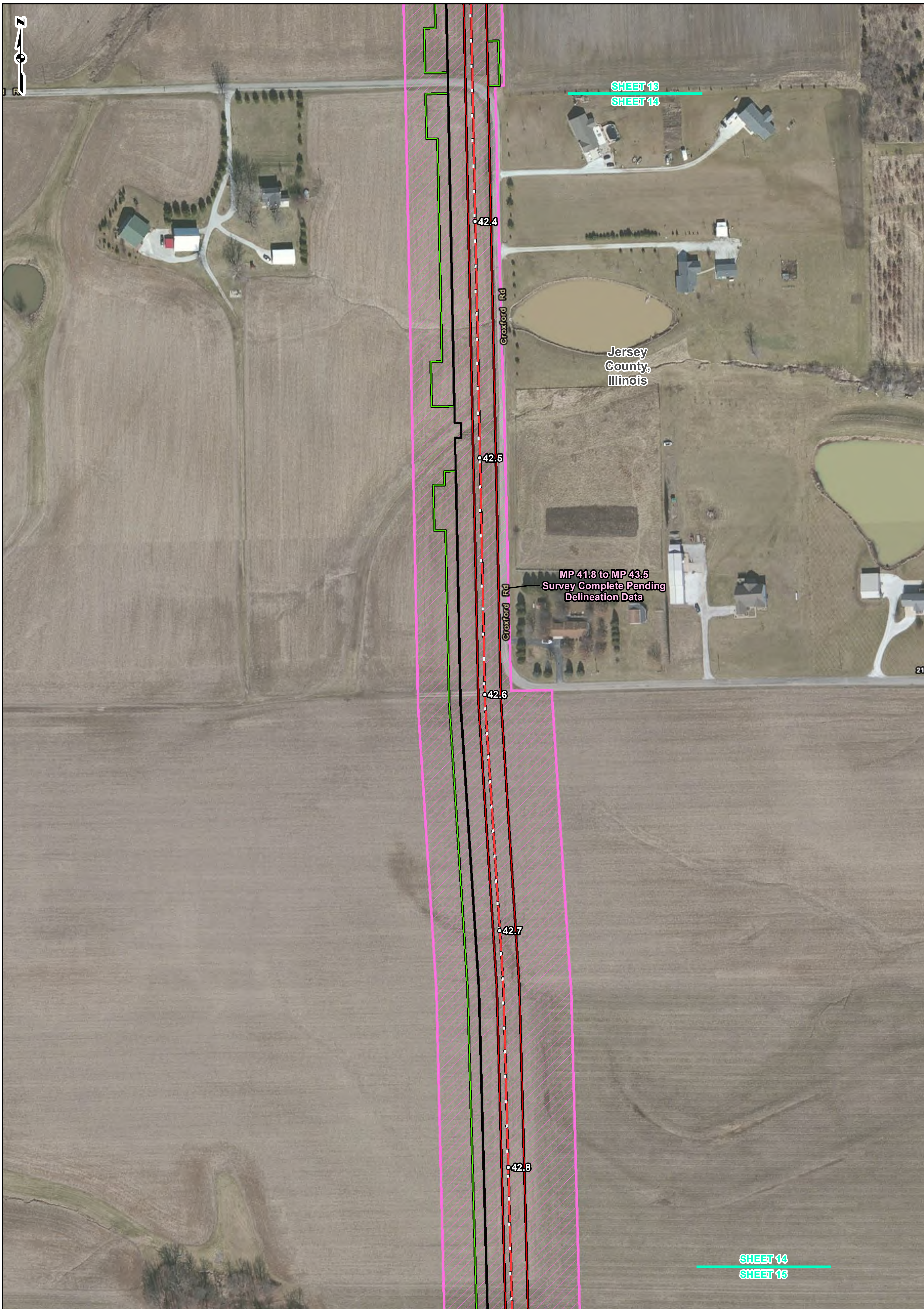

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LEGEND

- FACILITY
- MILEPOST
- ACCESS ROAD
- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
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- CONSTRUCTION WORK AREA
- ATWS
- STAGING AREA
- ACCESS ROAD WORK AREA
- PENDING SURVEY
- SURVEY COMPLETE PENDING DELINEATION DATA
- SURVEY COMPLETED
- COUNTY BOUNDARY
- STATE BOUNDARY

0 100 200 400 Feet

INCOMPLETE ENVIRONMENTAL SURVEY STATUS MAP
SHEET 14 OF 30

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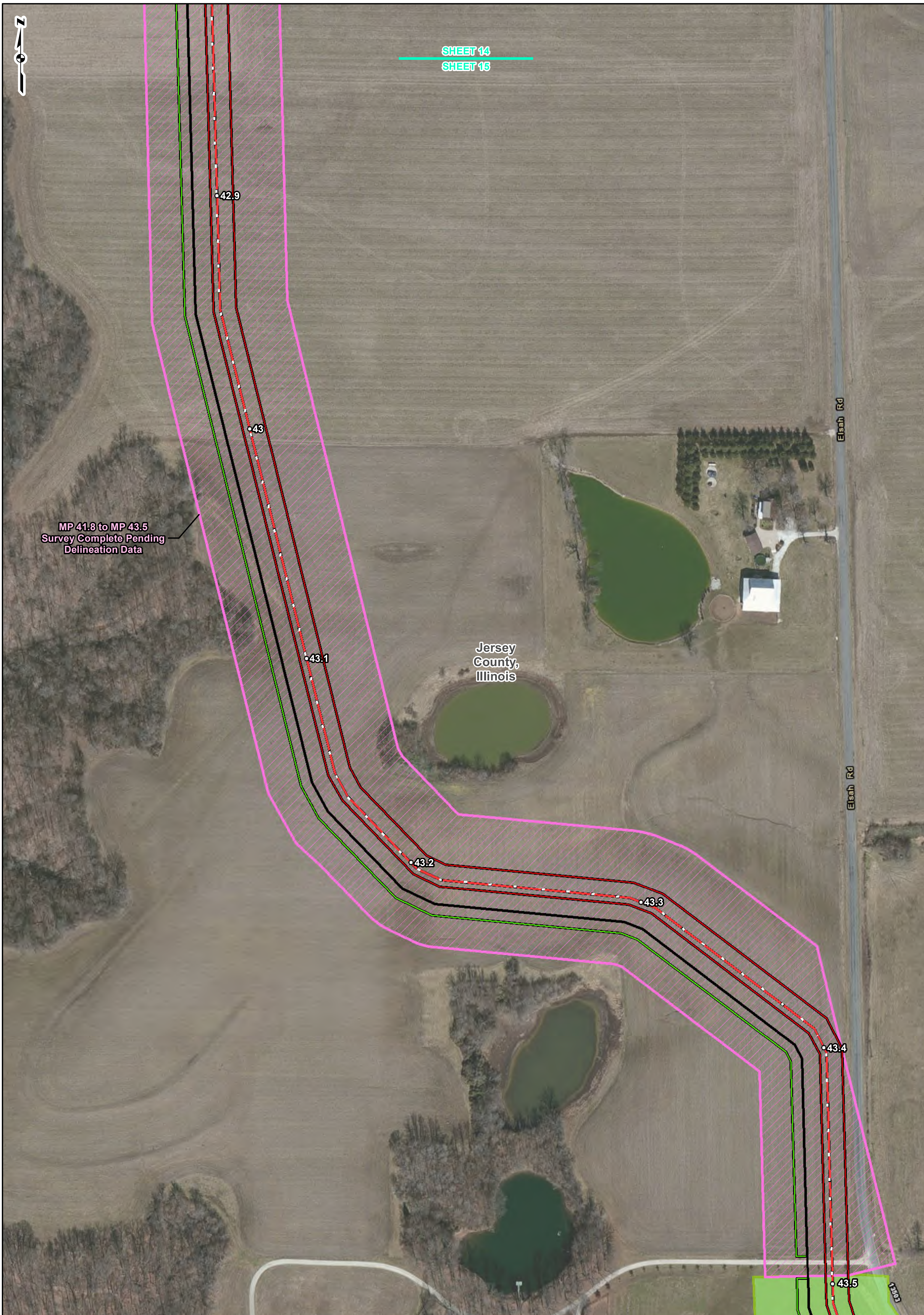

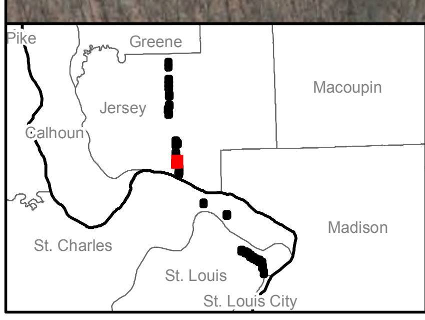

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LEGEND

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- MILEPOST
- ACCESS ROAD
- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
- PERMANENT EASEMENT
- CONSTRUCTION WORK AREA
- ATWS
- STAGING AREA
- ACCESS ROAD WORK AREA
- PENDING SURVEY
- SURVEY COMPLETE PENDING DELINEATION DATA
- SURVEY COMPLETED
- COUNTY BOUNDARY
- STATE BOUNDARY

0 100 200 400 Feet

INCOMPLETE ENVIRONMENTAL SURVEY STATUS MAP
SHEET 15 OF 30

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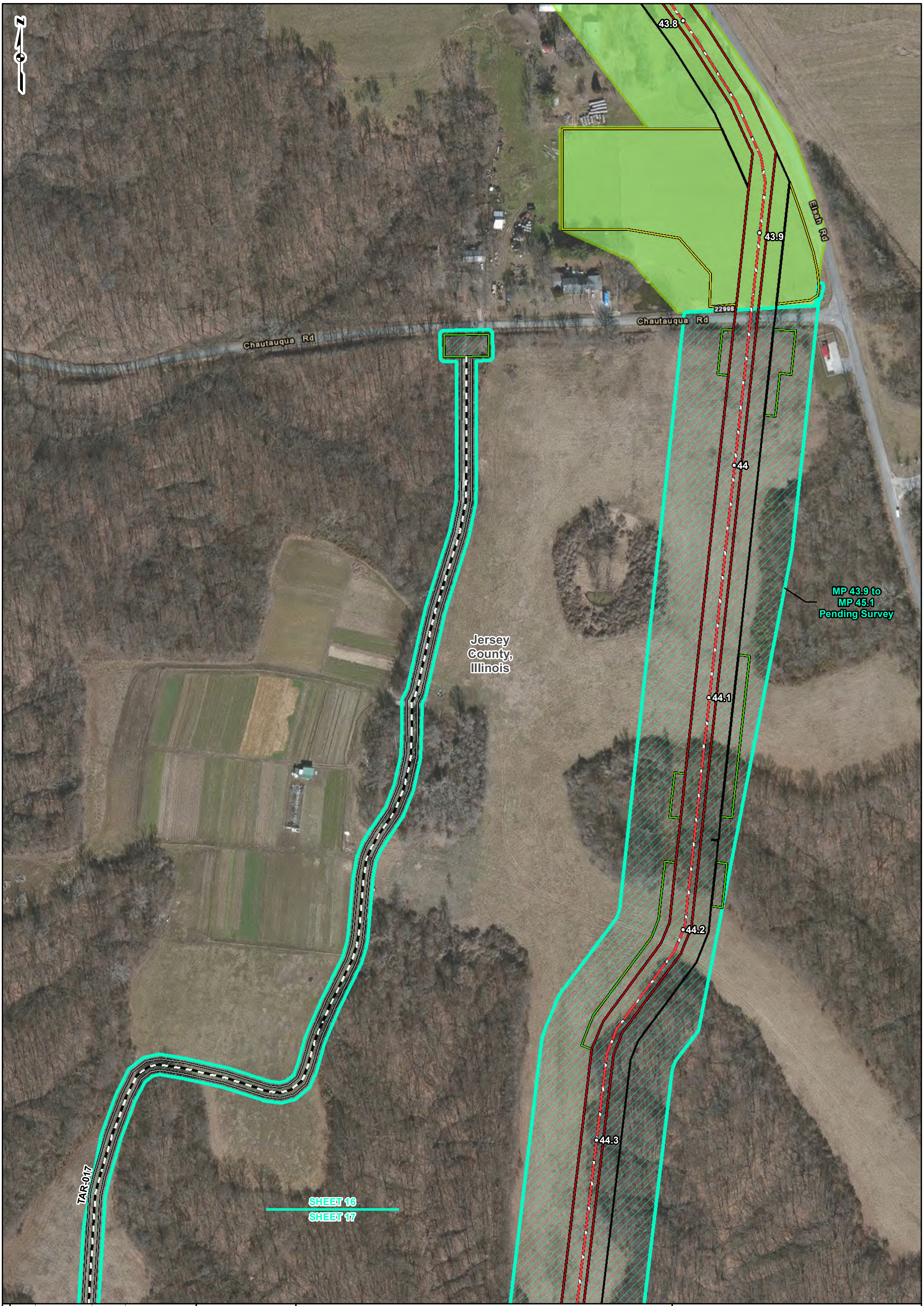

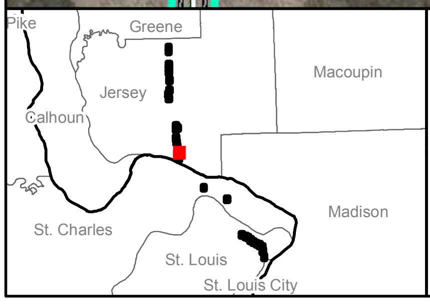

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LEGEND

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- MILEPOST
- ACCESS ROAD
- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
- PERMANENT EASEMENT
- CONSTRUCTION WORK AREA
- ATWS
- STAGING AREA
- ACCESS ROAD WORK AREA
- PENDING SURVEY
- SURVEY COMPLETE PENDING DELINEATION DATA
- SURVEY COMPLETED
- COUNTY BOUNDARY
- STATE BOUNDARY

0 100 200 400 Feet

INCOMPLETE ENVIRONMENTAL SURVEY STATUS MAP
SHEET 16 OF 30

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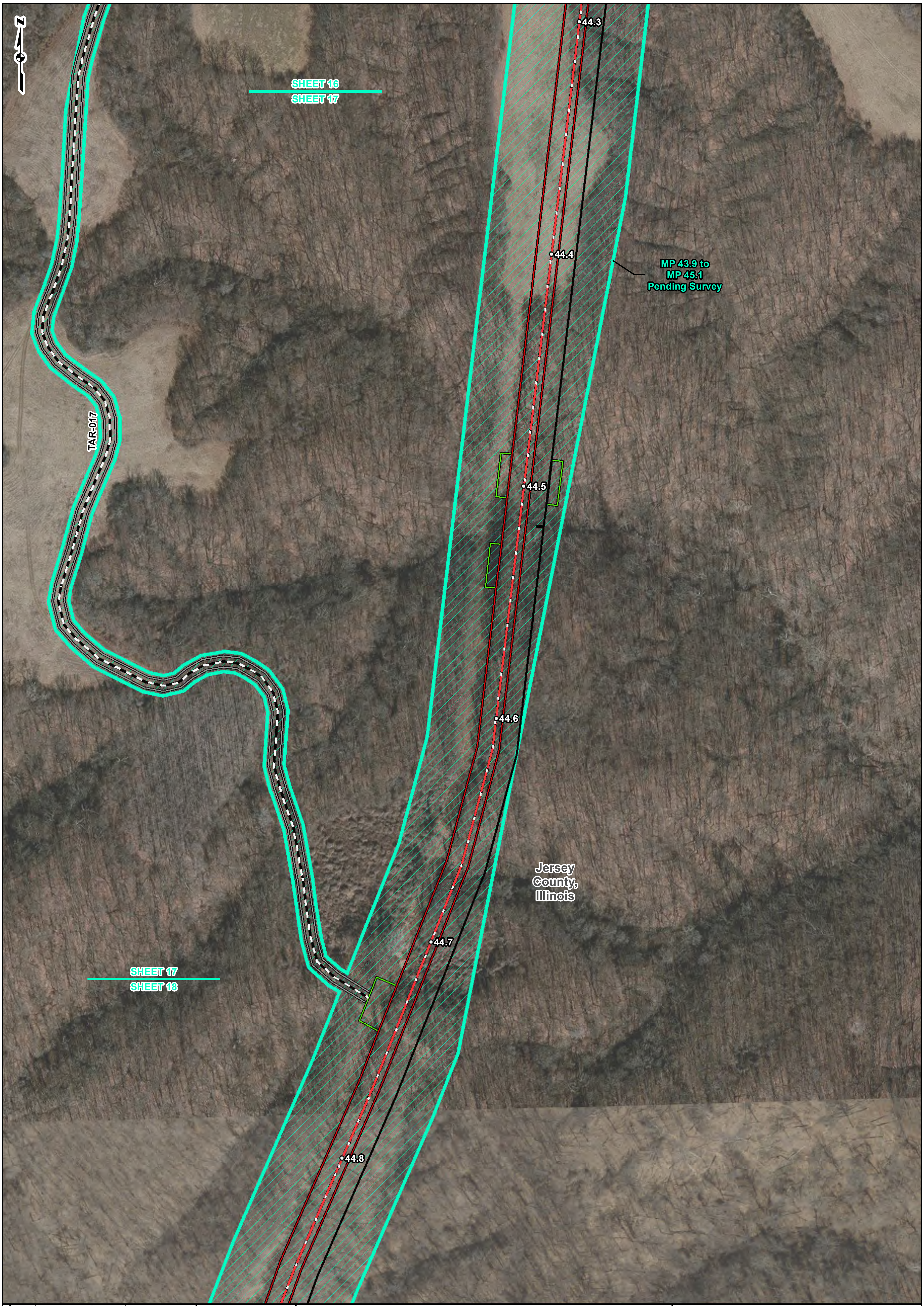

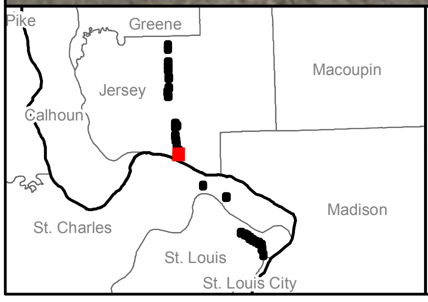

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LEGEND

- FACILITY
- MILEPOST
- ACCESS ROAD
- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
- PERMANENT EASEMENT
- CONSTRUCTION WORK AREA
- ATWS
- STAGING AREA
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- SURVEY COMPLETE PENDING DELINEATION DATA
- SURVEY COMPLETED
- COUNTY BOUNDARY
- STATE BOUNDARY

0 100 200 400 Feet

INCOMPLETE ENVIRONMENTAL SURVEY STATUS MAP

SHEET 17 OF 30

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LEGEND

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- ACCESS ROAD
- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
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- ATWS
- STAGING AREA
- ACCESS ROAD WORK AREA
- PENDING SURVEY
- SURVEY COMPLETE PENDING DELINEATION DATA
- SURVEY COMPLETED
- COUNTY BOUNDARY
- STATE BOUNDARY

0 100 200 400 Feet

INCOMPLETE ENVIRONMENTAL SURVEY STATUS MAP
SHEET 18 OF 30

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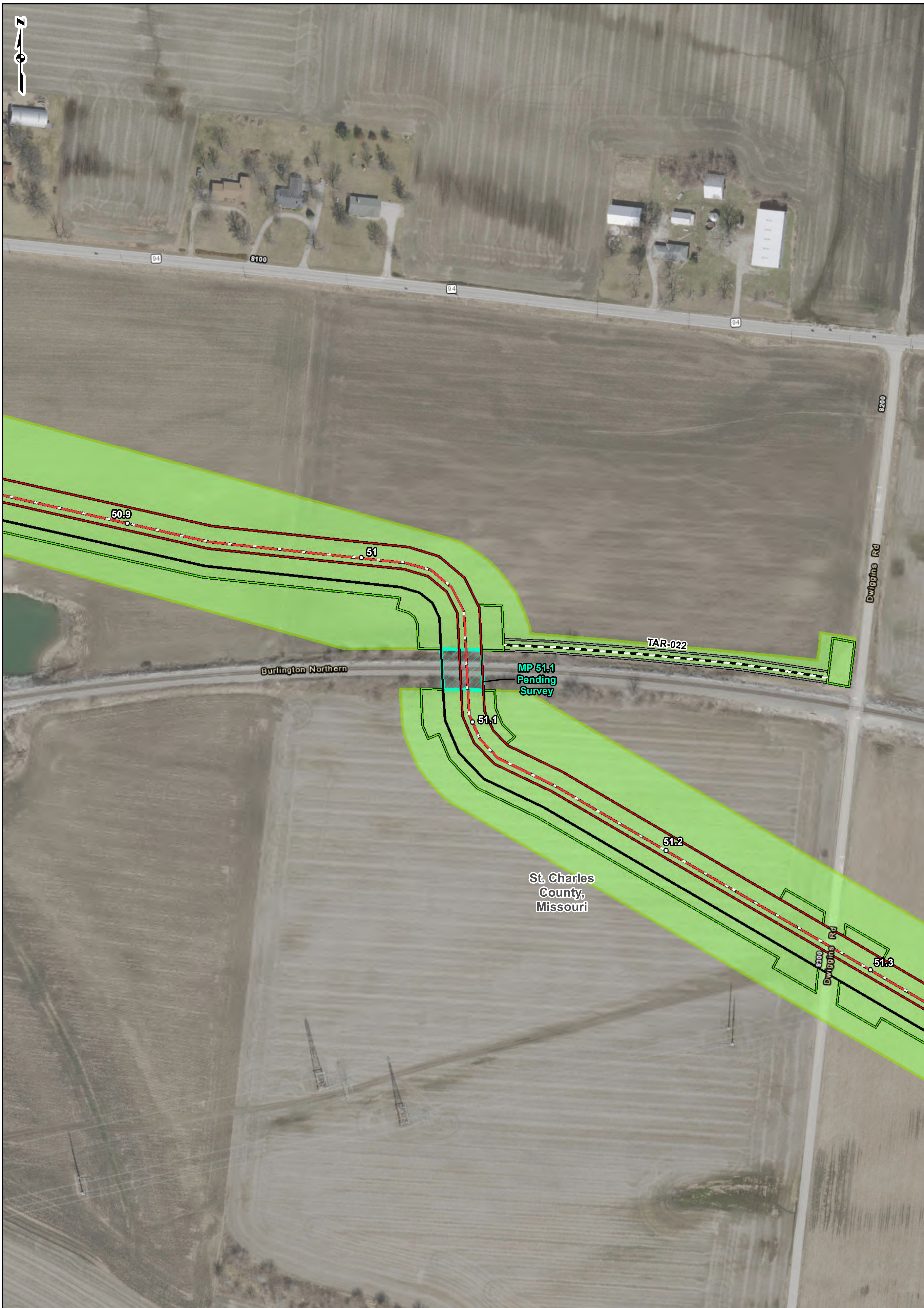

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LEGEND

- FACILITY
- MILEPOST
- ACCESS ROAD
- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
- PERMANENT EASEMENT
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- ACCESS ROAD WORK AREA
- PENDING SURVEY
- SURVEY COMPLETE PENDING DELINEATION DATA
- SURVEY COMPLETED
- COUNTY BOUNDARY
- STATE BOUNDARY

0 100 200 400 Feet

INCOMPLETE ENVIRONMENTAL SURVEY STATUS MAP

SHEET 19 OF 30

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LEGEND

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- MILEPOST
- ACCESS ROAD
- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
- PERMANENT EASEMENT
- CONSTRUCTION WORK AREA
- ATWS
- STAGING AREA
- ACCESS ROAD WORK AREA
- PENDING SURVEY
- SURVEY COMPLETE PENDING DELINEATION DATA
- SURVEY COMPLETED
- COUNTY BOUNDARY
- STATE BOUNDARY

0 100 200 400 Feet

INCOMPLETE ENVIRONMENTAL SURVEY STATUS MAP
SHEET 20 OF 30

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LEGEND

- FACILITY
- MILEPOST
- ACCESS ROAD
- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
- PERMANENT EASEMENT
- CONSTRUCTION WORK AREA
- ATWS
- STAGING AREA
- ACCESS ROAD WORK AREA
- PENDING SURVEY
- SURVEY COMPLETE PENDING DELINEATION DATA
- SURVEY COMPLETED
- COUNTY BOUNDARY
- STATE BOUNDARY

0 100 200 400 Feet

INCOMPLETE ENVIRONMENTAL SURVEY STATUS MAP
SHEET 21 OF 30

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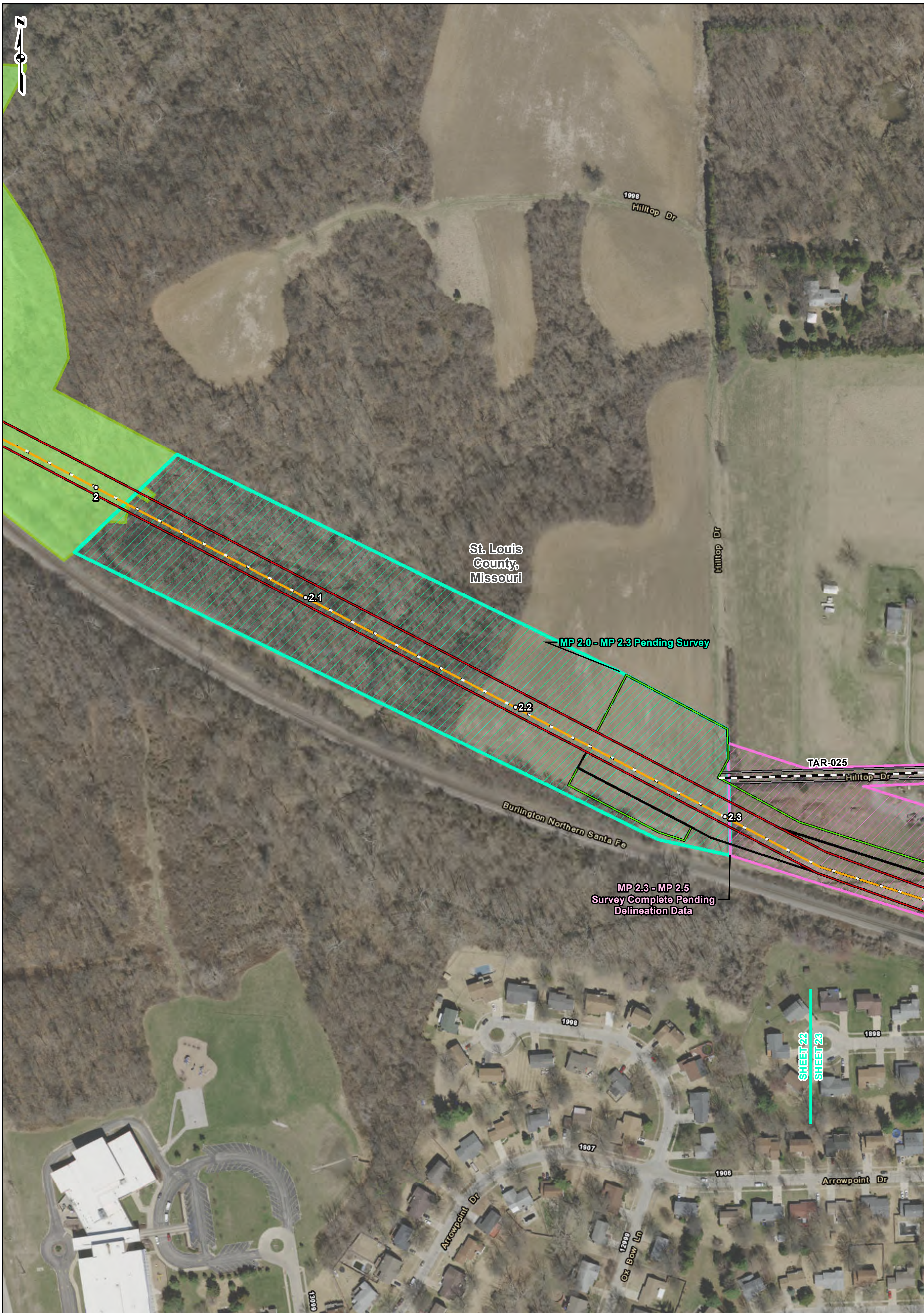

REFERENCE: ESRI WORLD IMAGERY AND TRANSPORTATION, NAIP, USDA FSA, 2014, ACCESSED 04/2017.

LEGEND

- FACILITY
- MILEPOST
- ACCESS ROAD
- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
- PERMANENT EASEMENT
- CONSTRUCTION WORK AREA
- ATWS
- STAGING AREA
- ACCESS ROAD WORK AREA
- PENDING SURVEY
- SURVEY COMPLETE PENDING DELINEATION DATA
- SURVEY COMPLETED
- COUNTY BOUNDARY
- STATE BOUNDARY

0 100 200 400 Feet

INCOMPLETE ENVIRONMENTAL SURVEY STATUS MAP
SHEET 22 OF 30

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LEGEND

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- MILEPOST
- ACCESS ROAD
- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
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- CONSTRUCTION WORK AREA
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- ACCESS ROAD WORK AREA
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- SURVEY COMPLETE PENDING DELINEATION DATA
- SURVEY COMPLETED
- COUNTY BOUNDARY
- STATE BOUNDARY

0 100 200 400 Feet

INCOMPLETE ENVIRONMENTAL SURVEY STATUS MAP
SHEET 23 OF 30

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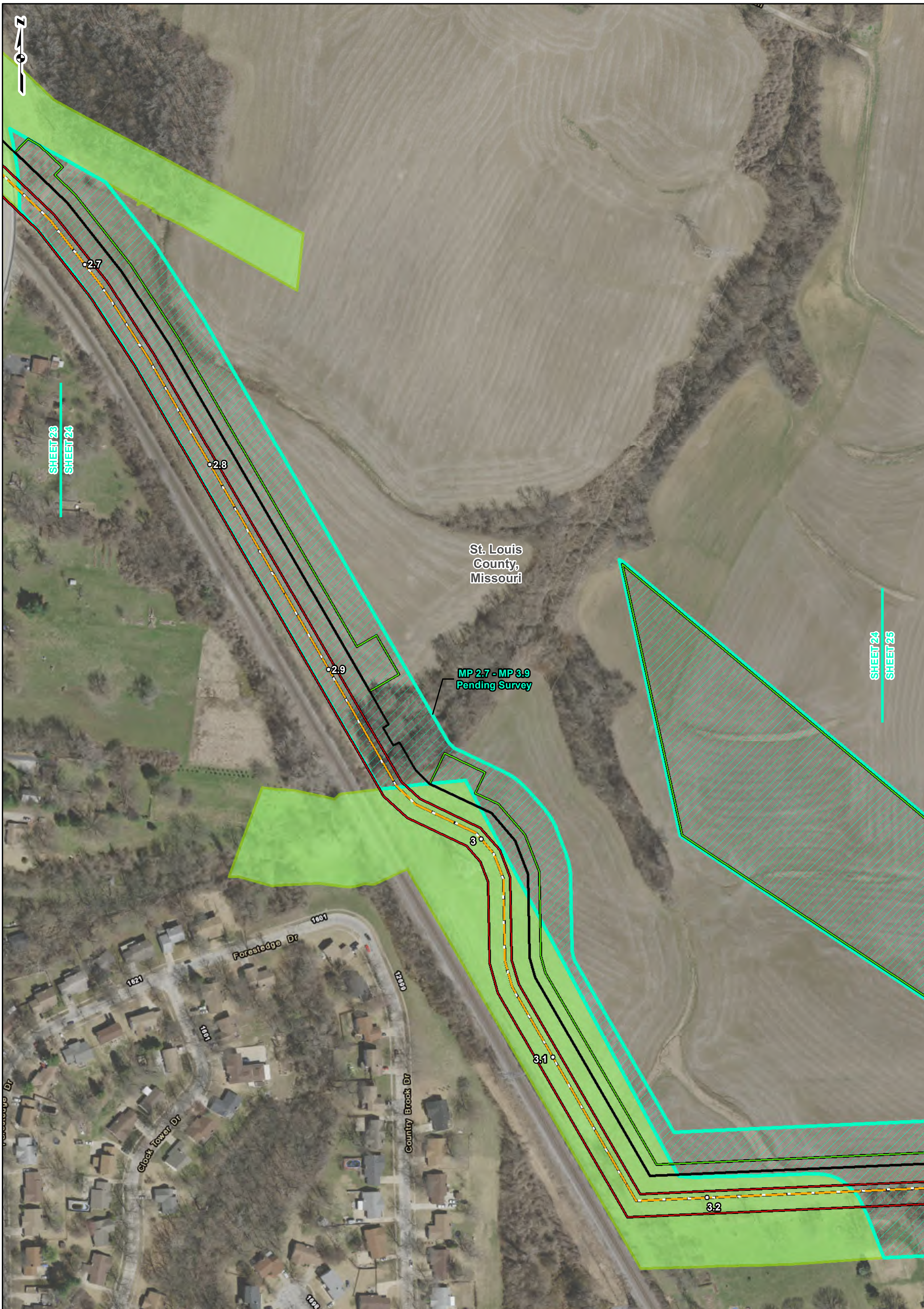

Pike
Greene
Macoupin
Jersey
Calhoun
St. Charles
Madison
St. Louis
St. Louis City

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LEGEND

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- MILEPOST
- ACCESS ROAD
- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
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- CONSTRUCTION WORK AREA
- ATWS
- STAGING AREA
- ACCESS ROAD WORK AREA
- PENDING SURVEY
- SURVEY COMPLETE PENDING DELINEATION DATA
- SURVEY COMPLETED
- COUNTY BOUNDARY
- STATE BOUNDARY

0 100 200 400 Feet

INCOMPLETE ENVIRONMENTAL SURVEY STATUS MAP
SHEET 24 OF 30

SPIRE STL PIPELINE PROJECT

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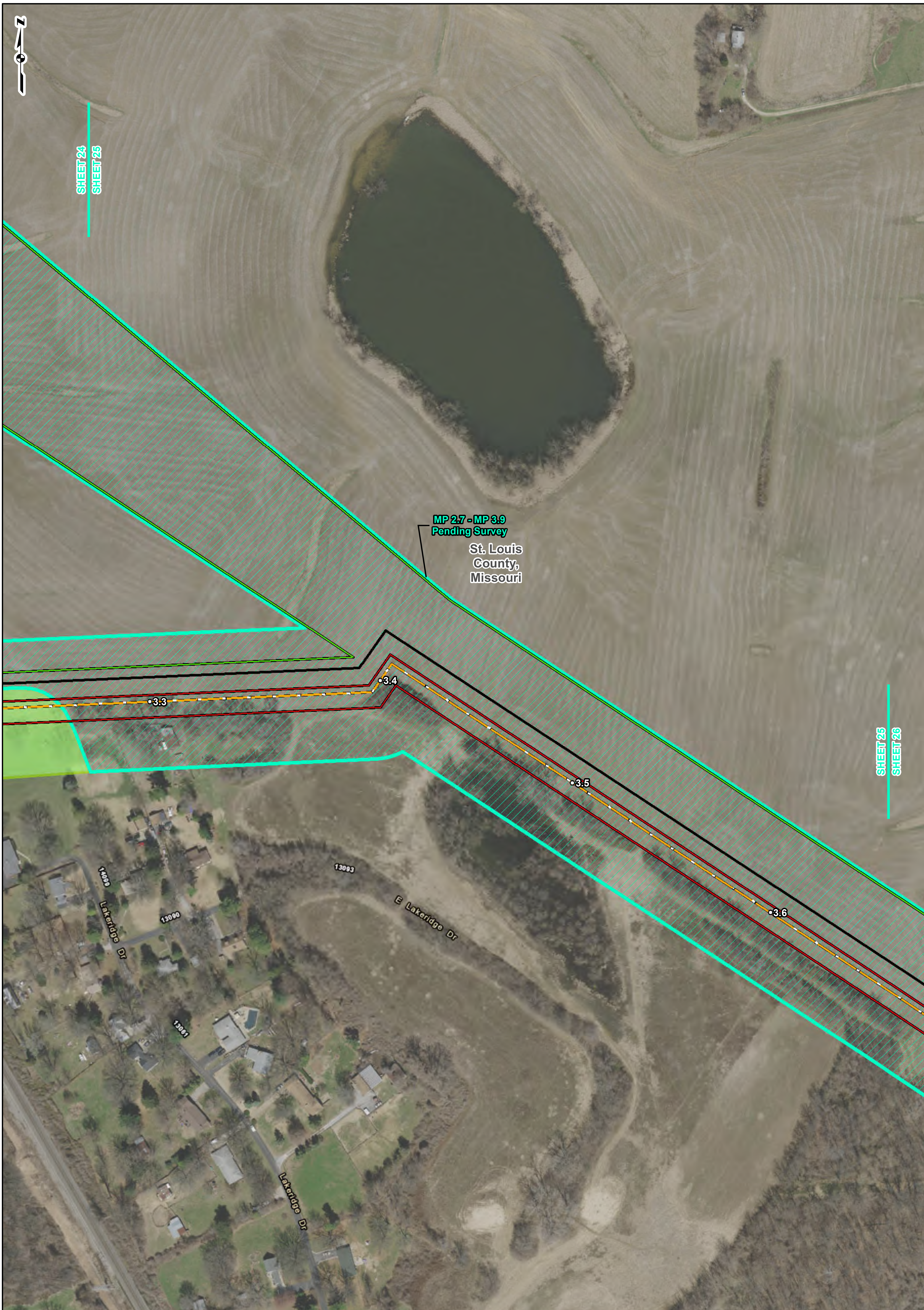

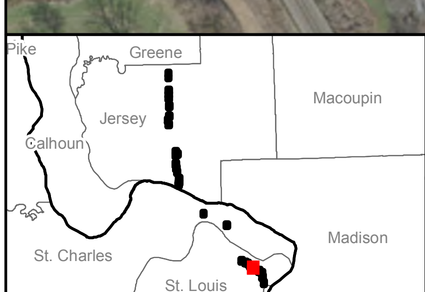

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LEGEND

- FACILITY
- MILEPOST
- ACCESS ROAD
- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
- PERMANENT EASEMENT
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- ATWS
- STAGING AREA
- ACCESS ROAD WORK AREA
- PENDING SURVEY
- SURVEY COMPLETE PENDING DELINEATION DATA
- SURVEY COMPLETED
- COUNTY BOUNDARY
- STATE BOUNDARY

0 100 200 400 Feet

INCOMPLETE ENVIRONMENTAL SURVEY STATUS MAP
SHEET 25 OF 30

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SPIRE STL PIPELINE PROJECT

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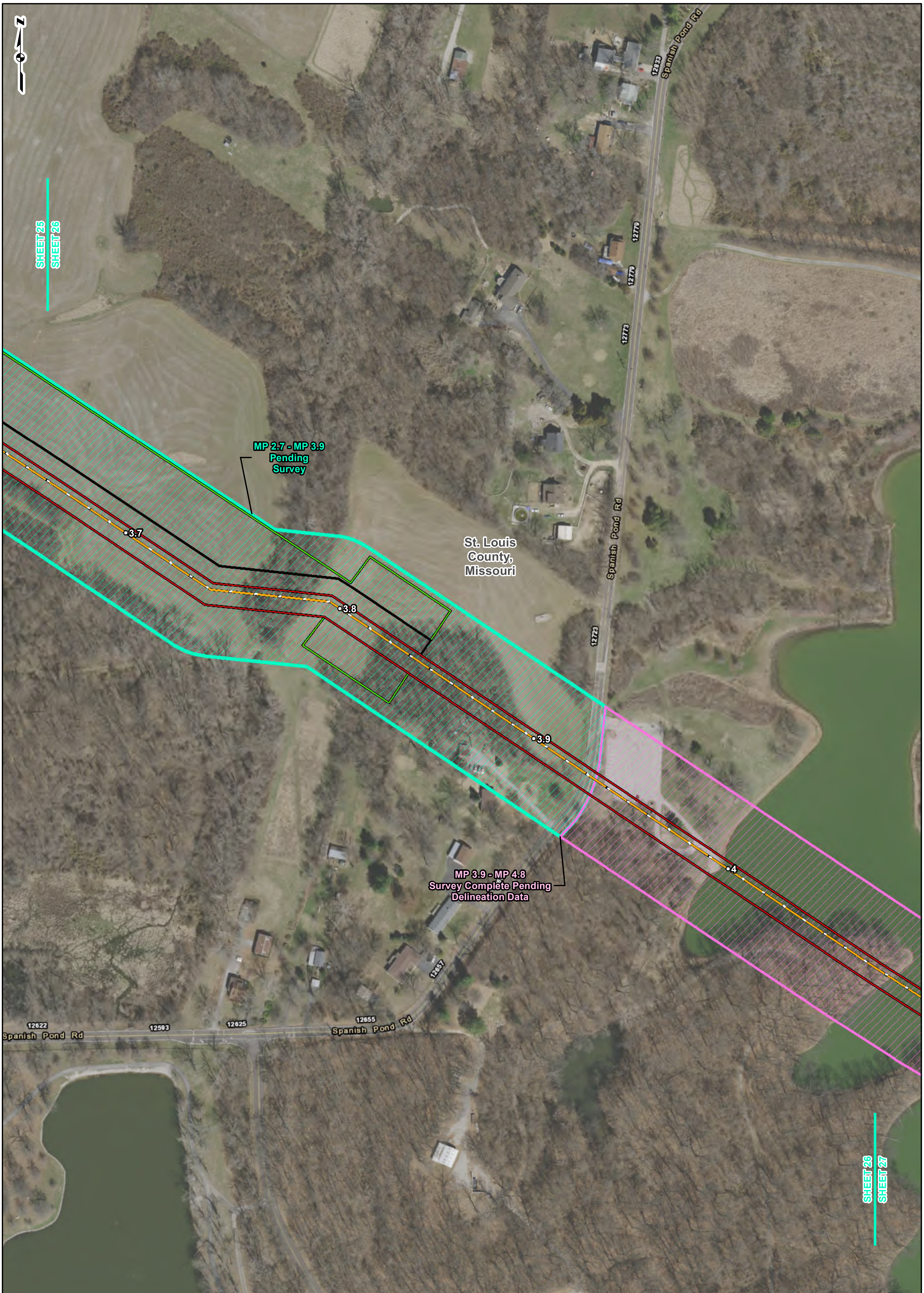

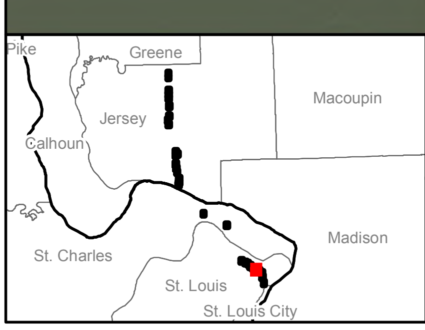

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LEGEND

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- SURVEY COMPLETE PENDING DELINEATION DATA
- SURVEY COMPLETED
- COUNTY BOUNDARY
- STATE BOUNDARY

0 100 200 400 Feet

INCOMPLETE ENVIRONMENTAL SURVEY STATUS MAP SHEET 26 OF 30

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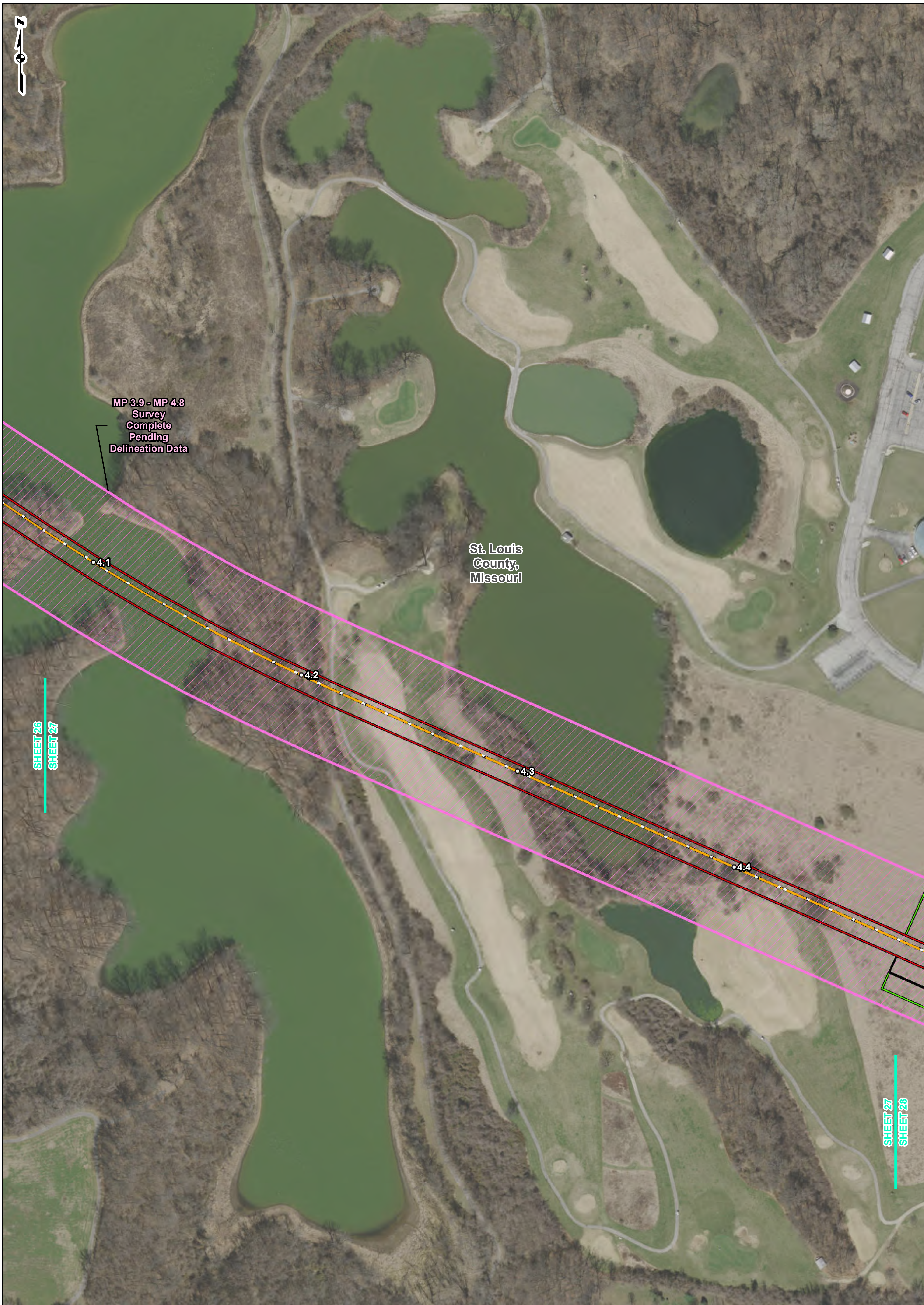

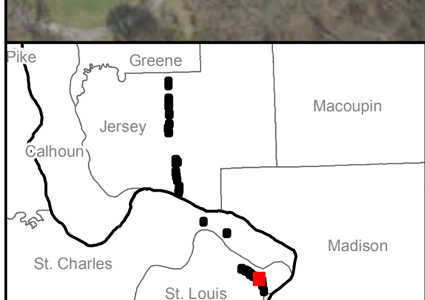

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LEGEND

- FACILITY
- MILEPOST
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- 24-INCH PIPELINE
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- ATWS
- STAGING AREA
- ACCESS ROAD WORK AREA
- PENDING SURVEY
- SURVEY COMPLETE PENDING DELINEATION DATA
- SURVEY COMPLETED
- COUNTY BOUNDARY
- STATE BOUNDARY

0 100 200 400 Feet

INCOMPLETE ENVIRONMENTAL SURVEY STATUS MAP
SHEET 27 OF 30

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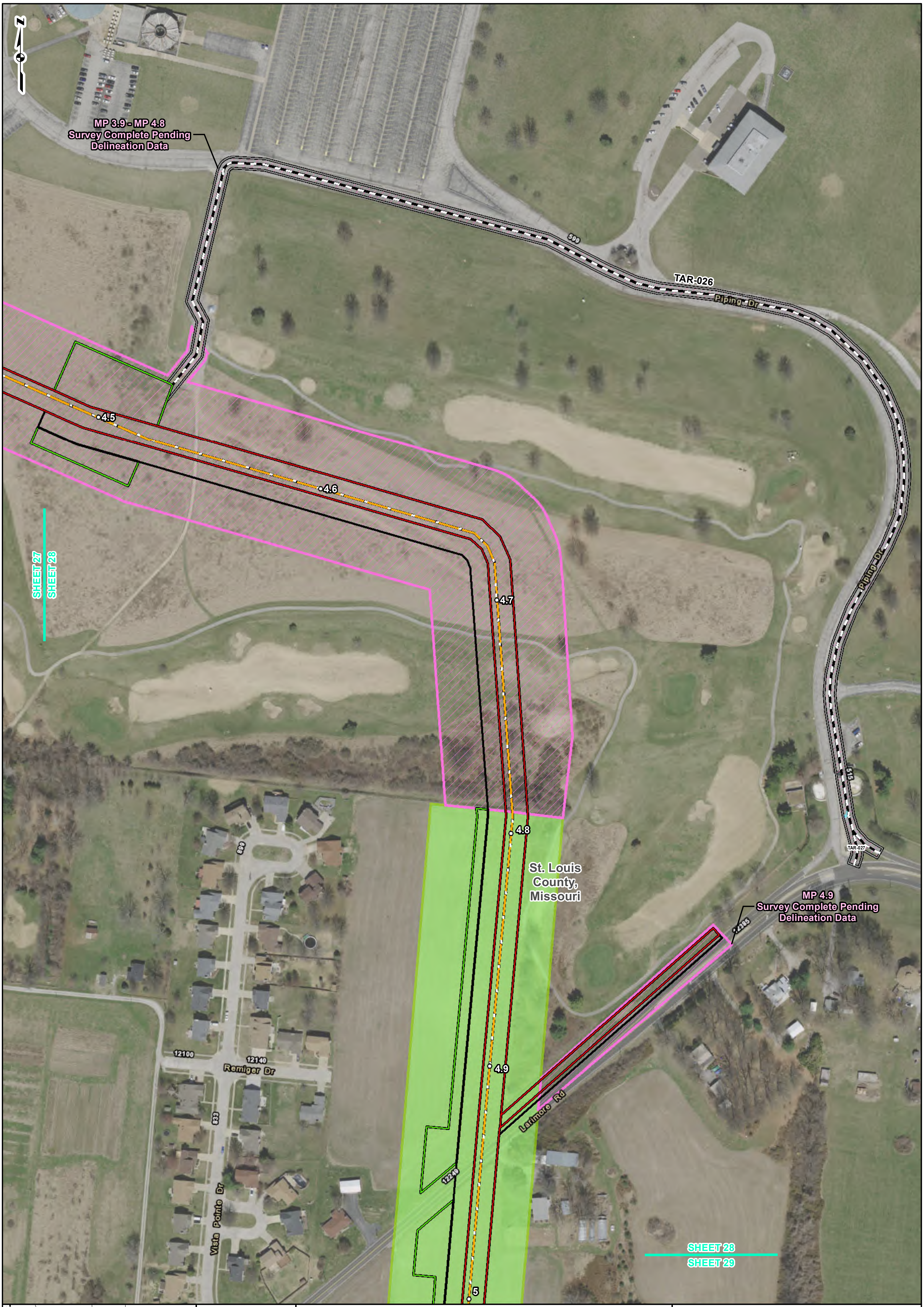

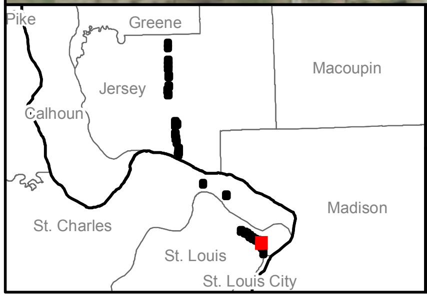

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LEGEND

- FACILITY
- MILEPOST
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- COUNTY BOUNDARY
- STATE BOUNDARY

0 100 200 400 Feet

INCOMPLETE ENVIRONMENTAL SURVEY STATUS MAP
SHEET 28 OF 30

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SPIRE STL PIPELINE PROJECT

spire

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CHECKED: SWW | APPROVED: LMF

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REFERENCE:
ESRI WORLD IMAGERY AND TRANSPORTATION, NAIP, USDA FSA, 2014, ACCESSED 04/2017.

LEGEND

- FACILITY
- MILEPOST
- ACCESS ROAD
- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
- PERMANENT EASEMENT
- CONSTRUCTION WORK AREA
- ATWS
- STAGING AREA
- ACCESS ROAD WORK AREA
- PENDING SURVEY
- SURVEY COMPLETE PENDING DELINEATION DATA
- SURVEY COMPLETED
- COUNTY BOUNDARY
- STATE BOUNDARY

0 100 200 400 Feet

INCOMPLETE ENVIRONMENTAL SURVEY STATUS MAP
SHEET 29 OF 30

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SPIRE STL PIPELINE PROJECT

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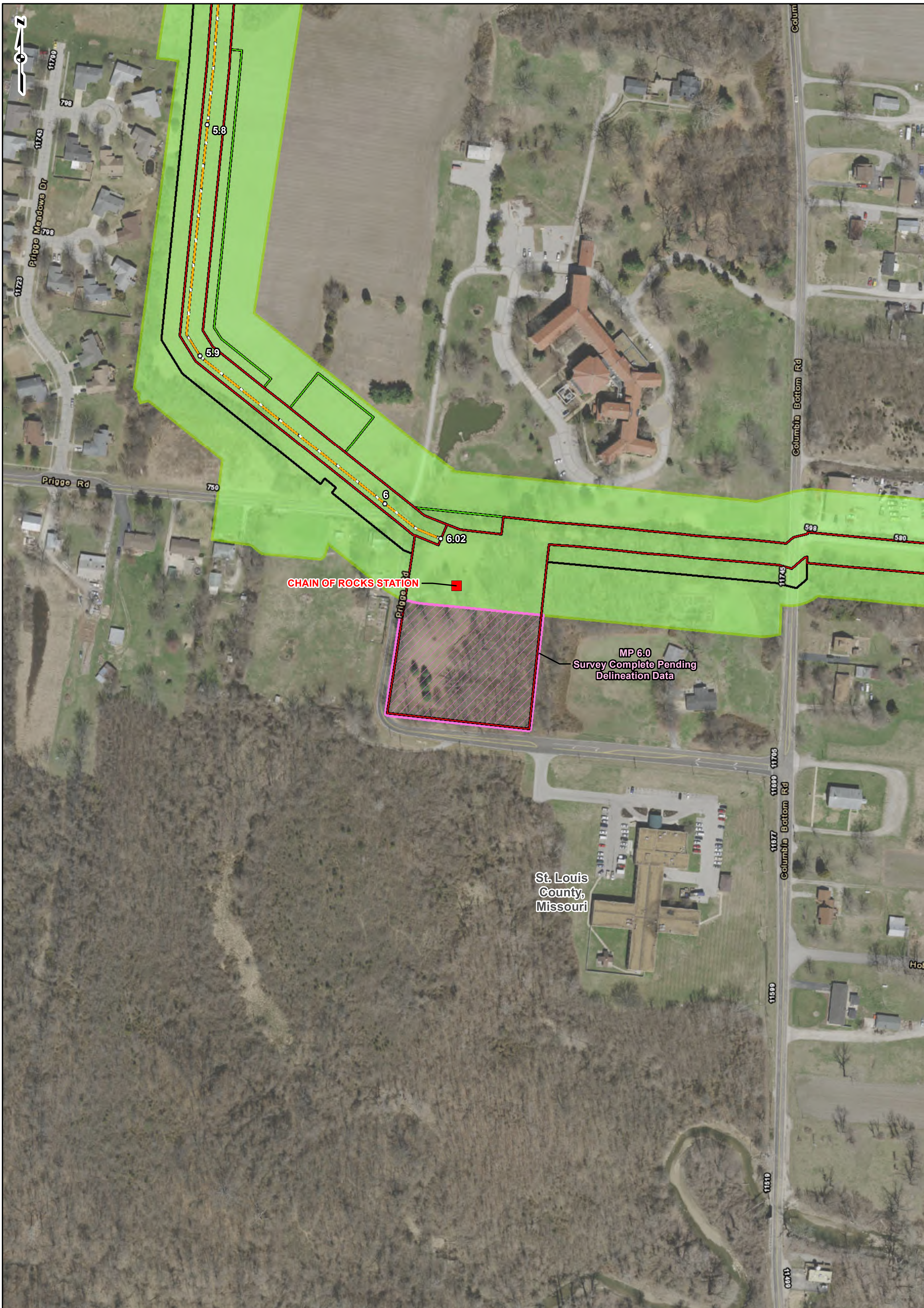

REFERENCE:
ESRI WORLD IMAGERY AND TRANSPORTATION, NAIP, USDA FSA, 2014, ACCESSED 04/2017.

LEGEND

- FACILITY
- MILEPOST
- ACCESS ROAD
- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
- PERMANENT EASEMENT
- CONSTRUCTION WORK AREA
- ATWS
- STAGING AREA
- ACCESS ROAD WORK AREA
- PENDING SURVEY
- SURVEY COMPLETE PENDING DELINEATION DATA
- SURVEY COMPLETED
- COUNTY BOUNDARY
- STATE BOUNDARY

0 100 200 400 Feet

INCOMPLETE ENVIRONMENTAL SURVEY STATUS MAP
SHEET 30 OF 30

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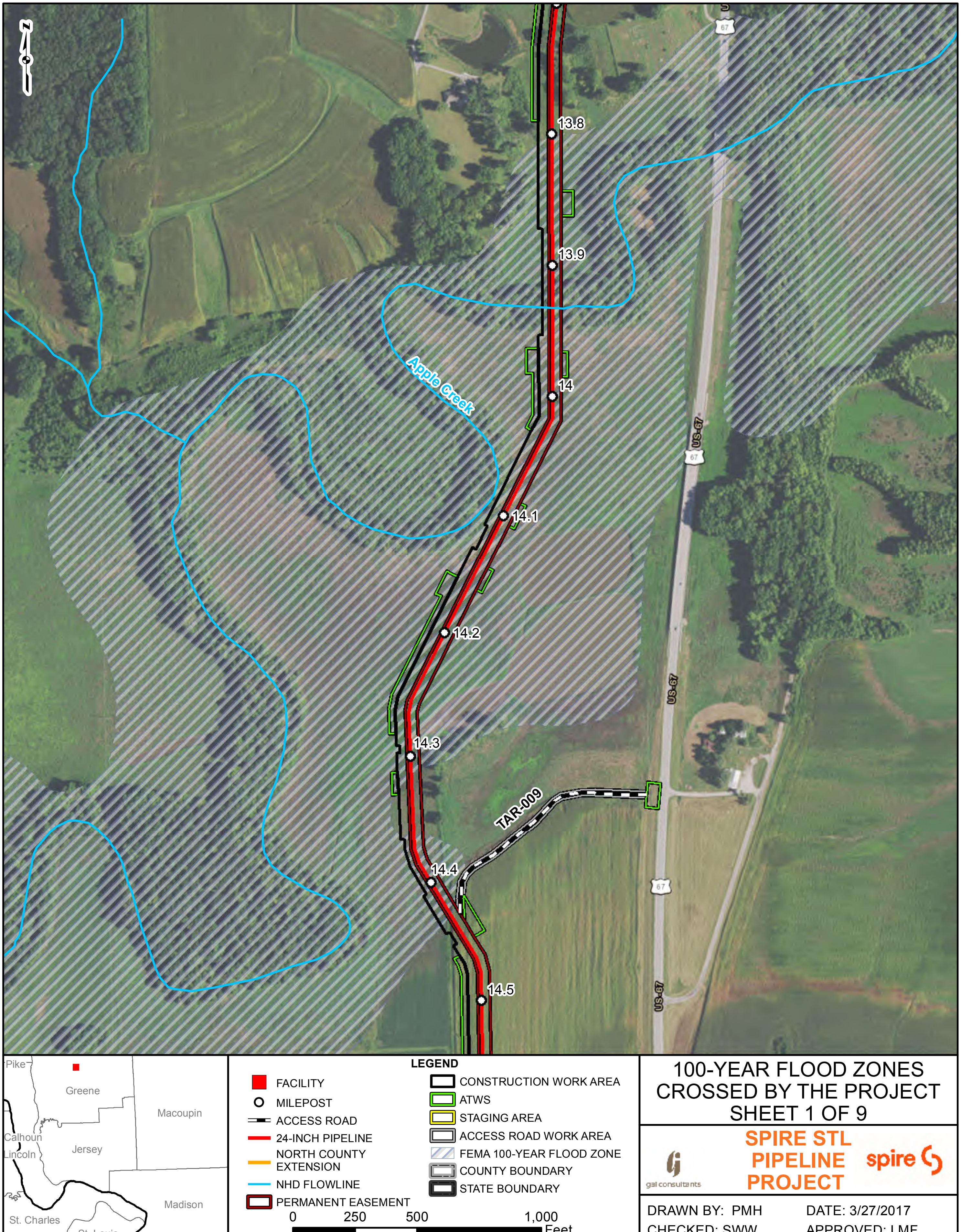
APPENDIX 2-D

Site-Specific Waterbody Drawings

APPENDIX 2-E

100-Year Flood Zones Crossed by the Project



100-YEAR FLOOD ZONES CROSSED BY THE PROJECT SHEET 1 OF 9

SPIRE STL PIPELINE PROJECT

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DATE: 3/27/2017
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APPROVED: LMF

REFERENCE: ESRI WORLD IMAGERY AND TRANSPORTATION, NAIP, USDA FSA, 2014, ACCESSED 03/2017. NATIONAL FLOOD HAZARD LAYER, FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA), ILLINOIS (2015) AND MISSOURI (2016).

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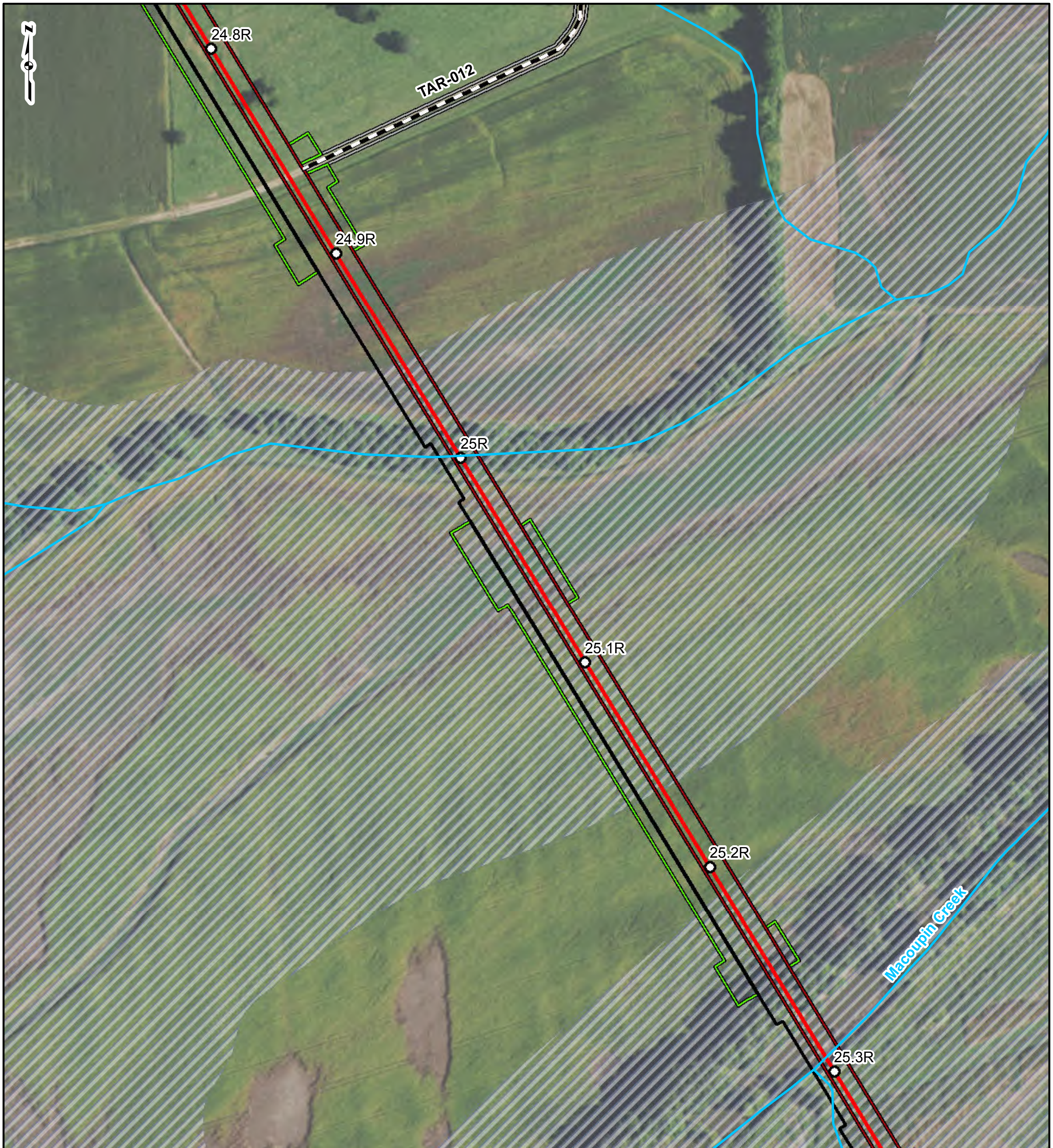

LEGEND

- FACILITY
- MILEPOST
- ACCESS ROAD
- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
- NHD FLOWLINE
- PERMANENT EASEMENT
- CONSTRUCTION WORK AREA
- ATWS
- STAGING AREA
- ACCESS ROAD WORK AREA
- FEMA 100-YEAR FLOOD ZONE
- COUNTY BOUNDARY
- STATE BOUNDARY

0 150 300 600
Feet

100-YEAR FLOOD ZONES CROSSED BY THE PROJECT
SHEET 2 OF 9

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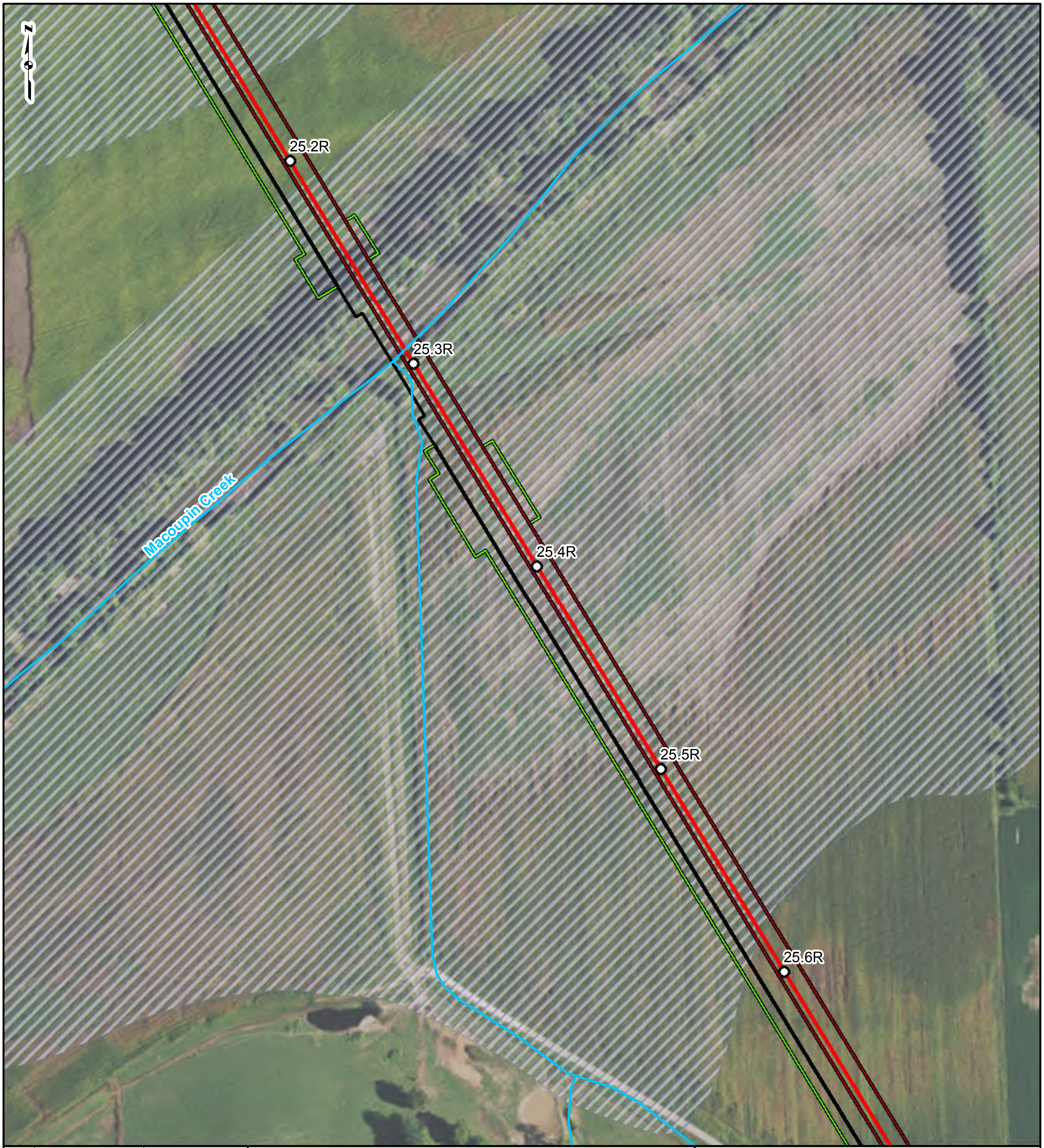

LEGEND

- FACILITY
- MILEPOST
- ACCESS ROAD
- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
- NHD FLOWLINE
- PERMANENT EASEMENT
- CONSTRUCTION WORK AREA
- ATWS
- STAGING AREA
- ACCESS ROAD WORK AREA
- FEMA 100-YEAR FLOOD ZONE
- COUNTY BOUNDARY
- STATE BOUNDARY

0 150 300 600 Feet

100-YEAR FLOOD ZONES CROSSED BY THE PROJECT SHEET 3 OF 9

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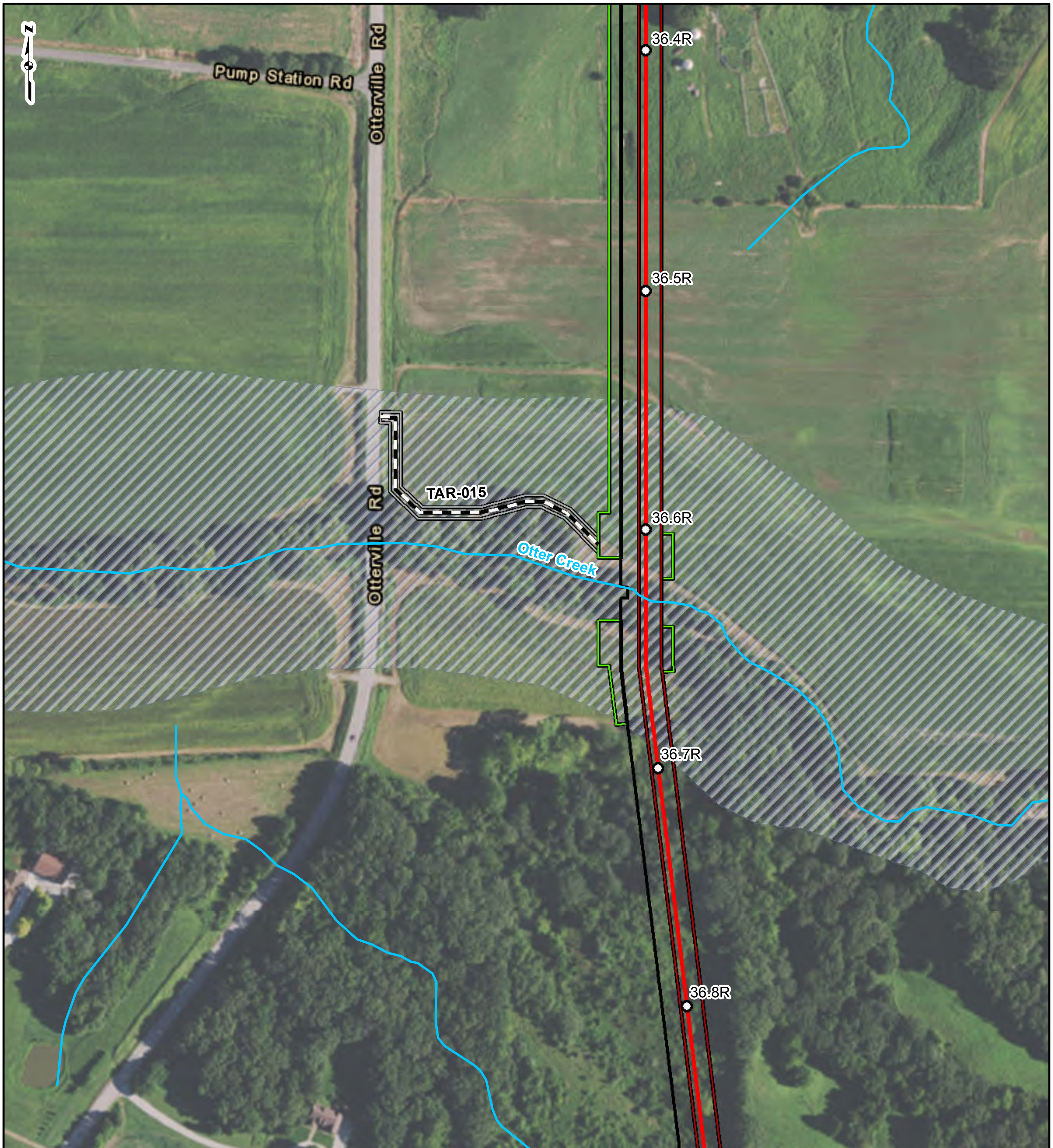

LEGEND

- FACILITY
- MILEPOST
- ACCESS ROAD
- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
- NHD FLOWLINE
- PERMANENT EASEMENT
- CONSTRUCTION WORK AREA
- ATWS
- STAGING AREA
- ACCESS ROAD WORK AREA
- FEMA 100-YEAR FLOOD ZONE
- COUNTY BOUNDARY
- STATE BOUNDARY

0 150 300 600 Feet

100-YEAR FLOOD ZONES CROSSED BY THE PROJECT SHEET 4 OF 9

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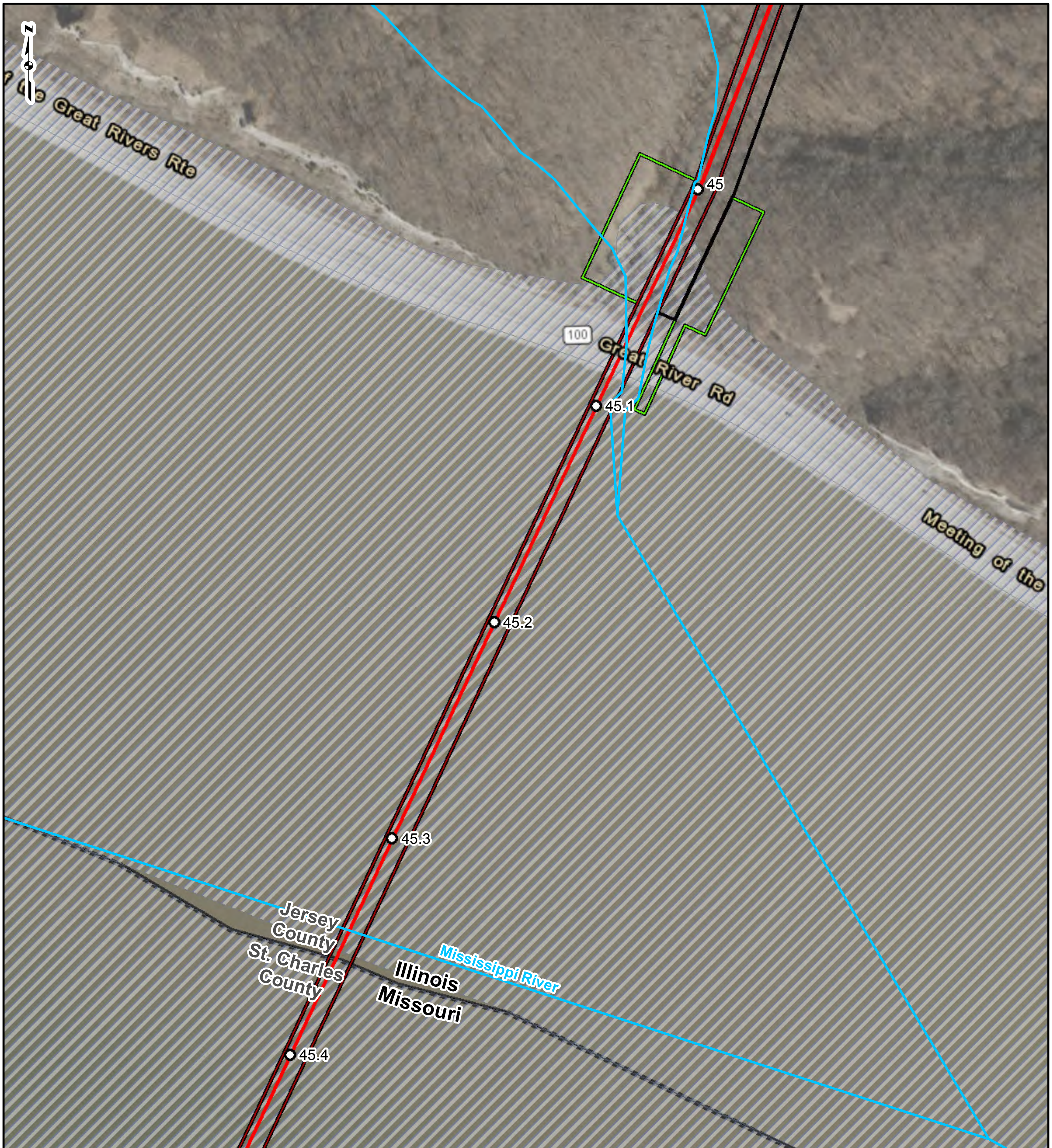

LEGEND

- FACILITY
- MILEPOST
- ACCESS ROAD
- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
- NHD FLOWLINE
- PERMANENT EASEMENT
- CONSTRUCTION WORK AREA
- ATWS
- STAGING AREA
- ACCESS ROAD WORK AREA
- FEMA 100-YEAR FLOOD ZONE
- COUNTY BOUNDARY
- STATE BOUNDARY

0 150 300 600 Feet

100-YEAR FLOOD ZONES CROSSED BY THE PROJECT

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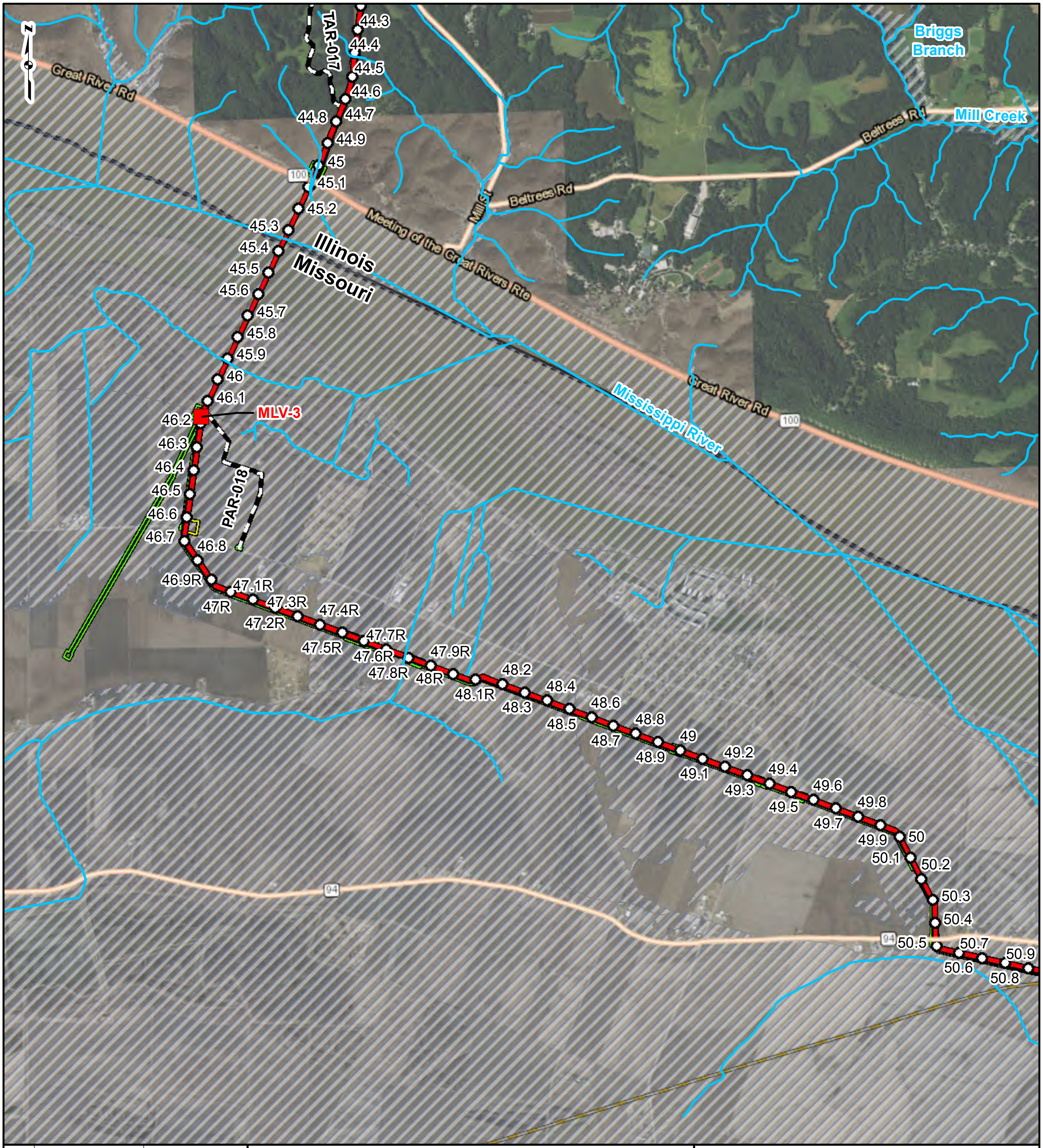

LEGEND

- FACILITY
- MILEPOST
- ACCESS ROAD
- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
- NHD FLOWLINE
- PERMANENT EASEMENT
- CONSTRUCTION WORK AREA
- ATWS
- STAGING AREA
- ACCESS ROAD WORK AREA
- FEMA 100-YEAR FLOOD ZONE
- COUNTY BOUNDARY
- STATE BOUNDARY

0 1,500 3,000 6,000 Feet

100-YEAR FLOOD ZONES CROSSED BY THE PROJECT SHEET 6 OF 9

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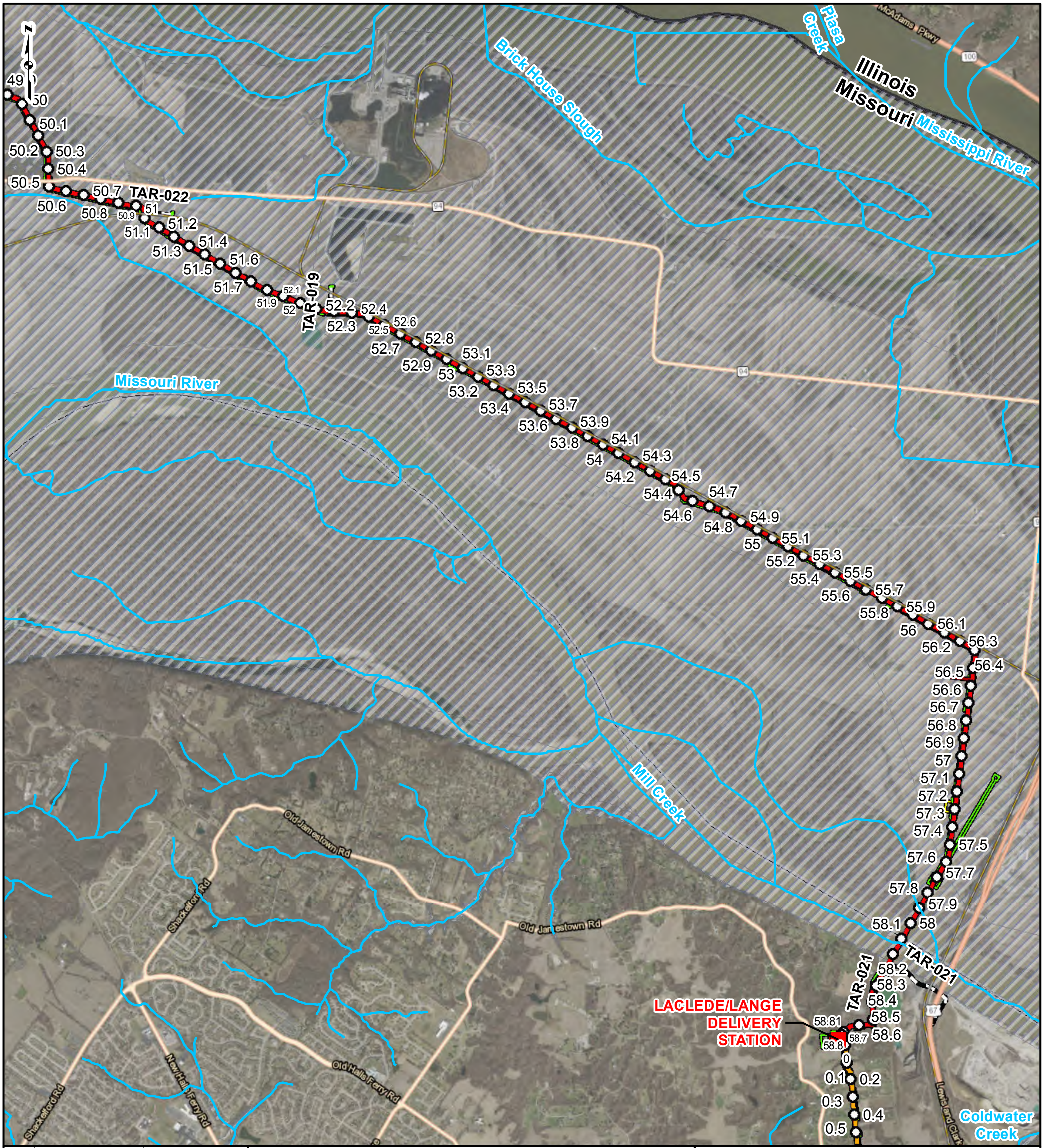

LEGEND

- FACILITY
- MILEPOST
- ACCESS ROAD
- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
- NHD FLOWLINE
- PERMANENT EASEMENT
- CONSTRUCTION WORK AREA
- ATWS
- STAGING AREA
- ACCESS ROAD WORK AREA
- FEMA 100-YEAR FLOOD ZONE
- COUNTY BOUNDARY
- STATE BOUNDARY

0 2,000 4,000 8,000 Feet

100-YEAR FLOOD ZONES CROSSED BY THE PROJECT SHEET 7 OF 9

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LEGEND

- FACILITY
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- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
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- PERMANENT EASEMENT
- CONSTRUCTION WORK AREA
- ATWS
- STAGING AREA
- ACCESS ROAD WORK AREA
- FEMA 100-YEAR FLOOD ZONE
- COUNTY BOUNDARY
- STATE BOUNDARY

0 100 200 400 Feet

100-YEAR FLOOD ZONES CROSSED BY THE PROJECT
SHEET 8 OF 9

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LEGEND

- FACILITY
- MILEPOST
- ACCESS ROAD
- 24-INCH PIPELINE
- NORTH COUNTY EXTENSION
- NHD FLOWLINE
- PERMANENT EASEMENT
- CONSTRUCTION WORK AREA
- ATWS
- STAGING AREA
- ACCESS ROAD WORK AREA
- FEMA 100-YEAR FLOOD ZONE
- COUNTY BOUNDARY
- STATE BOUNDARY

0 100 200 400 Feet

100-YEAR FLOOD ZONES CROSSED BY THE PROJECT
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APPENDIX 2-F

Wetland Delineation and Stream Identification Report

APPENDIX 2-G

NWI Mapping