

GOING THE DISTANCE

By B. Kerby Primm, P.E., CCI & Associates, Inc.

Installing a pipeline crossing beneath a sensitive resource over a length exceeding 15,000 feet may seem like a daunting endeavor for the majority of companies. Even in ideal conditions, drilling over 15,000 feet of any diameter hole would be a formidable challenge for even the most experienced HDD driller. This challenging scenario came to realization as WBI Energy, Inc., a subsidiary of MDU Resources Group, Inc. (NYSE:MDU) (WBI) was selecting the route for a proposed 24-inch natural gas line that involved approximately 60 miles of new NPS 24 (24-inch O.D.) steel pipeline that would connect WBI's Tioga Compressor Station near Tioga, North Dakota, with Northern Border Pipeline Company's mainline at a new interconnection point south of Watford City, North Dakota. The pipeline is for natural gas takeaway to help reduce natural gas flaring in the area.

The selected route would require WBI to cross Lake Sakakawea adjacent to Tobacco Gardens Resort, near Watford City, North Dakota, and comply with requirements of the Garrison District of the United States Army Corps of Engineers (USACE) for horizontal directional drilling (HDD).

With HDD as the only practical method of installing a crossing of such substantial length, WBI enlisted the services of CCI & Associates Inc. (CCI) to develop a design that could be used to successfully traverse the lake. After reviewing the existing conditions, recently completed crossings and available details of the area, a preliminary HDD crossing design exceeding 15,000 feet in length was developed as a basis for subsequent site characterization efforts.

Geotechnical Investigation

Thorough understanding of subsurface conditions in the vicinity of any proposed crossing is essential to determining if a HDD crossing is technically feasible. While crossing length and pipe diameter are also critical components that must be considered, technical feasibility is largely limited by subsurface conditions.

The project team, consisting of WBI, CCI, and Groundwater & Environmental Services, Inc. (GES), as the geotechnical sub-consultant under CCI, completed a detailed review of the local geology along with developing a plan for completing both land-based and water-based geotechnical borings.

A review of the regional geology indicated that the physiographic regions where the proposed HDD pipeline crossing is located consist of the McKenzie Upland Unit, located south of the Missouri River and the Coteau Slope Unit, located north of the Missouri River. These units are part of the Great Plains and characterized by rolling to hilly plains with both erosional and glacial landforms. The proposed HDD crossing



The selected route would require WBI to cross Lake Sakakawea near Tobacco Gardens to the south, roughly 24 miles north of Watford City, North Dakota

is located within the historic Missouri River floodplain that was flooded with the construction of the Garrison Dam in 1956 to form Lake Sakakawea. This area is located in the central portion of the Williston Basin.

The surface geology in the area consists of thin layers of glacial deposits underlain by the Paleocene-Aged Sentinel Butte Formation and the Bullion Creek Formation. The Sentinel Butte Formation consists of layers of silt, clay, sand, lignite, carbonaceous shale, and mudstone. The Sentinel Butte Formation outcrops along the south shoreline of the Missouri River and both the Sentinel Butte and Bullion Creek Formations outcrop along the north shoreline of the Missouri River along the proposed crossing alignment generally consisted of sedimentary bedrock overlain by alluvial deposits in the Missouri River channel and thin glacial deposits in the upland areas.

In April 2019, GES began work on two land-based exploratory borings near the proposed entry and one land-based boring near the proposed exit point locations, all of which extended to depths ranging from approximately 370 to 400 feet below the ground surface. These borings generally confirmed the results of the local geological review, showing evidence of sand, clay, and alternating layers of coal, and clay shale. Considering the results of the site-specific exploratory borings, the preliminary annular pressure (hydraulic fracture) analysis and the local geological review, the project team concluded that the subsurface conditions were conducive to the use of HDD.

Upon determination that the crossing was geometrically feasible and seemed likely to be geotechnically feasible based on



Barges were utilized for the completion of six geotechnical boreholes along the width of the lake, reaching depths of up to 315 feet below the bottom of the lake



One of CCI's drones used for drilling fluid release monitoring of the watercourse

the completed land borings, CCI recommended a further site-specific geotechnical investigation that included an additional six over-water-based geo-explorations to confirm technical feasibility.

Over-water geo-exploration began in April 2020 during a peak in the pandemic that year. Special safety precautions had to be outlined prior to mobilization. CCI worked with the owner, WBI, and its subcontractors to ensure these protocols were followed. Six borings were completed to depths ranging from 300 to 315 feet below the lake mudline. The program was successfully completed in May with no incidents of Covid-19 infections. Sub-surface conditions similar to those identified in the land-based borings were found in the over-water geo exploration. With the data obtained from the investigation, CCI and GES were able to identify the extent of the lignite seams detected in each boring

and approximate the arrangement of these layers throughout the crossing alignment, ultimately aiding in the detailed design of the HDD profile.

HDD Design

CCI outlined the three key objectives to achieve WBI's primary goal which was to install a 24-inch steel pipeline beneath Lake Sakakawea with minimal environmental impact:

- 1) to create an HDD design that would maximize the constructability of the proposed crossing;
- 2) to minimize the risk of an inadvertent drilling fluid release within or adjacent to the lake; and
- 3) to provide a detailed design that was permissible by the USACE.



For the HDD crossing design, the entry point location was placed on the south side of the lake in a flat agricultural field



On October 23, 2021, the HDD and pipeline crews successfully worked together to pull the 24-inch welded steel pipe through the reamed hole, completing the crossing



With these goals in mind, the exit point location (pipe side) was placed on the north side of the lake where there was ample space that was ideal for pipe stringing and fabrication. The north bank had a long, reasonably flat right of way area that stretched out within the surrounding agricultural fields and would enable the contractor to stage the product pipe in two segments. Having only one short tie-in weld during the installation would decrease the

UTI

**Premium Quality
HDD Drill Pipe
& Tools!**

In-Stock, Ready to Work

Get the high quality HDD tools & drill pipe you need, on your job site, when you need them from Underground Tools, Inc.

- **HDD Drill Pipe & Tools for All Makes & Models – In Stock**
- **Most Comprehensive HDD Tooling and Accessory Product Offering Industry-wide**

Contact UTI Today!
undergroundtools.com
1.866.488.3478
uti@undergroundtools.com



This installation, with a recorded length of 15,426 feet, marks a notable accomplishment in the HDD industry

risk of the pipe becoming stuck during pullback. One challenge for the pullback string layout was the crossing of Highway 17A. The decision was made to install a culvert beneath the road and pull the product pipe through rather than spanning above the road using cranes and/or Conex containers.

For the HDD crossing design, the entry point location (rig side) was placed on the south side of the lake in a flat agricultural field. The design utilized entry and exit angles of 15 and 12 degrees, respectively, a radius of curvature of 5,000 feet, and a depth ranging between 245 to 290 feet below the lake bottom, resulting in a total length of 15,426 feet. Of that horizontal length, approximately 11,870 feet is the water course crossing beneath the lake. The portion of the drillpath under the lake also incorporated some minor vertical curves to maintain the drillpath within the favorable subsurface layers (out of the significant lignite seams detected in geo exploration).

With the crossing design completed, the pilot hole tolerances were set such that the contractor was provided a constructible design that had flexibility in case unexpected ground conditions were encountered. Considering the difficulties in accurately steering the pilot hole as the distance from the rig to the drill bit increases, providing greater than normal pilot hole tolerances and exaggerated vertical curves was key to increasing the chance of success on a long HDD installation.

Construction & Oversight

The chosen HDD contractor, Michels, began construction in early August 2021 and continued through late-October. CCI provided HDD inspection services to record and monitor annular pressure, pilot-hole vertical and horizontal radii, and provide water course monitoring with drone flights. The drones provided rapid and accurate visual inspection of the lake and shoreline for signs of inadvertent fluid releases to the surface.

“The success of the North Bakken Expansion project is a reflection of the dedication of WBI’s employees, supporting contractors, and working alongside recognized industry leaders like Michels and CCI.”

**- JEFF RUST VICE PRESIDENT OPERATIONS,
WBI ENERGY**

Michels completed the pilot hole using the HDD intersect method, which involves drilling a pilot hole with two rigs from opposite ends of the crossing and ultimately intersecting borehole paths in a pre-decided location. After the pilot hole was successfully complete, Michels reamed (enlarged) the hole in multiple passes using a 24-inch hole opener then a 36-inch hole opener. On the morning of October 23, the Michels HDD and Michels Pipeline crews began pullback. By mid-day on October 25, the NPS 24 product pipe was pulled through the reamed hole, successfully completing the world record crossing.

Conclusion

Technology pushing, world record trenchless installations can be completed successfully when due diligence focused on proper planning, detailed design, and construction execution by experienced contractors are made a priority. The project team consisting of WBI, CCI & Associates, Groundwater & Environmental Services, and Michels worked together from the initial feasibility phase through the successful installation of the NPS 24 pipeline. “The success of the North Bakken Expansion project is a reflection of the dedication of WBI’s employees, supporting contractors, and working alongside recognized industry leaders like Michels and CCI.” Jeff Rust Vice President Operations, WBI Energy.

This installation, with a recorded length of 15,426 feet, marks a notable accomplishment in the HDD industry and demonstrates that seemingly infeasible crossings are achievable with the right team in place. †

ABOUT THE AUTHOR:



B. “Kerby” Primm has spent over 16 years as an engineer involved in multiple specialties including civil site design, transportation, and trenchless design. He is a Sr. project manager for CCI & Associates based out of Houston, TX.

T U F F R O D

HDD Drill Rod EXPERTS!

**Expertise that Runs Deep...
And on Target**

Choosing the right drill rod can mean the difference between HDD success and failure. With so much at stake, you need a source you can trust and a drill rod you can count on. At TuffRod, drill rod isn't a side business. Choose only high quality HDD drill rod, backed by the industry's most respected and knowledgeable drill rod experts.

The TuffRod Advantage

- American Owned & Operated
- Specializing in 1-piece Forged S135 Grade Drill Rod
- Rod for All Major Small to Mid-size HDD Rigs

TuffRod
The Pipe Authority

Check Out our DRILL ROD University
Offering Personalized Instruction!
Call Toll Free 844-586-9354
www.TUFFROD.com