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PipeLine

SPECIAL WATER EDITION

Contents

Michigan Ditch Rehabilitation Project

BELOW
Manufactured in ten foot sections, lightweight CCFRPM was easier to maneuver on the narrow job site.

The Michigan Ditch was built before 1900 and is a 5.2 mile long ditch system that carries mountain runoff into the water system for the City of Fort Collins, Colorado to utilize as re-use water. Michigan Ditch is located in the vicinity of Highway 14 at Cameron Pass, a 10,276 ft. elevation mountain pass, in the Rocky Mountains. The pass is a gap between the south end of the Medicine Bow Mountains and the north end of the Never Summer Mountains and sits on the border between Jackson County and Larimer County. The area offers winter recreation activities such as snowshoeing, cross-country skiing and also scenic driving and wildlife.

Fort Collins Utilities has trans-mountain water rights for conveying snow melt into their water system. Michigan Ditch along with Joe Wright Reservoir is a crucial part of the water storage and delivery system.

The Michigan Ditch is a combination of open waterway and pipelines. "Approximately 1,600 feet of the ditch still runs through the original wood stave pipe material, some of it exposed and still above grade," said John Beckos, project manager, BT Construction, Inc. of Henderson, CO. "The Michigan Ditch Rehabilitation Project replaced a combination of open ditch and buried 54-inch ductile iron pipe through the section of the ditch known as 'The Mudslide'."

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Year of Construction
2016
Total Length of Pipe
966 feet
Diameter
60-inch
Stiffness Class
46 & 62 psi
Installation Method
Tunnel Carrier, Direct Bury
Application
Water Re-use
Client
City of Fort Collins Utilities
Installer
BT Construction, Inc., Hydro Construction
Advantages
Various Installation Methods, Fittings

Continued from page 1

In 2015, movement of an ongoing slow-moving landslide that began years ago became so extreme that it changed the alignment of the pipe to an extent it could not be repaired with a cut and cover solution. In order to retain its water rights, Utilities determined that a repair of the collection system was necessary. After considering many options, a tunnel through the mountain was determined to be the best solution.

Field Versatility

A 765-foot-long curved tunnel was bored through the side of the mountain using a tunnel boring machine (TBM). The tunnel has an outside diameter of 96-inches and an initial support of steel rib and wood lagging. Following tunnel construction, 765 feet of 60-inch HOBAS pipe was inserted into the primary tunnel to serve as the carrier pipe for the water. The pipe for the tunnel was manufactured with a stiffness class of SN 62, in 10 foot sections, with a flush joint configuration that was blocked into place and subsequently grouted. BT Construction, Inc. was the installation contractor for the tunnel. Due to soil and ground conditions, the tunnel was designed with a slight curve. "It was determined that a 0.9 degree deflection for every ten foot joint would match up quite well with the Flush Reline pipe (1.2 degrees max)," said Beckos.

The open cut section was installed by Hydro Construction of Fort Collins, CO. This section consisted of 64 feet of pipe on the upstream side and 137 feet of pipe on the downstream side. These sections of pipe were also 60-inch pipe, stiffness class SN 46 and supplied in 10-foot sections. Three elbows were provided for the upstream and downstream angles.

"The elbows enabled the underground tunnel pipeline to be re-aligned to match up with the open cut ditch system," said Beckos.

Overcoming Obstacles

With the project location on a mountainside at such a high elevation, challenges were to be expected. "There was very limited staging area on the site," said Beckos. "Access from the delivery location on Highway 14 to the installation site is along a winding 2.5 mile long, single track road with an open ditch on one side and a drop off along the other; basically the side of a mountain. As portions of the open cut ditch were abandoned and filled in, small staging areas were created that could temporarily store HOBAS pipe." In addition to the ten foot sections being beneficial for maintaining the

curve alignment, it was easier to maneuver the shorter sections on the narrow job site than the standard 20 foot lengths.

Project Delivery

Fort Collins Utilities uses an Alternative Product Delivery Method (APDS) which brings the owner, designer and contractor together from the start of the project. Through this process they were able to complete the project ahead of schedule and under budget.

"Under the APDS, Utilities (owner) brought together Stantec Consulting (lead engineer), Lithos Engineering (tunnel engineer and onsite inspection), BT Construction (tunnel contractor), and Hydro Construction (open cut contractor) to develop the scope of the project," stated Beckos. "This team took the project from initial concept through the design and construction processes. It was a very schedule driven approach to get the Michigan Ditch reinstated before the start of the 2017 spring runoff. I am happy to report that the team finished the project safely, on line and grade, on time and under budget."

"Construction began in May 2016 and was completed under budget by end of October," stated Owen Randall, P.E., chief engineer, City of Fort Collins Utilities. Limited by the winter weather conditions in Colorado, completion of this project was crucial to allow full use of water rights by spring 2017. Original project cost was estimated at 8.5 million and the project was completed for around $7.3 million.

ABOVE
An Akkerman 1548 Haul Unit with an empty dolly and a custom built pipe carrier was used to drive the pipe into the tunnel.

CENTER
Three elbows were provided for the upstream and downstream angles. The elbows enabled the tunnel pipeline to be re-aligned with the open cut ditch system.

OPPOSITE
765 feet of 60-inch HOBAS pipe was inserted into the primary tunnel to serve as the carrier pipe for the water.

Bull's Bridge Replacement Penstock

In the early 1900s, the New Milford Power Company successfully completed the first commercially viable hydroelectric power plant on the Housatonic River in Connecticut. The project, Bull's Bridge Development, broke ground in spring 1902 and was in operation by 1903. Bull's Bridge was named after the Bull family that had lived in the area for generations.

The Bull's Bridge Power Plant, now owned by FirstLight Power Resources, is part of its five-station hydroelectric operation along the Housatonic River, which includes the Falls Village plant in Canaan, the Rocky River plant in New Milford, the Shepaug plant in Southbury and the Stevenson plant in Monroe.

The Bull's Bridge Power Plant generates up to 8.4 megawatts as a run-of-the-river hydroelectric facility with a discharge capacity of 1,250 cubic feet per second (cfs). This run-of-the-river facility diverts a portion of the river flow upstream of the main dam into a 2.5 mile long power canal leading to the forebay gatehouse and the recently replaced penstocks. The original, 420-foot long, 13 foot and 8 foot diameter steel penstocks dropped 98 feet from the forebay to the powerhouse. The plant still generates power with the six original horizontal, double-runner, Francis turbines.

Year of Construction
2015
Total Length of Pipe
600 feet
Diameter
120-inch
Stiffness Class
46 psi
Installation Method
Above Ground
Application
Hydro Penstock
Client
FirstLight Power Resources
Installer
Bancroft Contracting Corp
Advantages
Quick Installation, Leak-free Joints

Reliable Replacement

Each year, the aging Bull's Bridge penstock had to be dewatered, inspected and repaired as necessary. In 2013, numerous internal repairs were completed on the 13- and 8-foot diameter penstocks, but reliability concerns led to the need for rehabilitation or replacement of the 100-year old penstocks. Gomez and Sullivan Engineers of Utica, New York evaluated the alternatives for replacement or rehabilitation of the steel penstocks.

Four alternative solutions were developed and evaluated:

- Replace the existing 13-foot diameter in-kind
- Replace both penstocks with a single 14-foot by 14-foot cast-in-place concrete box type penstock or a single 15-foot diameter steel penstock
- Replace both penstocks with two 10-foot diameter fiberglass reinforced (FRP) penstocks
- Rehabilitate the existing penstocks and foundations

Evaluations focused on four possible replacement materials: steel, concrete, HDPE and fiberglass. "The alternatives analysis report provided to FirstLight by Gomez and Sullivan recommended either an in-kind replacement of the existing steel pipe or replacement with new fiberglass pipe," explained Ben Sawyer, civil/structural engineer, Gomez and Sullivan. "FirstLight selected the fiberglass replacement alternative because that alternative was the most cost effective option that still provided a similar amount of net generation compared to the existing configuration. FirstLight had also previously used HOBAS pipe at the nearby Rocky River Project and had a good experience using HOBAS pipe at that site." The penstocks were replaced with 10-foot diameter centrifugally cast, fiberglass reinforced, polymer mortar (CCFRPM) pipe. HOBAS Pipe USA manufactured 600 feet of 10-foot (120-inch) CCFRPM pipe for this replacement project.

OPPOSITE
Lightweight 120-inch CCFRPM pipe installed underneath Bull's Bridge.

CENTER LEFT
Fill material was placed approximately two feet above the pipe centerline, leaving three feet exposed.

CENTER RIGHT
An on-site transportation device used to install the pipe under the bridge was designed by Bancroft Contracting, Corp.

BELOW
FWC Couplings exposed to sunlight can be coated for extra protection.

After FirstLight selected FRP, they had to choose between HOBAS and another option. FirstLight's experience with HOBAS on the Rocky River Penstock had much to do with it. The selection criteria included: QC/QA program, uniformity of product, coupling sealing surface, assembly technique, joint testing, interior and exterior smooth finish, domestic manufacturing facility, proven at large diameters and wall thickness and last but not least, engineering technical assistance.

Field Versatility

Installation posed its own challenges. The steep job site was located in a remote area with a section under an existing highway bridge with low overhead clearance. It was also necessary to construct a temporary road and crane pad to access the penstock replacement area from midway along its route from the forebay to the powerhouse.

An ingenious on-site transportation device used to install the pipe under the bridge was designed by the installation contractor, Bancroft Contracting Corp. of South Paris, Maine. "The rig involved a long I-beam connected to a column," explained Sawyer. "The column was composed of two hollow steel square tubes with one sliding inside the other and held in place with steel pins. Wheels were attached to the bottom of the column. The end of the beam not connected to the column was attached to the arm of an excavator which could then drive the rig through a section of pipe and extend the column to lift the pipe off the ground. Then the rig was driven up to an installed section of pipe and the column could be lowered to drive the rig into the installed pipe and butt the new section of pipe against the installed section."

The new penstocks were partially buried utilizing no cradles for support. The fill material was placed to about two feet above the pipe centerline, leaving three feet exposed. The CCFRPM pipe was designed and manufactured with an operating pressure of 50 pounds per square inch (psi) to accommodate the operating pressure of the line. The penstock was put into service during winter 2015.

LNVA Repairs Jones Crossing at the Devers Canal

This fully automated cutter not only produces perfectly cut pipes, but since cutting is done in a wet environment, no dust is generated as with past methods.

The Lower Neches Valley Authority (LNVA) is one of the 23 River Authorities created by the State of Texas to develop and manage the waters of the State. The LNVA is responsible for fresh water management in far southeastern Texas in the entirety of Jefferson, Hardin, and Tyler Counties, and portions of Liberty and Chambers Counties. The watersheds of the Neches River and its tributaries occupy an area of approximately 10,000 square miles. The area receives generous amounts of rainfall, producing stream flows in the Neches and its tributaries of around 4,323,000 acre-feet of water a year at Port Arthur, Texas, where it empties into Sabine Lake, and ultimately into the Gulf of Mexico.

Although water in the Devers Canal System is pulled from the Trinity River, the LNVA acquired the Devers Canal System in 2008.

Potential Failure

Known as the Jones Crossing, the site of the potential breach is approximately 21 canal miles downstream from LVNA's Devers first pump station at the Trinity River. At this particular location about 20 miles southwest of Beaumont, an aged drainage system was piped under the Devers Canal via three parallel 48-inch reinforced concrete pipes. The canal, in turn, was piped directly under a farm access road also via three parallel 48 -inch reinforced concrete pipes. All three features converged at various angles at the Jones Crossing point.

"We were experiencing problems with the existing reinforced concrete pipe joints separating and allowing canal water to leak into the ditch," said Ryan Ard, P.E., lnva engineering manager. "LNVA made several repairs over time to patch any leaks that appeared. Over the years, erosion and weathering had deteriorated the original timber headwalls in the drainage ditch. This ongoing erosion exacerbated by the heavy rains in early 2015 and again in early 2016 eventually infiltrated and undermined the headwalls, allowing the banks of the drainage ditch to creep toward the canal. Had we allowed the problem to persist, the canal banks would have ultimately been breached by erosion, thereby allowing canal water to spill into the drainage ditch below."

As originally planned, this project would be designed by LNVA staff and put out for public bid for a general contractor in mid to late 2017. Given the circumstances and the need for urgency, and because LNVA's canal system is not in operation from October 31 thru March 15 over the winter months due to the agricultural cycle, LNVA decided to take on the construction project internally.

The Approach

The scope of the repair would include excavating and removing the existing drainage ditch and canal crossings. The drainage ditch and canal both included three runs of 48-inch reinforced concrete pipe. The pipe in the ditch measured approximately 160-feet and the pipe in the canal was approximately 40-feet long. The total depth of the drainage ditch was approximately 12 feet.

LNVA engineers analyzed several alternative repair designs, but ultimately decided the best option was to rebuild the crossing in its original configuration. The layout was somewhat complicated by the fact that a private road crosses both the drainage ditch and the canal at this location.

Because the hydraulics of both the canal and the drainage culverts had been performing satisfactorily for many years, and also because of vertical space limitations, they decided to use the same size pipe for the reconstruction. The driving consideration was trying to maximize the depth of the canal while maintaining the existing flow line of the drainage ditch.

The original headwalls in the drainage ditch were constructed of vertical timbers. "We wanted to go back with a hard armored headwall such as concrete or articulated block," explained Ard. "We determined a vertical headwall in the drainage ditch would be more costly to construct and maintain over the years compared to a sloped concrete liner. Based on this decision, we requested the pipe ends be mitered at a 2:1 slope from the factory. Once installed, the ditch slope would be graded to match and a concrete liner poured for erosion protection."

LNVA crews installed 600 feet of 48-inch HOBAS pipe relatively easily with no previous experience installing this type of pipe.

LNVA considered different types of pipe material for this application. Although corrugated metal and concrete are most commonly used materials for drainage culverts, LNVA engineers considered the life cycle cost benefit of fiberglass pipe. Leakage associated with corrugated and concrete drainage culverts are not generally of concern, but over time they will cause erosion and corrosion. For this particular site where a canal, a drainage ditch and a road all converged, the type of pipe material raised concern for LNVA engineers.

Ard stated, "At this diameter, the pricing was competitive with reinforced concrete pipe; however, the benefits of fiberglass pipe outweighed that of a reinforced concrete pipe in terms of handling the material and placement during construction." While the needed pipe would measure only 600 linear feet of 48-inch pipe, generally an amount falling below the dollar value required for a formal bid process, LNVA nonetheless, publicly advertised for bids to supply Fiberglass Reinforced Pipe (FRP). HOBAS Pipe USA was the low bidder.

Installation

The LNVA ultimately chose HOBAS centrifugally cast, fiberglass reinforced, polymer mortar (CCFRPM) pipe because, according to Ard, "We have a good service history with HOBAS and it is installed in various other locations on our system. We liked the fact that the joints came in 20-ft lengths and would be watertight, the pipe is lightweight when compared to its concrete counterparts, and HOBAS would factory miter the pipe ends to our specifications and install a headwall ring to be cast into a concrete headwall."

HOBAS pipe is easily customizable for specialty jobs, a task that is made even easier and faster thanks to the custom built water jet cutter, according to Kirk Eager, southeast texas/louisiana sales rep, HOBAS Pipe USA. Drawings are created in 3D mechanical CAD software and transposed into the required code. The water jet machine is then run by a computer-controlled program that produces perfectly cut pipes, quickly and in a more environmentally friendly manner.

All of these benefits facilitated the LNVA crews being able to install the pipe relatively easily with no previous experience installing this type of pipe. LNVA has several crews and operates a fleet of its own heavy equipment to perform day to day business. This allowed LNVA to help control costs by utilizing internal equipment and manpower to construct the project.

The installation of the three 160-foot runs in the drainage ditch took four days, while installation of the three 40-foot runs in the canal under the roadway was completed in only one day. Once the new HOBAS pipe was installed, LNVA crews re-graded the drainage ditch slopes and reconstructed the canal banks and rock road back to their pre-existing grades. Because repairs to the roadway and canal system were performed in the agricultural off-season, the road was closed for duration of construction, as no residences or local traffic were affected.

Year of Construction
2016
Total Length of Pipe
600 feet
Diameter
48-inch
Stiffness Class
46 & 72 psi
Installation Method
Direct Bury
Application
Stormwater
Client
Lower Neches Valley Authority (LNVA)
Installer
LNVA
Advantages
Lightweight, Special Miter Cuts

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