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## Dewatering Denver Water's Conduit 16: Using Sonic Drilling and Vacuum Wellpoints to Get Down to Bedrock

DENVER, CO—Denver Water's $80 million Conduit 16 replacement is successfully underway. TerraFirma Earth Technologies completed vacuum wellpoint dewatering services for its portion of the replacement of the 81-year-old pipeline that runs 8.5 miles from Ralston Reservoir to the Moffat treatment plant. Reynolds Construction is the General Contractor on this phase of Denver Water's decade-long, $600-million North System renewal project.


*The plan for dewatering the cut-and-cover portion of the pipe alignment consisted of installing a vacuum wellpoint system to parallel one side of the trench excavation, with wellpoints installed every 6 ft. The wellpoints extended up to 6 ft. below the excavation subgrade, or just into the confining shale layer located 13 to 17 ft. below ground surface. Boreholes were advanced by sonic drilling methods. Photo Credit: Josh Peltier, TerraFirma Earth Technologies*

Josh Kuper, Project Manager at Reynolds Construction, described the massive project this way: "The old pipelines carried untreated water. Because the new pipeline will deliver treated water from a new treatment plant, we had to replace the old pipe. Running treated water down the old pipes would have negatively impacted the water quality. Our section of the project consisted of

five tunnel installations in addition to approximately 5,494 linear feet (lf) of 84” diameter steel carrier pipe installed by cut-and-cover method.” The tunnels crossed Hwy 93, the BNSF Main Line Railroad Track, a BNSF Railroad Spur Track north of Highway 58, Highway 58, and I-70 and Applewood in Denver.

David Giles, President of TerraFirma, explained the dewatering methodology for the open cut portion of the project. “We installed vacuum wellpoints for a large section of the shallower, open cut portion of the project, which is a lesser-utilized method in the Denver area due to the higher elevation; however, under the right circumstances vacuum wellpoints are the best option for the unique geology in Denver.

“A typical wellpoint system consists of closely spaced, 1-1/2” PVC riser pipes connected to a wellpoint screen typically 3 to 5 ft. in length. The wellpoints are installed to parallel an excavation, and to a depth 25 ft. or less. The risers are connected to a common header pipe, which is connected to a vacuum wellpoint pump. One wellpoint pump can operate many wellpoints installed along several hundred feet of trench. Vacuum wellpoints function well in a wide variety of soil types, for excavations 15 feet or less. They work best where lowering of the groundwater table to the top of a confining layer, i.e. bedrock, is required, as was the case for this project. The depth to subgrade for these areas varies between 10 and 15 ft. below ground surface.”

*Detailed view of the vacuum wellpoint dewatering system components following the completion of the installation, prior to excavation. The wellpoint system was installed approximately 2 weeks in advance of the excavation, to allow as much time as practical to draw the groundwater to the very top of the confining shale layer located 13 to 17 ft. below ground surface. Photo Credit: Josh Peltier, TerraFirma Earth Technologies*

Mr. Giles explained the need for vacuum wellpoints over the more commonly used deepwell dewatering wells (also known as sump wells). “We’ve found that Denver is not familiar with vacuum wellpoints, even though this type of well is far superior to sump wells in many cases for Denver’s unique soil conditions. The usual dewatering technique is to use deepwell dewatering wells, which rely on a submersible pump placed near the well bottom extending many feet below the excavation subgrade to achieve the required drawdown; however, due to Denver’s shallow bedrock, deepwell dewatering wells are not always the most cost efficient. As was the case for this portion of the Conduit 16 project, lowering the groundwater table to below the excavation meant dropping the groundwater table as close as possible to the confining bedrock. Deepwell dewatering wells would have had to be placed so close together, it would have been cost prohibitive. Even then, supplemental sumping within the excavation would have been required, adding more cost, and further slowing down production.”

Josh Kuper agreed that due to TerraFirma’s successful dewatering, crews were able to move forward quickly with the open cut portion of this complex project.

*Detailed view of the vacuum wellpoint dewatering system components following the completion of the installation, during excavation. The wellpoint system was installed approximately 2 weeks in advance of the excavation, to allow as much time as practical to draw the groundwater to the very top of the confining shale layer located 13 to 17 ft. below ground surface. Photo Credit: Josh Peltier, TerraFirma Earth Technologies*

According to Ryan Haas, Denver Water’s Project Manager for the Conduit 16 replacement, Denver soils are full of cobbles and boulders – some up to 3.5 ft. in diameter. The sonic drilling method used by TerraFirma made the drilling within these difficult soil conditions much more efficient. Mr. Giles added, “Denver’s unusual geology is consistently water-bearing alluvial soils over shallow bedrock. In fact, I’ve come to call the soil in nearly every dewatering job we carry out in Denver as ‘sand-gravel-cobble’ (SGC) over shallow bedrock. The sonic drilling technique uses an oscillator located within the drilling head to create high frequency, resonant energy that

is directed down into the drill string and bit. When combined with the rotational movement of the drill string and bit, this causes a very thin zone directly surrounding the tooling to lose structure and become fluid to be flushed, or removed from the casing. The drilling operator controls the amount of vibration in the drill head to match the force needed to optimally penetrate the soil and bedrock, making it possible to efficiently drill a wide range of soil types, particularly the sand-gravel-cobble typical to Denver. The sonic drilling method appears to be more costly up front; however, it is less expensive over time, and gets the job done right.

*TerraFirma utilized sonic drilling methods to reach bedrock approximately 12 to 17 ft. below ground surface. The sonic method is more efficient in Denver's subsurface soil than other drilling methods such as self-jetting or sand casing, wet rotary, or hollow stem auger.*

*Photo Credit: Josh Peltier, TerraFirma Earth Technologies*

"We give a lot of credit to Denver Water for choosing to do this portion of the project the right way, with vacuum wellpoints and sonic drilling," said Mr. Giles. "We installed them the proper way and they worked perfectly for the two-month period it took to install this section of the pipeline. We look forward to additional work from Denver Water in the very near future."

**Why Replace Conduit 16?**

The Denver Water Moffat Treatment Plant began water treatment operations in 1937. Conduit 16 was completed in 1937 to convey water from the Ralston Reservoir to Moffat Treatment Plant. Conduit 22 was added to increase the capacity of the conveyance system in 1950. Prior to initiating the current project, Denver Water conducted a study of the existing raw water pipelines between Ralston Reservoir and the Moffat treatment plant (Dewberry, 2012). That study concluded that the two existing water conduits were approaching the end of their service life and needed to be replaced. Based on the findings of that study, Denver Water elected to replace the 42-inch diameter Conduit No. 16 with a single new 84-inch diameter pipeline. The alignment of the new pipeline will generally follow the existing easement for Conduits No. 16 and 22.

Design of the Conduit 16 replacement occurred in two stages. In 2013 to 2014, the design was progressed to the 60 to 90 percent completion levels assuming that the conduit would be a raw water conveyance bringing water to the Moffat Water Treatment Plant. In mid-2015, however, design was suspended while Denver Water made the decision to construct a new water treatment plant at the Ralston site, which is at the upstream end of Conduits 16 and 22. In early 2016, design resumed under the direction that the new Conduit 16 would function as a treated water conveyance to bring treated drinking water from the new treatment plant at Ralston and delivering it to the Moffat site, to be stored and distributed.

The massive renewal project continues. The entire pipeline is expected to be complete by 2020, but it won't go into service until the new Northwater Treatment Plant is operational in 2024.

*DISCLAIMER: Denver Water does not endorse or sponsor any of the products, services, or methods identified in the foregoing article.*

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**About TerraFirma Earth Technologies:** TerraFirma, a Houston-based dewatering firm with offices in Denver, helps owners and contractors throughout the United States maintain acceptable groundwater levels for both temporary projects and permanent installations, "*getting the job on firm ground – before it starts*". Past deep excavation projects include athletic stadiums, hospitals, high-rise facilities, transportation facilities, airports, tunnels, power plants, dams, waterways, petro-chemical plants, and municipal infrastructure sites such as pumping stations and treatment plants; as well as sewer and gas pipelines. Visit tfearth.com or phone main: 281-720-1212, or mobile: 281-435-3374. TerraFirma's Denver office is located at 7900 East Union Ave., Suite 1100, Denver, CO 80237 David Giles may be emailed at dgiles@tfearth.com.