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Under Par: Record Length Gravity Sewer Easements Under Riverbend Golf Course, Riverton UT

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ABSTRACT: Riverbend Golf Course, owned by Salt Lake County, UT, received 2,027-ft of two-pass gravity sewer interceptors, at subsurface depths in excess of 30-ft. A tunnel boring machine (TBM) installed three drives with one 787-ft drive marking the longest drive. The 12600 South Diversion to the Jordan Basin Water Reclamation Facility project, owned by the South Valley Sewer District serves approximately 22,000 homes and five municipalities.

Challenges with the tunnel construction included: 1) running silty sands for soil conditions with a ground water table at approximately 15-ft below the surface; 2) design tolerances of +0.1 foot vertical and +0.25 foot horizontal; 3) design specified shaft locations that required relatively long tunnel sections of 480-ft, 787-ft and 760-ft; 4) design requirements controlling the quality of water for dewatering operations; 5) noise specifications due to the proximity of homes and; 6) a tight schedule due to the golf season.

Bowen, Collins and Associates of Salt Lake City, UT designed the project for the South Valley Sewer District. The lead contractor, Condie Construction Company of Springville, UT performed all the open-cut and structure construction. Claude H. Nix Construction Company of South Weber, UT completed the trenchless pipe jacking and shaft installations and conducted all dewatering efforts. The total project cost was just under $5 million.

Attendees will appreciate the contractors' skill and efficiency to safely achieve these distances and their collaboration with the local residents and regulators to educate about the construction method, mitigate concerns and overcome project complications.

1. INTRODUCTION

In January 2010, trenchless contractor Claude H. Nix Construction, Inc. (Nix) began construction of 2,027-lft of 58-in. OD steel casing tunnel under the Riverbend Golf Course located in and owned by Salt Lake County. The golf course tunnel was part of a larger Jordan Basin Water Reclamation Facility (JBWRF) project, a new wastewater treatment facility serving the cities of Riverton, South Jordan, Draper, Herriman and Bluffdale. The project was commissioned by the owner, the South Valley Sewer District. The tunnels comprised approximately half of the overall project costs for General Contractor, Condie Construction Company of Springville, Utah.

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The project was specified as “the installation of a pipe by jacking the pipe or casing behind a remotely controlled steerable, laser or theodolite guided, microtunnel boring machine (MTBM) or by guided boring or by other means and methods that satisfy the contract requirement without open excavation except at launch and receive pits” (12600 South Diversion to JBWRF Sewer Project, 2009). Although the geology, ground water conditions and required lengths were on the fringe of tunnel boring machine (TBM) capabilities, the trenchless contractor selected an Akkerman TBM 480 machine with a closed face cutter head attachment and an extensive dewatering plan in the bid. Without the dewatering efforts, slurry microtunneling methods would have been required, which would have significantly increased the project costs. Seasoned TBM equipment operators, Nix crews felt confident about their likelihood for success.

The overall project included over 4,000-lft of open-cut 36-in. sewer line, 2,027-lft of 36-in. carrier through the tunnel section and 496-lft of 48-in. OD open-cut sewer line. Other construction details included smaller diameter stubs, connectors and laterals, five and six foot diameter manholes and a diversion structure.

2. DESIGN

The project is located in Riverton, UT, approximately 20-miles southwest of Salt Lake City and serves approximately 22,000 homes and five municipalities in Salt Lake County.

Some of the design considerations included crossing under the Riverbend Golf Course, wetlands mitigation, and two large, high-end subdivisions bordering the golf course on the south and west portions of the golf course (see Figure 1). Salt Lake County, owner of the golf course, required trenchless construction to protect the landscape and maintain business operations of the golf course.

The design grade of the sewer line across the golf course put the invert depth at an average 30-ft. In the high water table with running silty sand, open cut construction would have obliterated the landscape, hence, the county would not have granted an easement and the sewer district would have had to add footage and likely, a pump station.

The bid documents required substantial completion of the golf course tunnel by mid April 2010. However, due to delays in the award and notice to proceed, this construction schedule was revised for substantial completion by mid-May 2010. Crews assumed an average production rate of 30-ft per day.

The project design slope was very flat at +0.25%. Although microtunneling was specified as the construction method, the documents allowed the contractor to select the trenchless method. The choice of pipe materials and installation via single-pass direct jack or two-pass with casing installation and carrier pipe insertion was also left to the contractor’s discretion.

In order to satisfy the desire to protect the golf course, Nix proposed long jack and bore runs. Specifically, the bid planned for one 480-ft drive, one 787-ft drive, and one 760-ft drive.

The geotechnical reports indicated wet, sandy silt, followed by wet clay then more sandy silt encountered around 15-ft depths. The handling of water from dewatering operations required owner approval and the locations of the jacking shafts were specified to reduce impact to the golf course.

In order to appease public concern about vibrations during construction, Nix had an extensive seismic ground monitoring study conducted and used the report to educate the South Valley Sewer District and local residents about pipe jacking construction and its’ benefits as a method for minimal social and physical impacts.

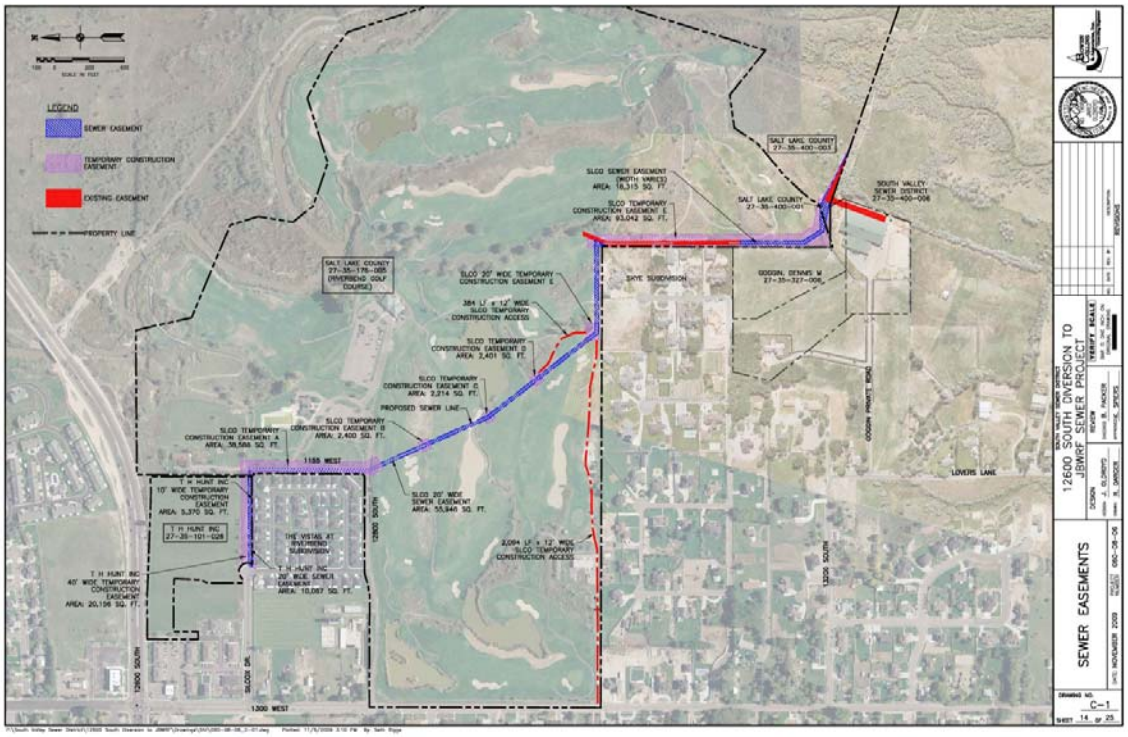

Figure 1. South Diversion to the JBWRF project map

3. SAFETY

The project's depth and length of the utility tunnels required much safety planning.

Nix implemented many safety precautions for tunnel ventilation and spoil control to protect their crew members. Two launch and two reception shafts were constructed using sheet piling and whalers for reinforcement and barring flowing spoils (see Figure 2). Nix contacted OSHA for a voluntary inspection prior to starting tunnel operations. Although the pits were deemed safe by OSHA, a few additional safety measures were implemented. Welded posts with a wire handrail, more than sufficient air-flow ventilation systems (see Figure 3) and proper ingress/egress are standard safety measures on all Nix construction sites. The TBM was outfitted with a closed face cutter head which prevents unstable spoils from entering the interior of the TBM during excavation and removal (see Figure 4).

Before the TBM launch, local emergency service personnel were trained on tunnel operations and what to do in a potential tunnel emergency extraction situation.

Weekly tool box meetings and safety meetings were held during construction. A white board detailing crew members' locations, what job they were performing and whether or not they were in the tunnel was mounted on a launch shaft post.

A self rescuer was added to the head of the TBM in addition to gas monitors and the cart operator was equipped with a rock climbing helmet to protect his head from the ventilation and lubrication lines hanging from the tunnel ceiling. Crew members operating the TBM were in close radio contact with the rest of the crew at all times.

These efforts resulted in no recordable accidents.

Figure 2. Shaft construction.

Figure 3. Tunnel ventilation duct work.

Figure 4. A closed face cutter head prevents spoils from entering the interior of the TBM and has the option to close the entire face.

4. CONSTRUCTION

Salt Lake County's foremost concern was mitigating disruption to the golf course property, so the layout of the project was critical. The Nix team, lead by Jon Nix, decided to construct a large "L" shaped shaft near the southern golf course boundary for two of the drives (see Figure 5), allowing them to connect into a manhole.

Figure 5. Construction of the second portion of the "L" shaped shaft.

The second launch shaft was located on the north boundary of the golf course. The retrieval shafts were also located at design manhole locations. Only one retrieval shaft was constructed near a fairway on the edge of a pond. Required by Utah code, the remaining two manholes were constructed by the general contractor in straight portions of the line where bases could be poured-in-place.

In order to use the manned TBM, the Nix team planned an extensive dewatering system. Initially, dewatering wells were drilled every 100-ft along the tunnel alignment (see Figure 6). The well depths ranged from 40-50-ft and were equipped with 2-in. high-head pumps. The plan was to construct the shortest drive first to test the dewatering system with the TBM operation. It was discovered that wells drilled every 100-ft were insufficient so additional wells were installed every 50-ft.

Since the design had strict water quality requirements, the ground water was pumped to a holding/settling tank before it was released to a stream within golf course boundaries. However, during construction, the golf course received complaints about staged pipe near the cart paths so the water was alternatively diverted to a nearby pond. The potential to re-circulate water in the dewatering system was a concern and near the end of the project, the owner granted Nix permission to drain the pond for a short period.

Figure 6. Dewatering along the first 480-ft alignment.

Nix selected 5/8-inch walled 58-inch OD steel casing Permalok pipe in 20-ft lengths with a 36-in. PVC carrier pipe for all three drives.

Nix used a series 5000 pump unit, yoke, and skid pipe jacking system with an Akkerman TBM 480 equipped with a closed face cutter head attachment and 524 haul unit for spoil removal (see Figure 7). Four, 250-ton intermediate jacking stations (IJSs) were used to help distribute thrust load on the drives (see Figure 8). Three IJSs were installed on the 480- ft drive and four were used on the 787 and 760-ft drives. In addition, a 210-ton jacking can, was placed behind the TBM to minimize jacking load and mitigate risk. All pipe jacking equipment was manufactured by Akkerman, with the exception of the 210-ton jacking can which was built by Nix.

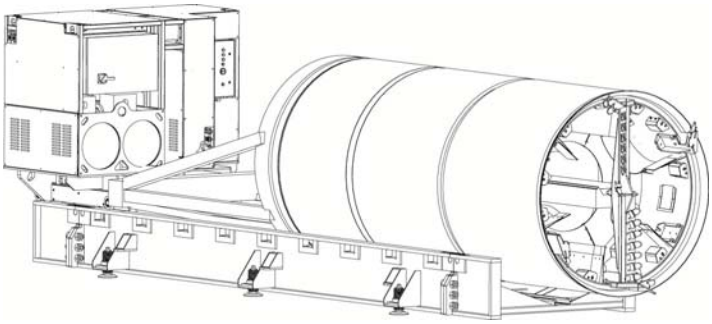

Figure 7. All-in-one pipe jacking system.

Figure 8. A jacking can is being installed between the TBM and the 5000 Series Pump Unit.

In January 2010, crews began construction on the shaft. The first drive, 480-ft feet in length, was constructed down grade and completed in 22-days. Ten dewatering wells along this alignment produced an average of 15,600 gallons-per-hour. Dewatering around the shaft in order to launch the TBM required multiple reconfigurations of the wells.

Upon the completion of the first drive, the second section of the shaft was constructed and the jacking frame was moved for the 787-ft drive (see Figure 5). A small triangular section of earth was temporarily left in place between the two sheet piled shafts to provide additional support for the jacking frame. This triangular section of earth was slated to be removed when the manhole was constructed and the connection made.

Learning from the first drive, dewatering wells were installed at 50-ft intervals. The optimum pumping power represented 14 wells, diverting approximately 22,000 gallons-per-hour.

The TBM is guided using a passive laser target which gives the operator a visual point to help manually steer the TBM with controls and joysticks to achieve accurate alignment. At about 600-ft into the second drive, the operator noticed the laser beam began to deviate about two inches while the jacks were engaged and it would return to the target when the jacks were disengaged. The operator also noticed the jacking pressures increased to 7,500 psi on the main frame. Although the pipeline had four IJSs installed and the jacking can right behind the head, the operator elected to not engage any of them and instead relied solely on the main jacking frame. Operation was stopped for 24-hours while the crew checked all possible causes. They discovered that the jacking pressure had bowed the sheet piles. The triangular section of earth sandwiched between two sheet pile walls was insufficient to withstand the jacking force. Crews decided that it was absolutely necessary to use the IJSs. When the laser was recalibrated to the check line and grade they discovered that the TBM had sunk eight inches in the unstable soil. With some extreme steering corrections and conversations with the sales team at Akkerman, they were able to recover and the drive finished in 36-days, well within the design tolerances of +/- 0.04-ft (see Figure 9 and 10).

Figure 9. The completed 787-ft tunnel.

Figure 10. Connecting the 480-ft and 787-ft drives.

Following the completion of the second drive, Salt Lake County required the trenchless contractor to shut the job down for the golf season. One of the unexpected complications that delayed the schedule at the beginning of the project was concern from residents along the southern border of the course about ground vibration during sheet pile installation. Several residents were home during the daytime when work was underway and they could hear the sheet pile hammer. Concerns could not be dispelled so a complete seismic survey was implemented. Several seismic monitors were installed in the subdivision; every house basement, foundation and exterior flatwork within a 100-ft radius was videoed and monitored during the construction of the shaft. The consequence of this maneuver resulted in a delay for the last drive until following November 2010.

Construction of the final 760-ft drive was relatively uneventful, short of freezing temperatures that complicated the dewatering process and theft of a $5,000 power cord for the pump unit. The crew was surprised at the low jacking force on this drive, typically not exceeding 150-tons. One remarkable note for this drive was that it was started at the

north border of the golf course with the goal to tie into the 787-ft drive, completed the previous April in the middle of the golf course. This was done, again, within +/-0.04 feet tolerance both horizontal and vertical.

Nix's seven-man crew worked 10-hour shifts during the project up-time. Their best production rate was reported at 60-ft in one shift and was replicated several times throughout the course of the project. The resulting grade on the longest drive was +0.04 foot falling well within the necessary manhole alignment.

5. CONCLUSION

The 12600 South Diversion to the Jordan Basin Water Reclamation Facility project was embraced by the public because of favorable experiences associated with minimal construction impacts. Project successes can also be measured by the mutual collaboration that took place between the contractors, project owner and designers to ensure the best design and installation methods. The contractor achieved critical grade success with several lengthy drives in poor soil conditions with no recordable incidents, providing them with an accomplishment to increase the diversity of their project portfolio.

6. REFERENCES

Oldroyd, J., & Darger, R. (2009). 12600 South Diversion to JBWRF Sewer Project, Project Number 060-08-06. *Bowen Collins & Associates, Inc.*