The cutting head of a hydraulic breaker used to install 100 m (330 linear ft) of pipe under a CSX railroad and South Piedmont Highway.

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dual-purpose PROJECT

This South Carolina treatment plant has a discharge system designed to handle effluent now and wastewater later

Andre Mathis and Anthony D. Greiner

For years, the 7570-m^3/d (2-mgd) Grove Creek Wastewater Treatment Plant in Piedmont, S.C., had been discharging its effluent to Grove Creek, but when its National Pollutant Discharge Elimination System permit came up for renewal in 2005, the South Carolina Department of Health and Environmental Control announced that it was time for a change. Because of the creek's low flows and the plant's new effluent limits, regulators effectively mandated that the plant either change its operations — which would require new infrastructure — or start discharging its effluent to another, more appropriate receiving waterbody by July 1, 2008.

A Matter of Timing

This order came at an awkward time. The Grove Creek plant is operated by the Western Carolina Regional Sewer Authority, which was in the preliminary stages of designing a new facility, the Piedmont Regional Wastewater Treatment Plant. This plant is expected to replace the existing Piedmont Wastewater Treatment Plant and the Grove Creek plant. It also is expected to manage flows from surrounding drainage basins, including the towns of Pelzer, West Pelzer, and Williamston. At press time, the new plant was scheduled to be operational in 2011.

Once the Piedmont treatment plant was commissioned, the authority planned to redirect wastewater from the Grove Creek plant to the new facility. Then it intended to decommission the Grove Creek plant and convert its aeration basin into an equalization basin for wet weather flows.

With this in mind, the project team began looking for an appropriate solution.

The Saluda River (7-day, 10-year low flow [7Q10 flow] of 3.1 m^3/s [107.9 ft^3/s]) is about 50 times larger than Grove Creek (7Q10 flow of 0.6 m^3/s [2.1 ft^3/s]) and is about 3.2 km (2 mi) from the existing plant. Modeling indicated that it would be a suitable receiving water. A new discharge system — pump station, force main, cascade aerator, and river diffuser — would be needed, but the team designed the system so its components could be reused. In the future, the pump station and force main could send raw wastewater to the new Piedmont plant, and the cascade aerator and river diffuser could discharge Piedmont's effluent.

Although the majority of the pipeline was installed via open-cut construction, sections such as this one were installed with a jack-and-bore method.

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Once and Future Design

The project team used census and land-use data to estimate wastewater flows in the Grove Creek drainage basin for the next 20 years. Team members then used the estimates to calculate the proposed discharge system's design flow. They determined that the pump station and pipeline had to be able to handle 22,700 m^3/d (6 mgd).

Pump station. Because the new pump station would pump both final effluent (immediately) and raw wastewater (eventually), it had to be located near both the existing effluent pipe and the incoming sanitary sewer line. The two pipelines cross each other about 61 m (200 ft) west of the existing influent pump station–administration building. Although this site already contains storage ponds and other structures, enough space remained for a new pump station.

The project team evaluated several options while designing the pump station, including

- two, three, or four pumps;
- variable- or constant-speed drives;
- submersible, wet pit–dry pit, or self-priming pump stations; and
- pumps that can handle both final effluent and raw wastewater with minor alterations.

The team determined that the optimal pump station configuration would have three variable-speed pumps (two duty and one spare) in a wet pit–dry pit station. The team also made provisions for the pumps, electrical capacity and infrastructure, instrumentation, and supervisory control and data acquisition system interface needed in future flow-equalization facilities. In addition, team members allocated space and hydraulic grade for a future influent screen and flow-measurement flume for the influent pump station.

Force main. Because the force main must meet both current and future needs, key design criteria included

- route (most direct route at the lowest cost);
- size; and
- discharge location (ideally, the cascade aerator and river diffuser would be installed at the Piedmont plant site so they can be reused when this pump station is converted to handle raw wastewater).

Because of the topography involved, the project team split the pipeline into two sections: 1770 linear m (5800 linear ft) of 450-mm (18-in.) ductile iron pipe and 2012 linear m (6600 linear ft) of 500-mm (20-in.) ductile iron pipe. A third section — 120 linear m (400 linear ft) of 1050- and 900-mm (42- and 36-in.) ductile iron pipe — runs from the cascade aerator to the river diffuser. The first section is under pressure; the other two operate via gravity flow.

Because the force main is so long, regulators suspected that the effluent's dissolved-oxygen concentration might drop by 1 ppm by the time it reaches the river. So, the revised permit required that plant staff periodically check dissolved oxygen at the discharge point. Also, the project design included a cascade aerator on the Saluda River bank to reaerate the effluent.

Complex Construction

The project team accepted bids on the project in late 2006. After evaluating all submissions, the team issued two contracts: a $3.94 million pump station contract and a $3.88 million force main contract. Construction began in January 2007.

Pump station. This contractor used an excavation support system that consisted of steel soldier piles, wood lagging, and grout–cable tieback anchors.

An eductor system dewatered the excavation. This involved installing 28 eductor wells around the excavation and pumping water into each well via a 100-mm (4-in.) supply pipe. The resulting vacuum extracted groundwater from the excavation area. This groundwater was sent to the dewatering system's reservoir and discharged via a 100-mm (4-in.) return pipe.

The pump station was substantially complete on June 25 and has since pumped treatment plant effluent to the Saluda River.

Force main. Most of the pipeline was installed via open-cut construction. Although the contract

Workers place a wall section of the pump station.

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An operator at the leading edge of the casing. The cutting head is visible in the background.

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included a rock allowance, only about 230 m^3 (300 yd^3) of rock was excavated during this project.

One subcontractor used a jack-and-bore method to install two sections of pipeline. The jack-and-bore method (also called horizontal auger boring) consists of a rotating auger–cutting head inside a casing pipe. A hydraulic drive unit advances the auger, which cuts and removes excavated soil from the boring. The drive unit also advances the casing pipe. Typically, entrance and exit bore pits are required.

This group installed 21 linear m (70 linear ft) of 450-mm-diameter (18-in.-diameter) pipe in a 1220-mm (48-in.) steel casing under Grove Creek. The group also installed 18 m (60 linear ft) of 500-mm-diameter (20-in.-diameter) pipe in a 1220-mm (48-in.) steel casing under Old Pelzer Road.

Another subcontractor used the jack-and-bore method with a hydraulic breaker to install 100 m (330 linear ft) of 500-mm-diameter (20-in.-diameter) pipe in a 1220-mm (48-in.) steel casing under a CSX railroad and South Piedmont Highway. This method is similar to the traditional jack-and-bore method, but the cutter head is somewhat steerable and the hydraulic drive unit is immediately behind the cutter in the casing pipe. The machine operator also is near the cutter head and can observe cutting activities firsthand. A smaller auger removes cuttings and discharges them into the bore pit.

This installation was completed in one continuous bore. About 95% of the bore was made with the hydraulic breaker; the remainder was hand-mined.

A third subcontractor used horizontal directional drilling to install twin 300-mm-diameter (12-in.-diameter), high-density polyethylene force mains across the Saluda River. Each force main was about 143 m (470 ft) long.

Horizontal directional drilling is a trenchless excavation method involving a steerable cutter head driven by a special drilling rig. This method typically has three phases: drilling the pilot hole, using increasingly larger reamers to enlarge the pilot hole to the desired size, and pulling in the carrier pipe. Usually, entrance and exit bore pits are not required. This group also recaptured the cutting fluid, pumped it back across the river to the drill rig, ran it through a recycling unit, and reused it.

A fourth subcontractor used a portable dam system to install the effluent river diffuser. This diffuser is about 18 m (60 linear ft) of 900-mm-diameter (36-in.-diameter) ductile iron pipe.

The portable dam system consisted of welded rectangular steel A-frames, which were placed in the river at intervals. This group then suspended a membrane from the frames and "sealed" it at the bottom via sandbags. Dewatering pumps then removed water from the cofferdam's interior.

The force main construction team finished its major construction activities in the first week of January 2008. The team completed pressure-testing and punch-list activities in April.

Next Steps

At press time, the entire project was completed and had been operating without any trouble. Detailed design of the Piedmont Regional Wastewater Treatment Plant began this fall. Plant construction is expected to be completed under a "construction manager at risk" approach, and plant commissioning is anticipated in 2011. The Grove Creek Wastewater Treatment Plant then will be decommissioned, and the Grove Creek Pump Station will be converted into a raw-wastewater pump station.

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The effluent river diffuser was installed using a portable dam system.
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