Creating Lift Stations with Culverts: Aurora, Colo. Project

Proactive measures stop a sewage problem in new Aurora neighborhood.

By Fernando Pages Ruiz

Imagine having to build a structure 40 feet tall by starting construction somewhere in the middle, moving to the top, going back to the foundation and then filling the parts in between. It doesn't make much sense. Yet this was the challenge facing Mike Menard, plant manager for Firebaugh Precast in Dacono, Colo.

Developers of the Highpointe neighborhood in Aurora, Colo. – a burgeoning city of nearly 300,000 situated just six miles southeast of Denver – were moving quickly with plans for build-out. With a modest number of residents living there and a nearby school holding classes already, Aurora Water needed to act quickly to provide sanitary water service to the master-planned community.

Located along an 18-mile stretch of E-470 toll road, on two square miles straddling the boundaries of Denver and Aurora near Denver International Airport, the Highpointe development is a regional partnership between the two cities and is expected to contribute substantially to the creation of new jobs and tax revenues for both municipalities.

Consequently, Aurora's mayor, Ed Tauer, and the Aurora City Council were motivated to act quickly to approve construction of the Highpointe Lift Station, a facility devised to move sewage from the Highpointe community into the city's existing wastewater system. Aurora Water's quick solution to providing Highpointe with wastewater service was to build a temporary, 40-foot-tall lift station underground. Although a temporary structure, the facility is devised to remain in place as a backup system once a new pump station comes on line in about two years. But for now, the immediate need for service required that work on the temporary structure proceed as quickly as possible, making precast concrete the construction material of choice.

Putting together the puzzle

Most construction projects can start only after engineers have completed their designs and the owner – in this case, the municipality – has approved all the drawings. Although drawing approvals are often phased, construction does not typically begin until contractors can start at the bottom and build in vertical, sequential order. Having a few odd parts of the design does not warrant an order to proceed with work – that is, unless the construction can be done off site in a factory setting with tight tolerances and modular components.

"The base of the lift station was the tricky part," says Dean Bedford of Black & Veatch, the engineering, consulting and construction company that designed the lift station for Aurora Water. "Because this lift station will eventually tie into a new pump station and become only a backup system, we had to design the station to easily convert from a wet well into an oversized manhole." In other words, after the pump station comes on line, the city does not want to remodel the lift station and reroute all the plumbing. To provide value-added cost savings, Aurora Water didn't want the expense of extensive retrofitting of the lift station so sewage could be later routed to the pump station. No one had ever done anything quite like this before.

But as the engineers and contractors refined designs for the critical bottom sections, Firebaugh Precast was busy building the rest of the modules as shop drawings were approved. The modules consisted of 10-by-14-foot box culverts 56 inches tall. Like masonry blocks, these were stacked one atop the other. Unlike ordinary blocks, however, they had to fit together with watertight keyway joints and precisely located perforations for pipes, valve boxes and even a railway system for three submersible sewage pumps.

"The production schedule was a real challenge," says Mike Menard. The submittal process was slow and arduous, but when the final approvals came, "the contractor wanted the product shipped the next day." Firebaugh was able to accommodate this seemingly unreasonable demand because, by the time the final approvals did arrive, it had only one module left to build. The first trucks left the plant within three hours of the contractor's order.

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On site, the parts fit together perfectly, according to Matt Durbin, project manager for RN Civil Construction, the Centennial, Colo., wastewater contractor building the Highpointe Lift Station. "It all fit together really well – perfectly level – and I was surprised at how tight everything measured out," said Durbin. The seasoned construction manager first doubted using precast concrete components. "We usually build with cast-in-place concrete. We know where penetrations are going to be, we can check them before pouring and we know everything will come out right," Durbin said. Building with precast modules, Durbin had to trust a third party to follow the blueprints as accurately as he would have. But precast manufacturers are used to exacting standards, and in the end, Durbin added, "it worked out pretty good. Precast construction proceeds way faster and with about 20 percent labor savings than cast-in-place." Precast concrete components shaved a month off the schedule, because RN Civil Construction could stack and backfill almost simultaneously without labor-intensive forms to build, without waiting for concrete to cure, and without stripping forms before loaders could move in with gravel and dirt. The quality of the finish and fit exceeded Durbin's highest expectations.

Evolution of the culvert

While large by any measure, the Highpointe Lift Station was not the biggest ever built, but it just may be one of the biggest ever built from precast concrete. "It was certainly unprecedented to our knowledge," says Paul Martin, precast engineer at Firebaugh. Although the plant used off-the-shelf box culvert forms to cast the lift station sections, the 283,000-pound structure required extensive reinforcement consisting of a double layer with 2.5 inches of black steel per square foot, all set at precise spacing and perfectly centered. To protect the concrete from hydrogen sulphate in the septic environment, the interior of the structure received a protective coating of trowel-applied epoxy. For added protection outside the structure, the exterior was treated with a sprayed-on bituminous coating. The keyway joints between culverts were sealed by a double layer of butyl rubber gaskets. With a life expectancy of at least 50 years, the lift station will see many years of use – even as a backup system.

The idea of stacking box culverts came to Bedford almost by accident. "We would usually use an 8-foot-diameter manhole section for a smaller lift station and cast-in-place concrete for anything else," said Bedford, "but because of the aggressive schedule, I was looking through a precast concrete catalog for the biggest vault I could find." This happened to be the largest box culvert available.

In the end, the solution to designing the lift station for easy conversion into a backup system was surprisingly simple. "We wanted to make sure that once the pump station came on line, the sewage could flow into the lift station and then back out without ponding in the wet well," Bedford said. This posed a challenge, because a sewage lift station is designed similar to a basement sump pit. As water flows in, it accumulates until it reaches a certain level at which the pump kicks in and drains the pit. Once the new pump station is built, any effluent entering the lift station will have to flow right back out without accumulating in the wet well.

The solution came with a straightforward, 2-foot-wide fiberglass gutter set in the lift station at the level of the intake pipe. At one end of the gutter, the sewage will flow in, while at the other end, the sewage will flow out – that is, once the pump station is constructed. Until then, without a ready outlet, the lift station gutter will behave exactly like roof gutters when the downspout gets plugged: the water will overflow. This overflow will spill into the wet well where three pumps will boost it 40 feet at 500 gallons per minute. Eventually, electronically controlled valves will regulate the inlets and outlets so that the lift station stands idle unless or until the pump station shuts down for maintenance or emergency repairs, thereby assuring residents of Aurora's Highpointe neighborhood uninterrupted service.

On schedule and under budget

With a 100-day construction schedule, the precast concrete manufacturer was busy building sections as the contractor excavated the site. On the day the excavation was ready, the first precast sections were delivered and erected using a small 40-ton mobile crane. A backhoe and loader moved pieces from the delivery trucks to the structure. As the tower went up, loaders backfilled immediately, raising the work platform for added safety and making it unnecessary to use more expensive hoisting equipment. "The schedule would not have allowed a contractor to dig a 50-foot-deep hole and only then start building forms, tying steel, pouring concrete and then waiting for the concrete to cure before backfilling," says Joseph Kleiner, project manager for the city of Aurora, "especially with win-

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ter coming on, when concrete can take as long as 14 to 28 days to cure. In the plant, they do it all in a controlled environment and get it done in a couple of days," Kleiner says.

Kleiner says Aurora Water was able to save the city time and money by specifying the use of precast concrete for the Highpointe Lift Station Project, saying, "In my experience, the labor savings with precast resulted in overall cost savings."