Venturing into the Pipe

Divers from W.H. Streit brave dangerous working conditions during sliplining project for the Philadelphia Water Department

By **Brian Fraley**

Try to imagine this workday. Upon arrival at the job site, you climb into a dry suit and strap on diving equipment. Next, you enter a diver's stage. Within seconds you're slowly being lowered by crane into a narrow, darkened, spherical tunnel. After descending 20 feet or so, you break through the surface of raw sewage. After that, it's lights out as you swim through a 50-inch diameter sewer pipe. Your mission: to repair, section by section, two 600-foot-long siphons 75 feet below the bottom of the Schuylkill River. For the divers on W.H. Streit's most recently completed project, it was all in a day's work.

The situation

Project Manager Pete McCarthy headed up the Philadelphia Siphon Repair Project for Streit, a Hammonton, N.J.-based general contractor with a knack for marine work. Covering most of the East Coast, the firm gets involved in bridgework, underwater pipeline crossings, sliplining, bulkheads and piledriving. The $2-million contract, awarded by the Philadelphia Water Department, required the contractor to complete a tunnel sliplining installation on a dual siphon. The siphon consists of two 50-inch-diameter steel pipes encased in concrete running through at least 25 feet of bedrock beneath the Schuylkill River. A horseshoe-shaped tunnel, the siphon collects about 12 percent of the city's untreated wastewater on one side of the Schuylkill and carries it to the sewage treatment plant. On rainy days, the siphons feed the pump station up to 185 million gallons collected from storm and sanitary sewers.

"After 50 years the one-eighth of an inch of steel gave up the ghost," McCarthy said of the original pipe, looking down at a pile of the damaged steel outside the sewage treatment plant. He said the steel had started to delaminate and fold, resembling "crumpled paper in the pipe."

Keeping the siphon in operation

One tube of the siphon had to be kept open during the repairs. To complicate matters, the water department reserved the right to put the siphon back in full operation at any time, namely if a major storm was in the forecast. At any given time, Streit would have to be prepared for up to 150 million gallons to come rushing through.

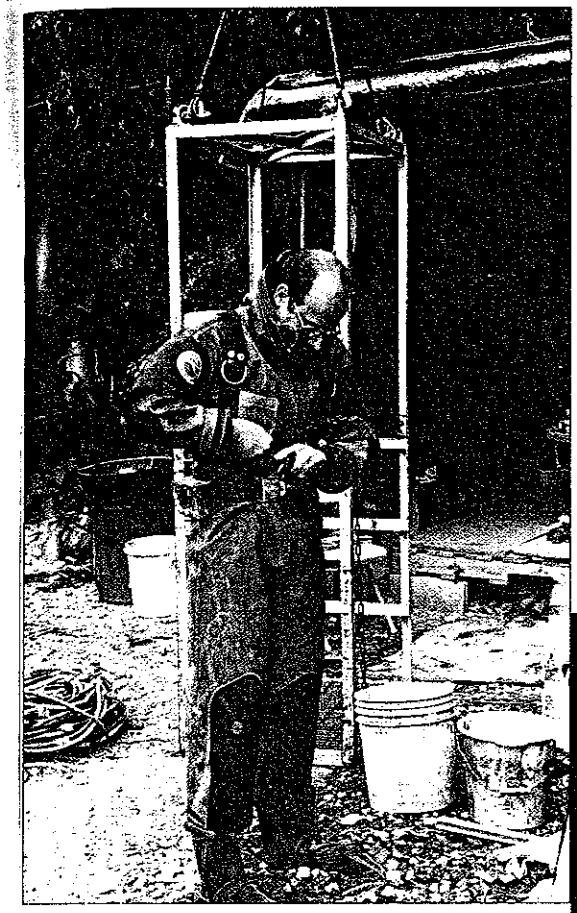
He continued: "They (water department) wanted a minimum of 42 (inches in diameter) and that's what we gave 'em as far as a slipline pipe. They didn't want any smaller than that because of the requirements of these two siphons. There is no plan B for these guys. They could have been dewatered and done in the dry a lot easier, but the capacity of this system is such that they must keep at least one of these pipes running at all times."

Divers from Walker Diving Co., a subsidiary of Streit, were sent down in the summer of 1998 to cut out some of the delaminated steel. This was fine temporarily, but it wasn't a permanent solution. That's when Streit suggested sliplining. The idea flew. Come March 1999, Streit's crew was on site attempting to put this rare form of sliplining to work.

W.H. Streit's Project Manager Pete McCarthy displays a piece of badly delaminated steel that was removed from the sewer pipes. The firm kept a double siphon in service for the Philadelphia Water Department while completing a tunnel sliplining project.

"We've done miles and miles and miles of sliplining, but never anything quite as daunting and unique as this," McCarthy said, indicating that he wasn't aware of a job of this nature being done anywhere in the United States.

What separates this job from others like it is that Streit sliplined the pipe section by section while the siphon was partially kept in service. The limitations were great. Basically the firm was dealing with 50-inch vertical shafts connected by an elbow to 50-inch horizontal shafts. All in all, 400 3-foot pipe sections were used to slipline 1,200 linear feet of pipe.



A diver suits up prior to being lowered into the double siphon.

The only area that wasn't sliplined was an elbow at the base of the intake shaft. Over time, heavy water flow had delaminated the steel and ate away at the concrete as well. At the end of the job, Streit's crew mixed up a special underwater grout to repair the walls. Small quantities were lowered to divers who handled the application.

Key word: simple

A complicated project tends to require complicated equipment, right? Wrong. According to McCarthy, the key was to keep things simple.

"The divers are down there in raw sewage," McCarthy said, watching as a diver is lowered into the intake shaft. "They have almost zero visibility. They're down in a dangerous tight place. We kept it very simple."

Everything down to the machinery was simple. One crane was kept on each side of the river at all times for hoisting pipe sections and diver's cages. One was a P&H CN122D 22-ton down cab crane on rental for several months from Anthony Crane & Equipment, Ridley Park, Pa. The other was Streit's B&E 35-ton truck crane that worked near the sewage treatment plant.

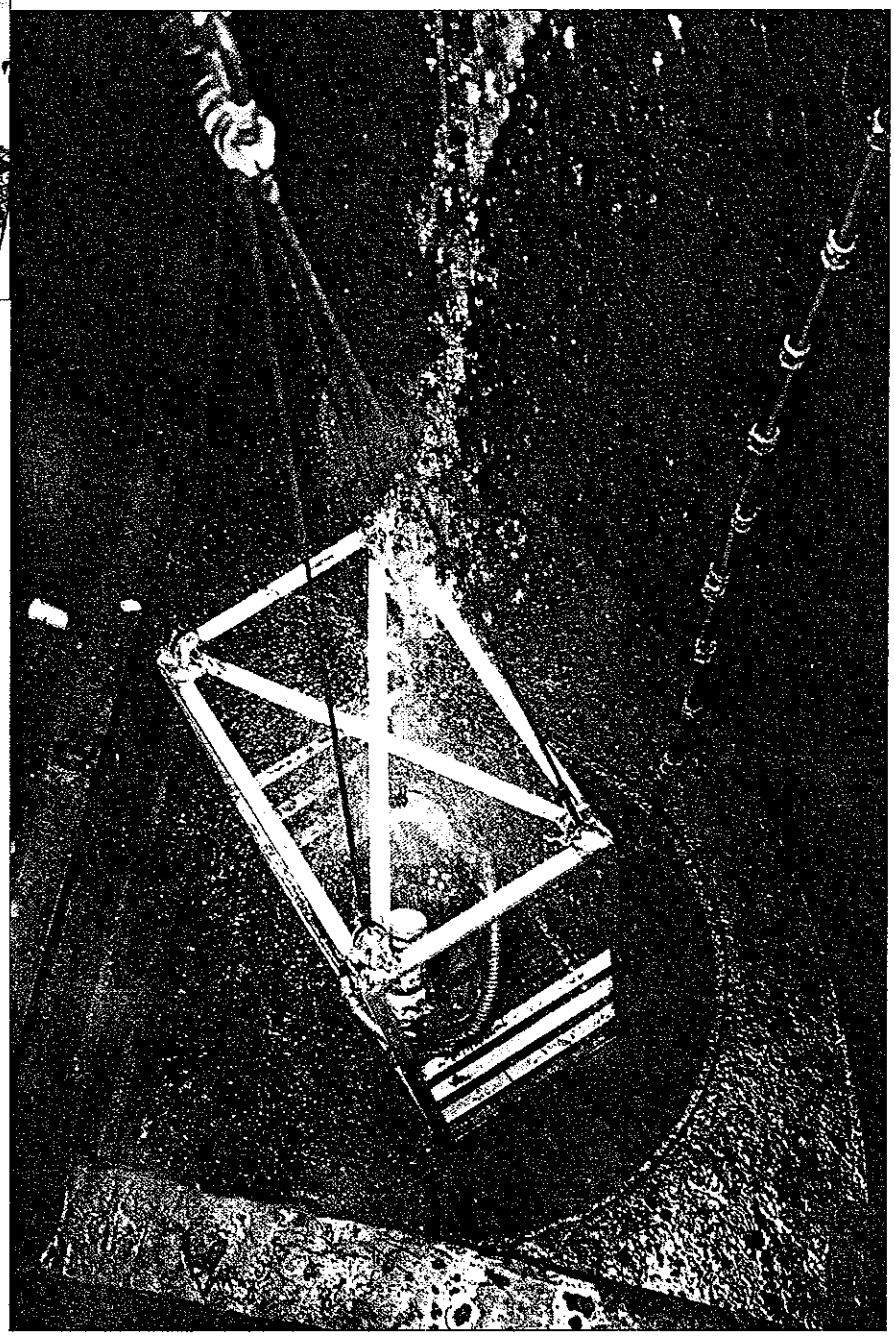
Using "clever rigging," Streit installed a 1-1/8-inch pulling cable at the bottom of the shaft. A crane advanced the pipe 3 feet at a time as each of the 400 joints were made.

Selecting and connecting

The contract allowed for the utilization of either a steel or fiberglass-reinforced pipe. Because making the joint was simpler, the decision was made to go with a 5/8-inch fiberglass-reinforced pipe.

Streit worked closely for two months with Beetle Plastics in Florida to design the new pipe. The contractor also selected the pipe with a mid rib, which enabled it to withstand up to 60 psi of external pressure.

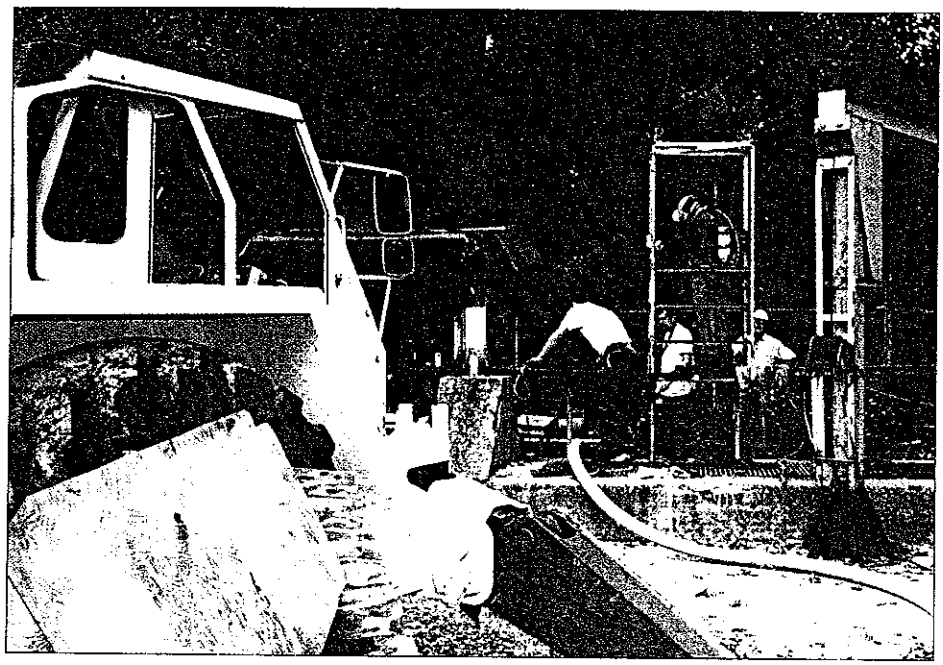
Because the pipe would be a snug fit and would have to withstand great amounts of pressure, a series of mock-ups and test riggings were conducted between Streit, Beetle and water department officials prior to start up.



Divers were hosed down and decompressed prior to being elevated to the surface.

Once the sliplining process was complete, the annular sections had to be grouted. McCarthy presented the situation. "Think about it," he said. "You're down there under 65 feet of water pressure, you've got an annular space that's full of sewage and you somehow have to grout that entire 600-foot-long space and displace the sewage that's there."

This work item was subcontracted to Pacific International Grout, Bellingham, Wash., who made the seal with a special mix that introduced foam to low-density concrete, lowering density and improving flowability. Pumping went on for three days with an average of one long run accomplished per day.



A P&H CN122D 22-ton down cab crane rented from Anthony Crane lowers a diver into the siphon. Two cranes were used for hoisting the diver's cage as well as pipe sections.

It was crucial that no water would leak from the end of the pipe upon completion and that the pipe would be able to contain 40 psi during Pacific's pumping. Under a separate subcontract, Edwin Brady Associates, Harris, Ky., helped to solve this problem beforehand by using a two-part foam grout to form six bulkheads up to 15 feet long (three on each siphon). One was constructed each day.

"Since we had to push this stuff 600 feet across the river, we were afraid of the pressure that would be exerted on the pipe. If you overstressed it and it collapsed, you'd have a catastrophic problem on your hands. We could have even lost the siphon. It was a nail-biting session when we did that."

A dangerous situation

Early on, as Streit was cutting out steel, it was discovered that there was a connection between the two parallel-running pipes. Holes in the concrete — large enough for divers to fit their heads and shoulders through — actually revealed a large cavern of about 40 feet. This problem resulted in cavitation, creating an air bubble in the cavern, which resulted in what McCarthy described as a "large, violent burp" when the bubble attempted to rise to the top. At one point, divers were blown close to 40 feet through the tunnel.

To combat this problem during sliplining, a large hose was fed from the riverside to the cavern and the bubble was bled, sometimes two to three times a day.

Plenty of backup

"No project's worth the loss of a man," said McCarthy from inside the diving supervisor's station, listening to a steady breathing pattern coming over the loudspeaker.

Normally a crew of six divers and a supervisor was on rotation. In recognition of dive tables, each diver was good for about an hour and a half of bottom time. Plenty of precautions were taken to ensure the safety of the divers, including heavy hazard analysis and safety meetings. Standard diving procedures, which include quadruplicate safety systems in some cases, were employed. Cranes with diver's cages were kept on each side of the river in the event of a breakdown. Just above the intake shaft was a lifting frame, which served as a backup in the event of a crane breakdown.

The air supply could be delivered by a main dive compressor, a backup compressor, or high pressure air bottles through reams of umbilicals, or lifelines, which were also stored in the working areas.

Divers were suited up in full contamination suits, but there was always the possibility of sharp steel puncturing the suits. McCarthy spoke of other dangerous diving situations such as nuclear reactors on past projects, but raw sewage, he said, is "pretty nasty stuff." All the more reason the safety of the divers was well thought out. Divers also received Hepatitis inoculations.

While it wasn't necessary at any point, a decompression chamber was kept in the work area as well. There was also a large hyperbaric chamber nearby at the University of Pennsylvania.

The divers were always looking out for their own. McCarthy said: "When a diver penetrates, there's two divers in the water — a diver that actually enters the pipe and a diver that stays on the bottom in full dive gear at the bottom of the shaft. He helps this man and he's also available if a guy gets in any kind of trouble." A suited up standby diver is also ready for action on the surface.

In late September, Streit finished up and prepared a video depicting the successful repair. Godwin Pumps, Bridgeport, N.J., supplied the contractor with an HS 100 4-inch hydraulic submersible pump and 150 feet of hose to pump clean water into the siphons. Fire hydrants supplied clean water to provide a clear view for the camera. ❖