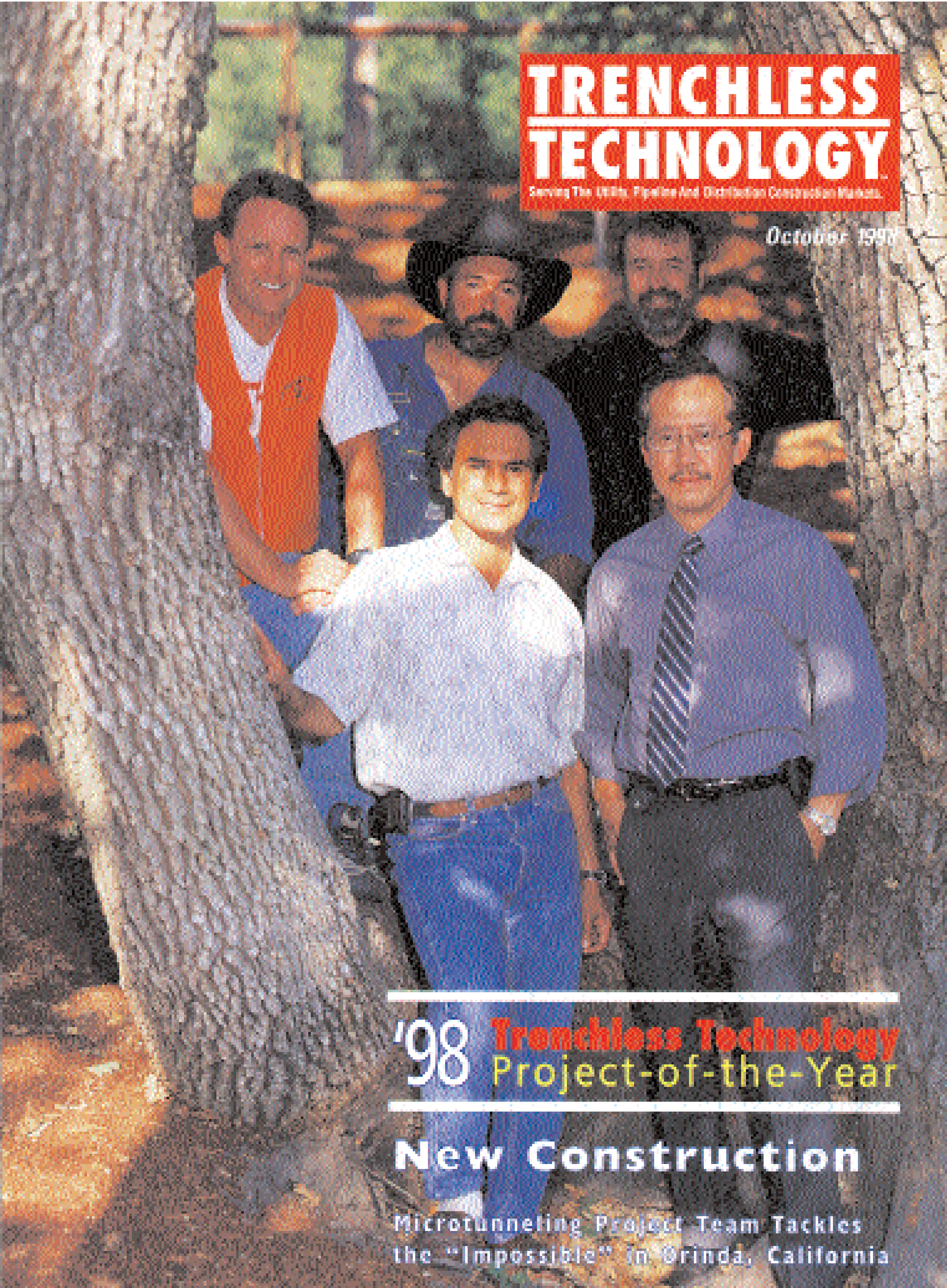

TRENCHLESS TECHNOLOGY

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'98 Trenchless Technology Project-of-the-Year

New Construction

Microtunneling Project Team Tackles the "Impossible" in Orinda, California

Heritage Oaks and Harried Commuters Saved in Orinda

New Construction

'98 Trenchless Technology Project-of-the-Year

by Paul J. Miller

To understand the accomplishments of the South Orinda Sewer Improvements Project, it is helpful to know the district design staff dubbed it "the unbuildable project."

The South Orinda Sewer Improvement Microtunneling Project is the Trenchless Technology Project-of-the-Year – New Installation for 1998. Involving 8,250 lf of 36-in. trunk sewer installed in the valley's primary traffic corridor, the South Orinda project demonstrated how the Central Contra Costa Sanitary District (CCCSD) planned and carried out what is believed to be one of the largest microtunneling projects in the San Francisco Bay area. Despite a host of design and construction challenges, the project is successfully moving toward completion by early fall.

The towns of Orinda and Moraga, Calif., lie in a steep valley due east of the San Francisco Bay. A heavily traveled two-lane highway –Moraga Way– joins the two towns as the region's primary traffic corridor. More than 1,200 vehicles per hour during commute hours travel the corridor, with a total of 22,500 vehicles per day. Paralleling the roadway through most of the valley is the San Pablo Creek. The creek, steep slopes, private residences, and massive trees precluded the relocation of the sewer outside of the street's right-of-way. Open-cut installation was not a feasible or cost-effective alternative because the new sewer lies at depths up to 35 ft and the entire roadway would have had to be completely shut down. Closing the highway was not acceptable to the local government.

The same constricted right-of-way created headaches for the tunnel alignment. There were very few sites large enough for a jacking pit and a conventional layout of the microtunneling equipment spread. CCCSD wanted to keep the alignment located such that if the microtunneling equipment became stuck, it could be dug up. This required a layout for tunneling diagonally back and forth across the street. Many proposed locations were unacceptable due to natural obstructions or highly improved properties. Ultimately, the design staff and the microtunneling subcontractor had to "get very creative" with pits and equipment layout to accommodate the 16 pits needed for the 8,250-ft project.

Ground conditions presented their own complications. The region's variable soils consist of river bed deposits of sands, gravels with cobbles and occasional boulders, weak sedimentary rock formations of siltstone and claystone, fills and landslide deposits. The rock contrasts in hardness and suitability of cutters; the siltstone requires a cutter that does not perform well in claystone. In addition, both the siltstone and claystone break down into "sticky" clay particles that challenge the slurry and separation equipment.

The South Orinda project team *(l-r, back)*: Jim Falk, Mountain Cascade; John Gay, Westcon/Dillingham Microtunneling; Tad Pilecki, Central Contra Costa Sanitary District; *(front)*: Jackie Zayac, CCCSD community liaison; Dave Mathy, DCM/Joyal Engineers; Henry Thom, CCCSD; Cal Terrasas, Nada Pacific Corp.; *(sitting)*: Craig Pyle, Montgomery Watson.

Project Design

After preliminary investigations, the design team decided to deepen the tunneling alignment to 15 to 35 ft in the more uniform rock formations for the majority of the project. A 36-in. ID diameter reenforced concrete pipe, supplied by Gifford-Hill Inc., Sacramento, was specified, which enabled the use of interjacks, if needed, and a larger 44-in. microtunneler, which in turn permitted longer drives. It still contended with variable soils and fills in some regions.

Orinda has numerous protected California Heritage Oak trees, redwoods and other trees along Moraga Way. Residents were concerned the trees were endangered by the construction activity and the city council demanded action to protect them. CCCSD retained an arborist who specializes in construction impacts on trees. The arborist reviewed each proposed shaft site prior to construction. Specific protective measures were drawn up and implemented before construction. Following construction, the arborist again inspected each site and identified mitigation measures required to restore the site and trees to their natural, pre-tunneling conditions.

Microtunneling represented about 40

percent of the total length of the South Orinda Sewer Improvement Project. The overall project consisted of the construction of 20,000 lf of 8-in. to 36-in. sewer, utilizing conventional construction, pipe bursting and microtunneling.

Project design was completed by an inhouse CCCSD team with the aid of outside consultants. Tad J. Pilecki is the project manager for the district. The district hired trenchless specialists Bennett and Staheli Engineers, Vicksburg, Miss., and geotechnical consultant DCM/Joyal Engineers of Walnut Creek, Calif., to review the plan and specifications. DCM/Joyal Engineers also completed the project geotechnical analysis.

Subsurface investigation during the design phase employed a new process of seismic tomographic imaging along Moraga Way to evaluate the consistency of the layers of bedrock. The seismic imaging technique uses seismic compression wave velocity measurements to establish soil and bedrock stratigraphy. Three 60-ft deep test bores were completed along the project alignment, and each was outfitted with a vertical series of seismic detectors.

By measuring the seismic response time, the seismic imaging technique extends the subsurface profile laterally 180 ft in either direction from the borehole. The images indicated the variability in the upper soils and more consistent formations in the bedrock layers. This information led the team to lower the tunnel alignment out of the mixed face conditions into the bedrock.

A second design investigation measure was the use of slake durability tests for the breakdown of rock cuttings from the siltstone and claystone rock. The tests evaluated the effect of different slurry fluids on the rock cuttings, and they confirmed the need to use slurry polymers to increase the slake durability index. This affected the thickening of the slurry with the clay content and maximized the solids separation in the spoil handling equipment.

Results of both tests were shared with bidders during the proposal stage and were later verified in the actual microtunneling operation.

The project was awarded in July 1997 to Mountain Cascade Inc. of Livermore, Calif., with a bid of $10.6 million, of which $7.2 million was for the microtunneling. Nada Pacific Inc., Caruthers, Calif., was chosen as the microtunneling subcontractor. The district retained Montgomery Watson, Walnut Creek, Calif., for construction management.

Construction Challenges

The combination of claystone and siltstone rock formation reared its head quickly in the first launch of the 48-in. Akkerman Microtunneler. The standard cutting head on the microtunneler made slow progress in the mixed conditions, causing the unit to be retracted in the initial drive. Contractor Nada Pacific opted to install a "Christmas Tree" cutting head, which had worked well in conventional tunneling in similar soil conditions. Although this was Nada Pacific's first experience with the Christmas Tree head, the contractor was able to install the head on the bidirectional microtunneler and modify it to counter a tendency to create a roll problem. Production rates in the weak bedrock rose dramatically with the new head, Pilecki reported.

Site constraints presented persistent difficulty for the contractor. Most of the bore pits had limited space and poor access. In the space that was available, large trees and other landmarks hampered the construction process. To minimize equipment needs, the contractor chose to go with half the normal tanks for the separation plant. That raised difficulties in keeping the slurry water density stable and slowed the advance rate. Support trailers and pipe were stored at a staging area away from project sites. Each site required a new scheme for equipment layout, calling on the creativity of the crews to make efficient use of limited space.

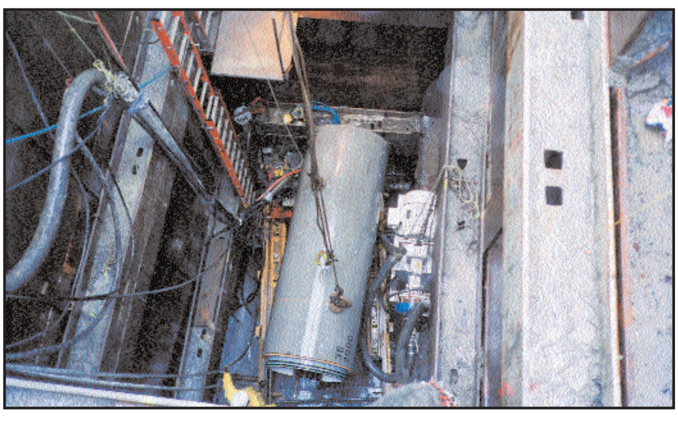
Unplanned recoveries of the microtunneler were necessary on two drives of the project. The first was caused by oversized material and metal scraps in a fill area in the downtown portion of the project. Since the microtunneler was stuck under the roadway, the contractor was able to dig down in front of the machine to remove the obstructions. The cutting head was slightly damaged and required the replacement of several bits, which took several days before the operation was running again.

A second emergency recovery was needed after the microtunneler hit an obstacle that turned out to be an abandoned support pier for an electric transmission tower. The incident happened at the 210-ft mark of a 300-ft run, leaving the microtunneler stuck directly under a city sign and fountain. Close by was a large redwood tree and an electric tower. Open-cut recovery was not an option. The project team decided to recover the microtunneler by hand-mining from the receiving pit and jacking a 60-in. casing in line with the machine. This time the microtunneler was heavily damaged, requiring shipment of the machine back to Akkerman's Minnesota plant to install a new rock crusher, bearing, seal and drive shaft. Though the manufacturer expedited repairs, the total process lost two months of production time.

El Nino

A major construction challenge were the heavy El Nino rains of the past season. The Orinda area received 70 in. of rain where 30 in. is the norm. The heavy rains took their toll on microtunneling operations, including flooding one shaft over a weekend. Controlling the storm water runoff caused numerous difficulties because the Stormwater NPDES Permit carried stringent regulations on its disposal. Crews were given crash-course training on how to comply with the regu-

Top: **Nada Pacific lowers the 44-in. Akkerman microtunneler into a launch pit.**



Right: **A 10-ft section of 36-in. RCP is placed into the jacking frame during heavy El Nino rains.**

An Akkerman slurry separation plant is perched in the confinded area under a large Heritage Oak.

lations. Runoff and slurry tank overflows were contained and discharged into the sanitary sewer. In all, the rainfall caused a further two-month slippage in the construction schedule.

The construction team had to work together to deal with the challenges of the project, but the schedule alterations, due to the four-month delay, required a great deal of team cooperation. A number of steps were taken to make up time, including the deployment of additional tunneling equipment. Mountain Cascade subcontracted with Pacific Boring, also of Caruthers, to mobilize a conventional tunnel boring machine. Mountain Cascade also subcontracted with Westcon/Dillingham Microtunneling, Pleasant Grove, Utah, to bring in two additional microtunnelers — Herrenknecht and Soltau machines. Nada Pacific also brought in another Akkerman microtunneler, bringing a total of five tunneling machines on the project. CCCSD paid Mountain Cascade an additional $100,000 to mobilize the additional equipment.

At press time, the last drives have been launched. The overall project is expected to be completed by early fall.

Milestones

The South Orinda project is believed to be the first and longest microtunnel installation in the Bay Area sedimentary bedrock. The experience and lessons learned may provide a baseline project for future projects in the region.

The complex project is among the largest microtunneling works designed by a public agency design team. CCCSD believes that this demonstrates microtunneling projects are feasible for the average district that is willing to team with qualified specialist consultants to assist in the project planning and design.

Central to the success of the project were the district's efforts to communicate with the public and address its concerns. Among steps taken to identify concerns were public workshops, letter campaigns to area residences and businesses, meetings with impacted property owners, and presentations to the Orinda City Council and to adjacent towns. Once in construction, site tours were given to interested citizens. Posted signs invited residents to provide feedback by asking "How are we doing?"

The South Orinda project gained distinction for its complexity and scope. Despite many challenges and even reversals, CCCSD and its team of consultants, contractors and suppliers have completed the project successfully with creativity and ingenuity.

The author is endebted to the in-depth nomination reports provided by CCCSD and Bennett and Staheli Engineers in the preparation of this story.