

WINNER: 2011 ASCE HAWAII SECTION OUTSTANDING CIVIL ENGINEERING ACHIEVEMENT AWARD

WANA'AO ROAD AND KEOLU DRIVE RECONSTRUCTED SEWER PROJECT

KAILUA, OAHU, HAWAII

The Wanaao Road/Keolu Drive Replacement Sewer involved the construction of approximately 15,000 linear feet of new sewer pipes, by-pass lines and connections to the existing sewage collection system including many sewer laterals and collector lines along Keolu Drive and Wanaao Road in Kailua, Oahu, Hawaii. The replacement sewer line is a gravity flow system except for an inverted siphon crossing under Kaelepulu Drainage Canal.

The replacement sewer closely follows the alignment of the existing 12-inch, 21-inch, and 24-inch sewer lines, with a horizontal clearance that varies from 5 to 16 feet. The new sewer cuts across the existing sewers under city streets at several locations requiring sewer by-passing and removal of the existing sewers prior to construction of the new sewer. The inside diameter of the new sewer is 12 inches and increases incrementally to 15 inches, 18 inches, 30 inches, and 36 inches as sewage travels downstream.

The new sewers were installed by microtunneling, horizontal directional drilling, jet grouting, and open excavation depending on the size, type and complexity of the sewer segments and the anticipated subsoil conditions.

- *Mini (pilot tube) microtunneling.* Along Keolu Drive, 3,451 linear feet of new 12-inch and 15-inch sewers and lateral connections were installed by mini (pilot tube)-microtunneling. Segments of the new sewer were underlain by highly compressible soils and consequently jet grout columns were drilled to support the pipeline.
- *Horizontal Directional Drilling.* Due to narrow easements and sewer profile constraints, the crossing under Kaelepulu Stream was designed and installed as an inverted siphon consisting of three pipelines, 8-, 10-, and 20-inch in diameter fusible PVC pipe by horizontal directional drilling (HDD).
- *Microtunneling.* Approximately 4,699 linear feet of the new 36-inch trunk sewer was installed primarily by microtunneling. The crossing under Kawainui Canal was constructed by microtunneling at shallow depths because of the existing wet well and gravity sewer profile. To reduce the potential for future maintenance dredging damaging the new sewer, the 36-inch internal diameter sewer pipe was initially designed to be installed inside a minimum 42-inch I.D. stainless steel jacking casing installed by microtunneling.
- *Jet Grouting.* Due to the presence of saturated, highly compressible lagoonal soils beneath portions of the sewer, ground improvement by means of jet grouting was necessary to stabilize segments of the microtunnel zones for control and steering of the microtunneling

boring machine to within the required tolerances for sewer profile and alignment, and to reduce the potential of the new sewer from sagging after installation due to future consolidation of the highly compressible subsoils.

- *Open Excavation.* Open excavation was necessary to connect the pipelines installed by HDD and microtunneling methods, installation of shallow by-pass lines, laterals connections, and installation of sewer manholes.

Design of large sewers in highly congested areas is not unusual. But none required innovations as a large sewer project in the middle of dense residential and commercial development in Kailua, Oahu. Reconstruction of 7,000 feet of a major trunk sewer was designed with often conflicting demands of environmentally sensitive wetlands, canal and stream crossings, and poor soil conditions.

Yogi Kwong Engineers defied conventional engineering wisdom using innovations in trenchless technology to solve these unique challenges.

- To solve pipe buoyancy problems during microtunneling under a stream, YKE designed an innovative partial steel bulkhead welded at each end of the steel casing section. The bulkheads formed a “bathtub” inside the casing where a specified amount of grout was temporarily pumped during installation to overcome buoyancy forces.
- Constrained by a narrow easement, installation of an inverted siphon under a stream by horizontal directional drilling (HDD) dictated pipe bending requirements which set the maximum size of the sewer pipe to 20 inches diameter, too small to carry the projected sewage flows. To meet these constraints, YKE bundled three fusible PVC pipe: a 20-inch sewer to carry the dry weather flow; a 10-inch pipe for the overflow from wet weather; and an 8-inch bypass pipe to allow cleaning of the 20- and 10-inch pipe. The design protected the small pipe from being crushed by the large pipe in the bundle during HDD pullback, and that pullback stresses were not exceeded for the weakest pipe.
- Pioneering use of mini-microtunneling in flowable sand under high pressure that could cause sinkholes and flooding during construction. Heretofore, mini-microtunneling under these conditions nullified the warranty of the microtunnel boring machine.

The entire sewer reconstruction was successfully completed on schedule and within budget, and avoided adverse impacts to the community and natural environment.

Project Owners: City and County of Honolulu, Department of Design and Construction

City and County of Honolulu, Department of Environmental Services

Design Team: Sato & Associates, Inc. (Sato) – Prime Consultant and Civil Engineer.

Yogi Kwong Engineers, LLC – Geotechnical and Trenchless Subconsultant to Sato & Associates, Inc.

Construction Manager: Bowers + Kubota Management (BKM) – Prime

Yogi Kwong Engineers, LLC – Subconsultant to BKM (trenchless construction and vibration monitoring)

Contractors: Frank Coluccio Construction Company (General, Microtunneling, Pilot Tube Microtunneling, Shaft and Sewer Construction and Jet Grouting)

Michels Directional Crossings, Inc. (Horizontal Directional Drilling)