Pearl City Force Main Repair

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The City and County of Honolulu (CCH) faced a serious public health and environmental problem with one of its large-diameter dual wastewater force main systems after experiencing four breaks between April 2006 and July 2010.

Pulling the new 24" Fusible C905 pipe into the borehole while working over existing meter station and Caltrans signalized intersection.

Site constraints included an uncovered electrical duct bank

All four breaks occurred within a 250-linear-foot section of the force main system. The failure locations were discovered to be near a fuel pipeline corridor with an aggressive cathodic protection system, in corrosive soils, and in tidally influenced groundwater levels.

The Limtiaco Consulting Group (TLCG) was contracted by CCH to design an immediate repair solution for a 1,200-plus-LF section of the dual force main in spite of the challenging and physically restraining site conditions.

Constructed in the late 1970s as part of a large-diameter dual wastewater force main system (comprised of ductile iron pipe of 30-inch, 36-inch and 42-inch diameters), the Pearl City Force Main (PCFM) serves an urban region of the CCH with daily maximum dry weather flow of approximately 27 million gallons per day (MGD) from the Pearl City Pump Station (PS) to a junction box located at the Waipahu PS where flow from the Waipahu SPS combines with the PCFM system.

While only one force main is needed during normal dry weather conditions, both force mains are utilized during wet weather conditions to accommodate peak flows as high as 47 MGD. The complexity of the system layout, including the addition of flows from the Waipahu PS, creates operational challenges. Pump throttling and valve adjustments require advance planning as flow from one PS directly affects the hydraulics of the other; essentially two pump stations are connected by one force main.

DESIGN

This project faced a number of design challenges from the very beginning. The force main system was constructed with unconventional bends (reportedly 74 degrees and 60 degrees) and very close together, near existing structures. The force mains were constructed in unstable and corrosive soil conditions. Due to the recent history of pipeline failures, the project had an accelerated schedule. Construction materials were subject to long lead times (typically six to eight weeks) because of Hawaii's remote location. Supporting a densely populated urban region of Honolulu, the force main system needed to remain operational during construction.

Several construction alternatives were evaluated during design: sliplining, CIPP (steam, water, and ultraviolet curing methods), HDD, tight-fit liners, and shallow-bury open-cut pipe replacement. The sliplining method using fusible PVC pipe was selected to meet the challenging site conditions and aggressive schedule.

The recommendation proposed to line the 30-inch host pipe with 24-inch fusible PVC pipe, while the 42-inch host pipe would be lined with a 36-inch fusible PVC pipe. Hydraulic analysis confirmed the reduction of inside diameter would have negligible effect, which met CCH criteria. To keep the aggressive schedule, a construction contract was awarded with pre-final design drawings with the understanding that engineering adjustments would be made as site assumptions and conditions changed during construction.

CONSTRUCTION

After the sewer bypass system was constructed, repair of the force main system proceeded from the upstream end. The contractor exposed the unconventional bends to confirm the angles and determine their condition. Fortunately, the bends appeared to be in good condition and a collaborative decision was made to retain them in place and restore the cathodic protection system. The design was modified with additional pipe fittings to accommodate the bends.

The contractor was required to clean and inspect the host pipe prior to sliplining. Initial investigations did not reveal any problems; however, a series of force main deflections were discovered during excavation of the entry pit. The deflections

Pulling Fusible C905 over the adjacent drainage channel and into the 30-inch force main

Receiving pit at existing 74-degree bend

were severe enough to threaten the sliplining recommendation. TLCG suggested testing the pipe deflections by pulling a sacrificial 20-foot pipe section through the host pipe. The test confirmed the host pipe deflections were not severe enough to prohibit sliplining and provided the contractor an opportunity to perform a practice run.

Site constraints had a big impact on this project. Proximity to the pump station and force main system alignment made it difficult for the contractor to make a direct insertion. Furthermore, during excavation of the entry pit the contractor uncovered a concrete electrical duct bank (not shown in location on as-builts). The duct bank turned out to be the main electrical feed for the pump station backup power. Interruption of the electrical feed or moving the pump station were not feasible options, so the contractor decided to bend the fusible PVC pipe around the pump station building and electrical duct bank, into the host pipe. To minimize the pipe deflection and assist with the sliplining process, the contractor extended the entry pit and used a pulling head on the fusible PVC pipe.

LESSONS LEARNED

Sliplining with fusible PVC was successful in repairing the dual force main section and restoring its service life. Post-construction review with CCH wastewater operators confirm the new fusible PVC pipes are performing well. The sliplined pipes have had negligible impacts to the system's hydraulic performance despite the inside-diameter reduction of the host pipes.

Awarding the project at pre-final design allowed for valuable contractor feedback when developing the final construction documents. The approach created an effective and efficient transition from design to construction. The process allowed the contractor to inventory materials and plan for long-lead items. TLCG emphasized a collaborative approach to foster productive relationships between the designer, contractor, and owner. This, in turn, opened communication lanes and expedited solutions when construction issues emerged. Technology innovation, design creativity and designer-contractor-owner teamwork were the pillars for this successful project.