

Unique Trenchless Solutions for Sewers in Southern California

By D. Craig Camp, Jacobs Associates

In his over 25-year career in underground construction, Craig Camp, Senior Engineer at Jacobs Associates, has handled over 80 trenchless projects, installing more than 200,000 feet of pipeline throughout the United States. Contractors, engineers, and project owners, both public and private, have called upon Mr. Camp to help resolve troubled trenchless issues. Two of his recent jobs, the Redwood Trunk Sewer in Oxnard, and Inverted Siphon No. 7 Replacement Design in Ojai, have received kudos from the American Public Works Association. Mr. Camp revisits his experience on these projects, as well as the Meiners Oaks Trunk Sewer crossing of the Ventura River in Ojai, which received an award from the Consulting Engineers and Land Surveyors of California.

A seasoned microtunneling expert, Mr. Camp has taught for the Colorado School of Mines Microtunneling Short Course. The North American Society for Trenchless Technology (NASTT) and American Society of Civil Engineers have published Mr. Camp's writings on "Fast Track Design and Installation of a 30-inch Casing Pipe Crossing the Ventura River" in their 2004 Proceedings for No-Dig and Pipelines, respectively. Mr. Camp holds a degree in Mining Engineering from the University of Idaho.

NASTT recently recognized Jacobs Associates with a NASTT 15th Anniversary Industry Achievement Award for "significant contributions to the development of technology and to the growth of the trenchless industry in the last 15 years." Jacobs Associates, an engineering consulting firm based on the United States West Coast, celebrates its 50th anniversary this year.

Redwood Trunk Sewer

This interceptor sewer, as originally envisioned, contained four major reaches for a total of approximately 45,000 feet. The southern two reaches, Redwood and Ventura, consisted of approximately 15,000 feet of 48 to 60-inch sewer, and 10,000 feet of 42-inch gravity sewer, respectively. The ground conditions consisted of flowing silts and sands at approximately 40 feet of depth with approximately 10 to 20 feet of groundwater above the sewer. The two northern reaches, Hemlock and Gonzales, consisted of 36 to 12-inch gravity sewers. The Hemlock reach comprises a gravity sewer and force main. The shallowest and smallest diameter gravity sewer portion faced ground conditions of dry sand. The larger diameter sewer faced similar ground conditions, but with groundwater approximating the tunnel horizon in some locations. The Hemlock reach faced flowing silts and sands with approximately 10 feet of groundwater. Additionally, in a few areas the ground contained refined petroleum products.

Jacobs Associates, as a subconsultant to Kennedy/Jenks, provided design services to evaluate trenchless design and construction alternatives. The design team determined early on that, due to the soil conditions, microtunneling likely would provide a cost benefit and reduce social impacts for the southern section. Final design confirmed that microtunneling offered clear cost, schedule, and



The Redwood Trunk Sewer brought relief to the growing City of Oxnard, California.

social benefits for the southern reaches. The northern reaches and the Hemlock reach bid as a separate, open trench construction contract with microtunneling as a viable option.

Final design consolidated the southern reaches, which in preliminary design listed four different diameters, into two diameters, thereby reducing the number of machines required for the project. Jacobs Associates' final design services included specifications for microtunneling, shaft construction, and ground movement monitoring; mark-up of drawings for constructability; and an engineer's estimate of microtunneling construction costs.

The design involved several details of note. The maximum distance between manholes measured 500 feet; the contractor had a choice to either complete 500-foot drives or drive 1,000 feet and install intermediate manholes. The railroad permitted the gravity sewer to pass under its tracks without a steel casing. Concrete-lined storm channels paralleled the deep sewer for several thousand feet. Additionally, the sewer passed under another storm channel. At



The Meiners Oaks Trunk Sewer Relocation alignment shows the existing sewer in red and new sewer in purple.

another location, sewer construction took place at the end of the airport, under the lake-off and landing pattern. The landing pattern required special operating parameters and hours, as the surface equipment stood in direct conflict with the aircraft.

The Redwood Trunk Sewer, which bid in late 2003, reached a price that confirmed this project as the largest microtunneling project in the North American market as measured by footage, and second largest as measured by bid price, \$33.4 million. This price fell in the midrange of the engineer's estimate. Construction utilized typical interlocking sheet pile jacking shafts with 20-foot long segments of Hobas jacking pipe. The microtunneling portion concluded in early 2006 after two years of construction. The Redwood Trunk Sewer received a 2005 Project of the Year award in the environment category from the American Public Works Association, Ventura County Chapter.

Meiners Oaks Trunk Sewer Relocation

Also known as the Ventura River Crossing, the Meiners Oaks Trunk Sewer Relocation called for replacement of approximately 5,000 feet of existing wastewater pipeline that parallels and also crosses the Ventura River in Ojai, California. Scour during river flows had put the existing pipeline at risk. The project owner, the Ojai Valley Sanitary District, requested an inverted siphon to replace the current sewer line, formerly constructed utilizing open-cut construction methods - an accepted practice at the time, but no longer preferable since the local riverbed became designated as an environmentally sensitive area. The replacement plan called for horizontal directional drilling (HDD).

A diagonal crossing design - the hypotenuse of a right triangle formed by the legs of the existing sewer - reduced the total footage of pipeline from approximately 5,000 to 3,000 feet. At each end of the crossing, connections to the existing pipeline included facilities for sending and receiving pigs. The crossing, designed to act as an inverted siphon, featured an HDD design, which had the added benefit of improving the system hydraulics for this reach of gravity sewer. The inverted siphon design comprised three 10- to 12-inch diameter HDPE carrier pipes, and three 2-inch diameter HDPE conduits, installed within a steel casing. Structures at each end transitioned the flow based upon flow volume in order for the inverted siphon to operate. Jacobs Associates, as a subconsultant to Boyle Engineering, provided engineering support services to facilitate final design of the project. These services include assistance in eval-

uating geotechnical impacts, HDD plan and profile, technical specifications, cost estimating for the HDD crossing, and risk management. Follow-on services included construction monitoring and inspection. The project's cost estimate rang in at approximately \$2.5 million.

Before commencing with the pilot hole drilling, steel surface casing had stabilized the entrance hole and its surrounding alluvium, which consisted of mostly sand cobbles and boulders. As an additional benefit, the surface casing fulfilled Caltrans' requirement for a steel casing under their roadway. Installation via pipe ramming

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drove the surface casing approximately 100 feet. The oversized, 48-inch casing allowed an additional, 30-inch casing to be driven inside, in the event that the first casing installation failed. The drill path then advanced from the upstream end to the downstream end, and the HDD rig re-mobilized and moved to the downstream end. The back reaming and pullback took place from the downstream end. Assembly of the steel casing and HDPE carriers occurred on the upstream end, which could accommodate the 3,000-foot-long pipelines, laid out behind the hole.

The project design accounted for the line to have one carrier to accommodate normal flow, a second for wet weather flow, and a third in the event that one of the other two carriers became disabled. A 30-inch steel casing enclosed all three carriers.



A test pit at Meiners Oaks reveals sand cobbles and boulders.



A 30" steel casing, pulled through 48" surface casing into the hole.

Construction of the Meiners Oaks Trunk Sewer Relocation finished within budget and schedule. The entire project, from initiation of design through completion of the HDD installation, lasted approximately one year. The Consulting Engineers and Land Surveyors of California pinned the job with an Engineering Excellence Merit Award in 2005.

Inverted Siphon No. 7 Replacement Design

Due to the success of the Meiners Oaks Trunk Sewer Relocation, the Ojai Valley Sanitation District requested that replacement of

the San Antonio Creek Sewer also use HDD. This sewer required replacement due to a washout, which destroyed the area immediately east of the San Antonio Creek and exposed the downstream end of the sewer. The District uses inverted siphons as a common crossing tool and has developed a vertical profile and hydraulic flow requirements that have proven successful over years of operations. The design requires one carrier for daily peak flows and a second carrier to accommodate wet weather flows. The downstream end of the inverted siphon, typically less steep than the upstream end, lies between 8 and 10 degrees.

The new sewer consists of a 12-inch interior diameter carrier pipe for an inverted siphon, installed with directional drilling methods for approximately 1,200 feet. The project included a second line parallel to and near this alignment. Installation of the second carrier, approximately the same size as the first, would use the same profile and right of way. The contractor had the choice of one drill path with two carriers installed in one hole, or two parallel drill paths, one for each carrier.

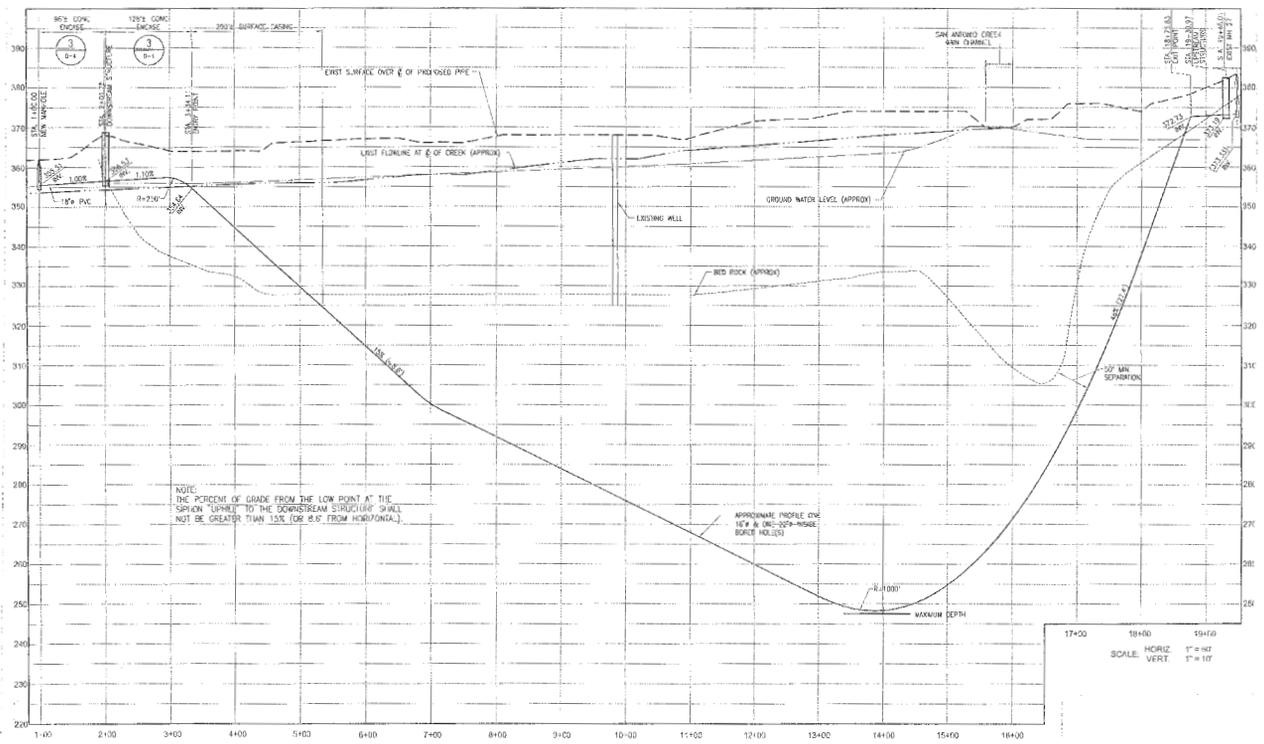


The Inverted Siphon No. 7 Replacement alignment shows the existing sewer in green and new sewer in red.

The drill path, designed to stay in the formational rock and avoid the riverbed materials, advanced from the downstream end to the upstream end. This path proceeded at approximately 8 to 10 degrees through fill, placed due to the recent washout, into river alluvium and then formational claystone. A steel surface casing, installed by pipe ramming through the fill and alluvium, prevented collapse of the hole. The entrance angle, kept at approximately 8 to 10 degrees, accounted for favorable siphon hydraulics and provided maximum velocity for cleaning. The upstream side of the project required a steep exit angle in order to create the tie-in point between the river and the roadway. The contractor elected to complete the project with two parallel drill paths and pulled the carrier pipes in from the upstream to downstream side as three long segments, with the segments joined together as the carrier pipe was installed.

From design through construction, the project wrapped up within one year. Jacobs Associates, as a subconsultant to Boyle Engineering, provided HDD design services, including a Geotechnical Baseline Report to assist with the bidding of this fast-track design project. The American Public Works Association, Ventura County Chapter, awarded the Inverted Siphon No. 7 Replacement with a 2005 Project of the Year in the disasters and emergency construction category.

For further information or project inquiries, please call Jacobs and Associates at 415.249.8209 or visit their website at www.jacobssf.com



A profile of the Inverted Siphon No. 7 Replacement illustrates a steep exit angle for the drill path.

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