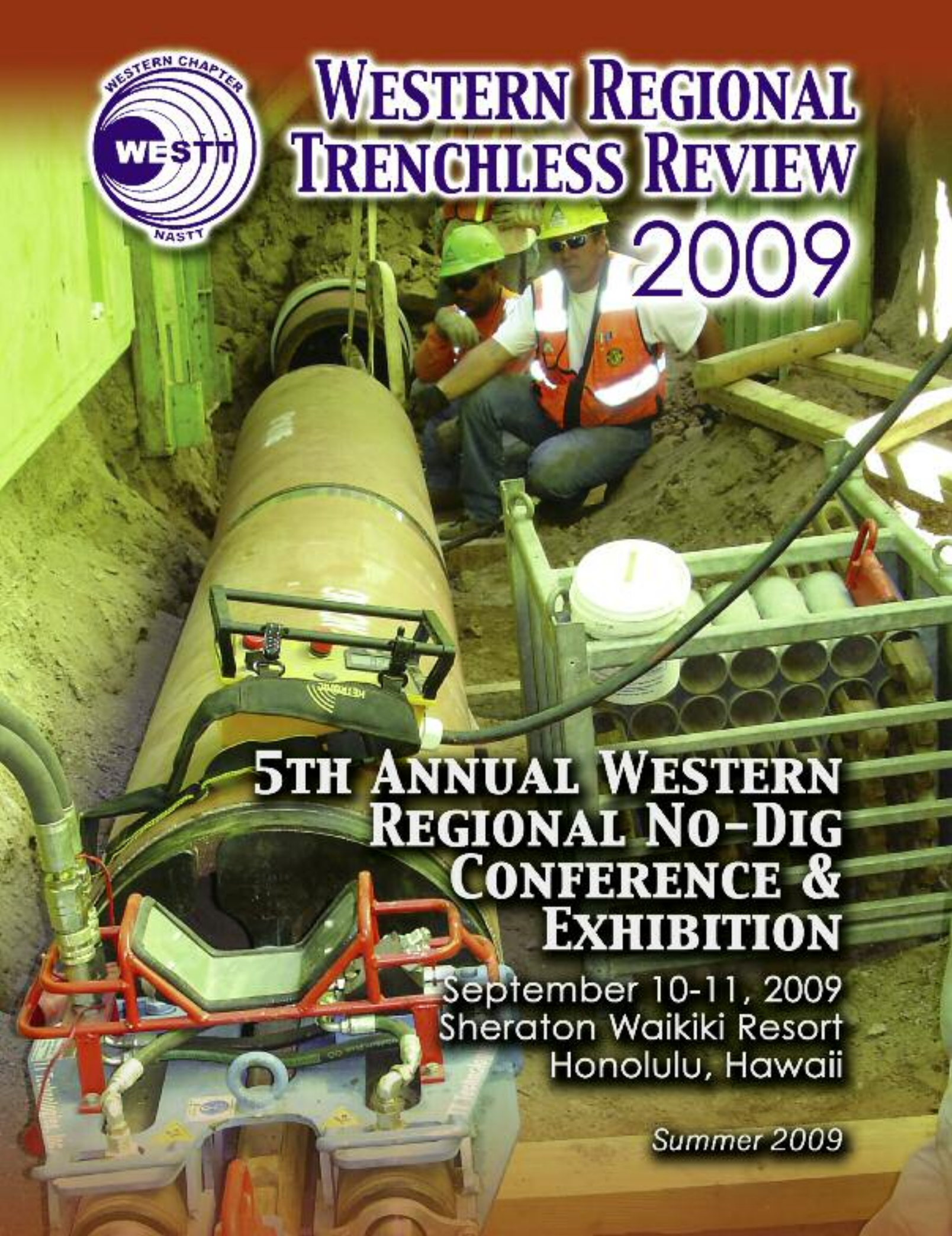

Western Regional Trenchless Review 2009

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A Trenchless First in Phoenix:

Static Pipe Bursting Teams With NO-DIG VCP

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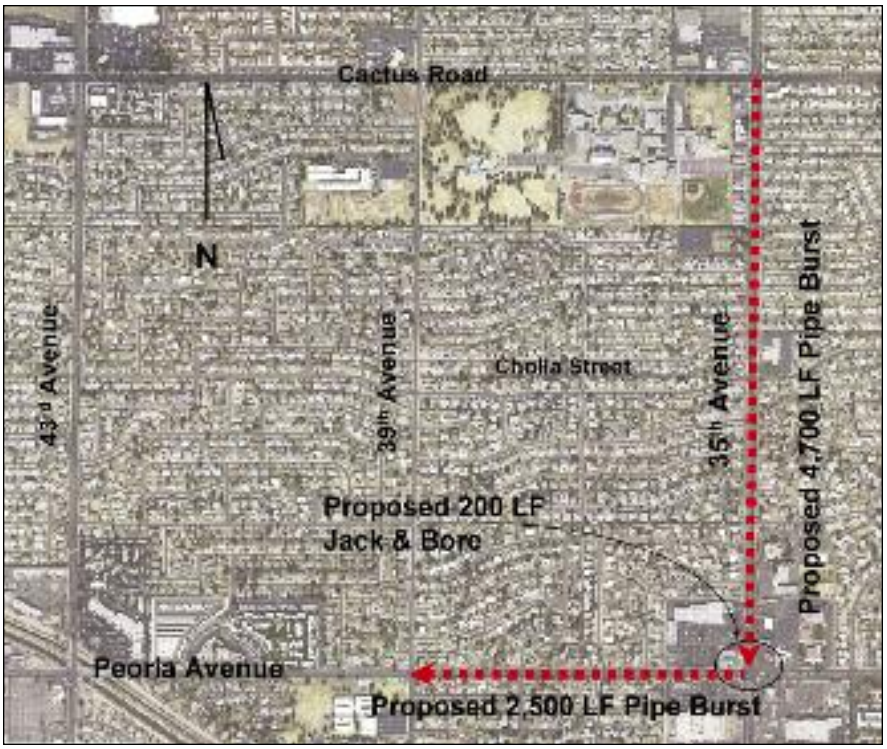
The city of Phoenix, Ariz., recently undertook a large-scale sanitary sewer static pipe bursting program utilizing vitrified clay (VCP) jacking pipe as the replacement pipe material. The GMP for the project was $5,323,524.05. This project represents one of the most significant uses of the static pipe bursting method with new replacement VCP jacking pipe and demonstrates a commendable level of cooperation between equipment manufacturer, product pipe manufacturer, contractor, engineering firm and municipality.

The city of Phoenix has been experiencing tremendous population growth in recent years, as part of the growing southwest region of the country. This growth has taxed their collection system. The addition of the new I/I design requirements, coupled with the recent population growth and calibration of their sewer model, indicated that the city's collection system would require immediate upgrades in many locations.

The Sanitary Sewer Relief and

Peoria Avenue Pipe Burst– 375 mm (15 inch) to 450 mm (18 inch) VCP



Project Site Map

Replacement Program was developed to tackle these issues. Full pipe replacement and upsizing, diversions and other techniques were considered as solutions to this potential capacity deficiency. The use of trenchless technologies was determined to be a suitable alternative approach to minimize the impact created by all of these construction projects. Pipe bursting was chosen to fulfill the need for upsizing these capacity deficient pipes without open trenching their streets.

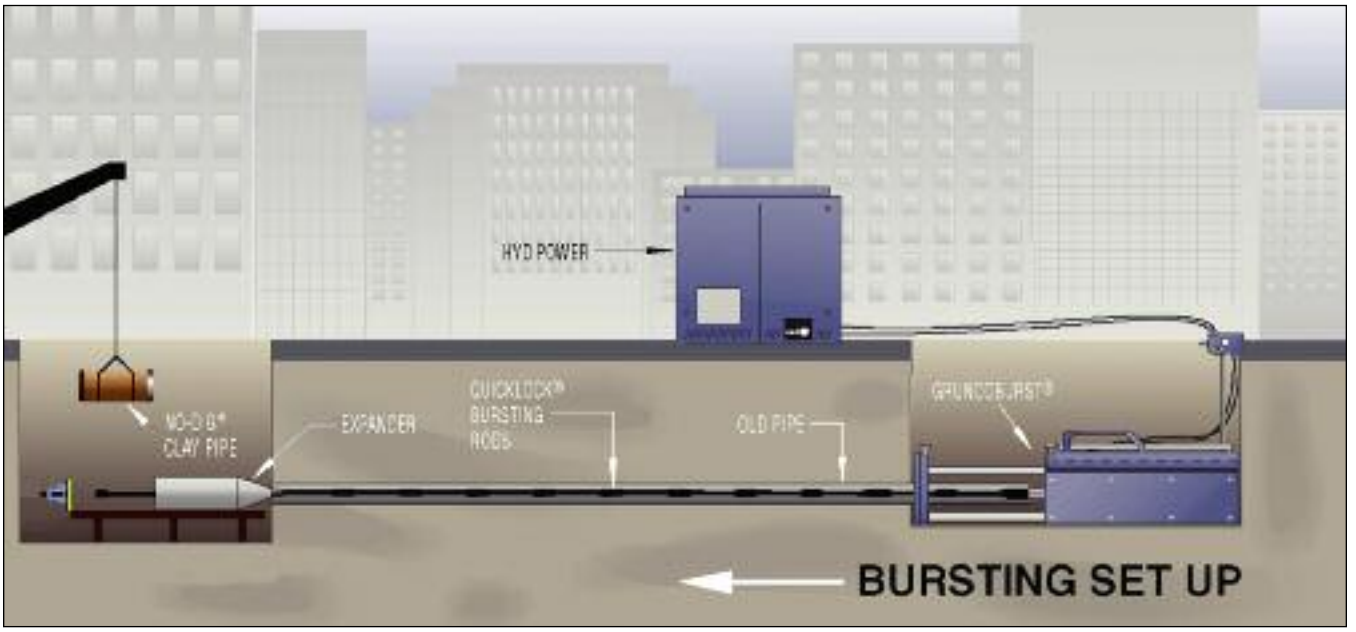
PROJECT DETAILS

The total project consisted of upsizing of nearly 6,400 linear feet of 12- and 15-inch pipe with a 10- to 20-foot depth within major streets with the usual multitude of utilities. Trenchless equipment manufacturer TT Technologies, Aurora, Ill., provided the Grundoburst static pipe bursting equipment and technical instruction during the design and construction phases. Mission Clay Products, Corona, Calif., supplied the 15- and 18-inch No-Dig VCP, which the city preferred.

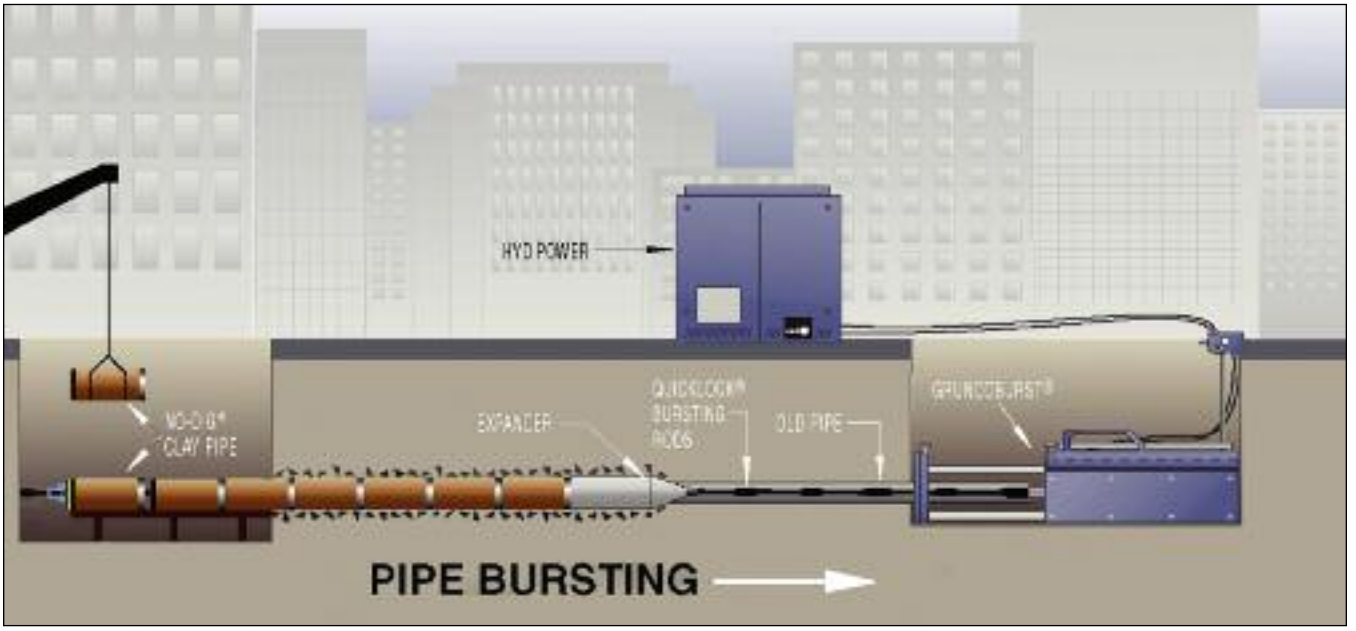
One of the first sections replaced included bursting and replacing 3,938 feet of existing 12-inch VCP with 18-inch VCP. The existing sewer line's capacity had been exceeded due to growth of the surrounding area. The utility corridor encompassing the existing line was congested with other utilities making open cut construction challenging. Trenchless pipe bursting was ultimately chosen because of the adjacent utilities and concern of traffic disruption. Soil conditions in the area proved to be one of the biggest challenges. The original pipe to be burst was bedded in a soft, dry, silty sand material and installed in a trench width ranging from 3 to 5 feet depending on depth. Existing trench depths range from 10 to 20 feet deep.

Dry, dense soil conditions adjacent to the existing trench and the existing sewer pipe alignments, among other minor obstacles, caused some production issues. However, pipe bursting has proven to be a cost effective process for upsizing capacity deficient sewers with VCP.

Utilizing segmented pipe eliminates the need for a long laydown area on the project site as would be required with welded pipe. This is highly beneficial in high-traffic urban settings. Long strings of welded pipe are not inhibiting traffic flow before the bursting operation begins. This is commonly referred to as the cartridge loading method and keeps the jobsite footprint relatively small and compact. This same technique is successful when pulling other types of sectional pipe such as ductile iron and others.



Bursting Operation – Steps One & Two



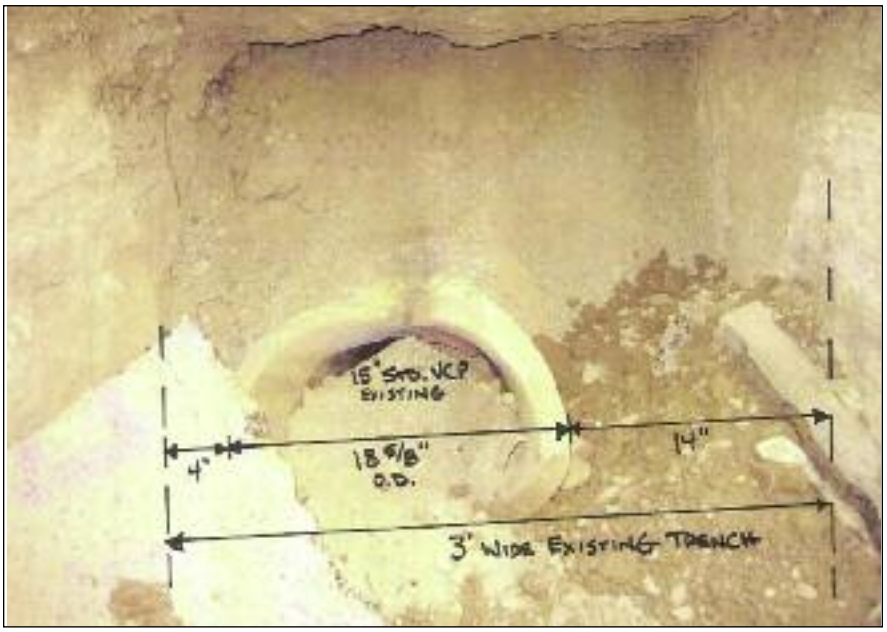
Bursting Operation – Step Three

Traffic control was not a major issue during the pipe bursting operation. The city's traffic operations worked with the contractor, allowing some freedom during non-peak times for better and faster movement. The engineer had a full-time inspector dedicated to the project and the team met weekly to review work completed and the look-ahead schedule.

STATIC BURSTING WITH VCP

Static pipe bursting equipment has been around the industry for many years. Over time the equipment has evolved from a cable-pulled bursting head to a more sophisticated system that uses a system of interlocked rods to pull the bursting head. The rigid rods do not stretch under heavy pulling as a cable would. This becomes particularly crucial when bursting with sectional pipes such as No-Dig VCP.

Mission Clay Products first introduced No-Dig vitrified clay jacking pipe in 1992. Vitrified clay pipe is manufactured from 100% natural materials, a blend of clays, shales and slate. No-Dig



Existing pipe off-center in original 1 m (3 ft) excavation

vitrified clay jacking pipe has been the predominant jacking pipe material used in the 8-inch thru 36-inch size range due to its high compressive strength (18,000 psi average), low-profile zero-leakage joint, affordability in the typical 1 or 2 meter pipe lengths, and elimination of an external casing pipe.

For this particular project in Phoenix, the bursting equipment was designed and assembled for the specific purpose of bursting the existing VCP and towing in the new, non-restrained joint VCP. Because the pipe sections are pushed together with restraint, the bursting system was designed to push each pipe joint home and keep the column of assembled pipe sections in compression during bursting. As the bursting head is pulled forward, fracturing the existing VCP and expanding the fragments into the backfill, the rear cylinder pack, called a squeezer, with pressure plate keep the assembled pipe sections under compression so the joints remain tight.

GrundoburstR 2500G and extraction cage in receiving pit

Equipment included the world's highest capacity static bursting machine, the Grundoburst 2500G from TT Technologies. This machine is capable of pulling up to 315 tons. It would prove necessary to use virtually all of the machine's capacity in the difficult soil conditions encountered on the project.

ON THE JOB

Project Engineering Consultants (PEC) of Phoenix was one of eight engineering firms selected for this program. PEC worked closely with utility contractor Kiewit Western, Omaha, Neb, to develop an innovative approach to increase the capacity deficiencies with minimal socio-economic impact. The pipe handling, assembly and bursting plan worked very well when put into operation. The project superintendent spent the first couple of bursts working in the excavations with the crew, ensuring he fully understood what was needed and how to pass proper meaningful instructions onto the crew as the project progressed.

Launch and receiving pits were located in areas where existing manholes were to be replaced. The manholes were located at approximately 400-foot intervals. The pits were adequately shored with trench boxes to stabilize the walls of the pit. This provided a safe environment for workers and ample room for equipment and pipe. The bursting equipment

24 inch OD expander followed by new 18 inch VCP jacking pipe on arrival into the receiver

could easily be rotated 180 degrees in the launching pit and begin bursting pipe from the opposite direction.

The Grundoburst 2500G machine utilizes Quicklock rods. The rods were connected to a special expander for 18-inch VCP (22.14-inch O.D.) The expander O.D. was 24 inches. The expander had a special internal socket arrangement for the lead piece of VCP to butt against. As sections of pipe were installed additional Quicklock rods were added to the trail end of the expander and then the new pipe section was slipped over the rods.

First, the cylinder pack (squeezer) with pressure plate was pinned to the rods. Then it was hydraulically energized to push the pipe joint fully home and then it would hold the assemble pipe sections in compression as the pipe bursting expander was pulled forward by the 2500G. The cylinder pack provided 40 tons of force to keep the assembled pipe segments in compression as the bursting head was pulled toward the static pipe bursting machine.

Cycle times for each section of pipe to be assembled and pulled forward during bursting began at an average rate of 1 foot per minute. As the project progressed, the crew became much more efficient resulting in average rate of 2 feet per minute. Thus, a typical 350 linear foot reach was completed in 2 to 3 hours or so.

PROJECT REVIEW

Generally, the pipe bursting went smoothly considering the conditions that had to be overcome. Some of the most challenging conditions and short sections had to be hand laid. Without the additional soils information in the trench zone, the operation ran into an area where the pipe was capped by slurry. It appeared to be low strength because the bursting operation pulled through much of it. But, in a couple of instances, the head could not burst through and the operation switched to open cut until they passed the area with slurry. The pipe bursting was then restarted again.

It was the most economical choice for the contractor to be able to pipe burst and avoid open cut because they could obtain much higher production with pipe bursting. When they would come upon these conditions, pressures exceeded the limits of the machine and it was mutually decided to open cut those portions.

Based just upon the cost differential between conventional open cut and pipe bursting, pipe bursting wins handily. This amounted to $2.6 million or over 30% savings to the City of Phoenix. The contractor opted for open cut over pipe bursting in a few locations; however in some instances, where open-cut was called for, they chose pipe bursting. Pipe production via pipe bursting exceeded everyone's expectations. However, in some instances, where unknown concrete caps or harder soil conditions were encountered, production using pipe bursting slowed and eventually resulted in an open cut excavation. For the most part, the static push-pull segmented pipe bursting technology using No-Dig VCP proved to be very successful.

350 kN (40 ton) Cylinder Pack