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ONE PROJECT, FOUR TRENCHLESS METHODS

Marc Gelinas[1], Dave Mathy[1], Juni Rotter[2], Stacy Creviston[3], Parastou Hooshialsadat[3], Mark Soldati[3], and John Jay Winzler[3]

[1] DCM/GeoEngineers, Walnut Creek, CA
[2] Alameda County Water District, Fremont, CA
[3] Winzler & Kelly, Santa Rosa, CA

ABSTRACT:

The Alameda County Water District recently completed the construction of over 9,100 linear feet of 16- and 22-inch diameter water pipeline through residential neighborhoods and commercial/industrial areas of the cities of Fremont and Newark, California. Along its alignment, the project pipeline crossed under the Hetch-Hetchy Aqueduct (a major water supply transmission pipeline for the City of San Francisco and surrounding communities), several major arterial roadways, two flood control channels, and Interstate 880. The majority of the project pipeline was constructed by open-cut trenching; however, site specific geotechnical and operational concerns (e.g., existing utilities, space constraints, etc.) at critical project undercrossings warranted the evaluation and eventual selection and use of four different trenchless construction methods. Trenchless construction methods that were evaluated and utilized include microtunneling, horizontal directional drilling, auger bore and jack tunneling, and pilot tube guided boring.

The paper will present case histories for four of the project undercrossings, discussing: why specific trenchless construction methods were selected for the individual crossings; the design measures that were implemented to account for specific subsurface conditions (e.g., high groundwater table, flowing ground, contamination, etc.); issues that arose during construction; and how construction-related issues were resolved.

1. INTRODUCTION

1.1 The Alameda County Water District

The Alameda County Water District (the District) is a retail water purveyor that serves a population of approximately 328,000 within the cities of Fremont, Newark and Union City, in southwestern Alameda County. The District's service area encompasses approximately 103 square miles.

The District's existing sources of supply include State of California Project Water, San Francisco Public Utilities Commission (SFPUC) Hetch Hetchy aqueduct and the Alameda Creek Watershed. The District's existing facilities that produce and distribute potable water include two surface water treatment plants, one groundwater blending facility, one brackish groundwater desalination facility, eight takeoffs from SFPUC Hetch Hetchy aqueduct, five potable water storage tanks, six potable water storage reservoirs and 825 miles of pipeline. The District's customer water use is comprised of 13% business, 10%

industrial, 70% residential and 7% miscellaneous. The District has a total of 79,620 customers. The average daily production rate is approximately 49 million gallons per day (MGD).

1.2 The ARP Wells to Desal Pipelines Phase 2 Project

The District had an existing 5 MGD desalination facility, the Newark Desalination Facility (NDF), which was scheduled to be expanded to 10 MGD. In order to accommodate the expansion, new pipelines were required to convey an additional 5 MGD of brackish supply water from existing Aquifer Reclamation Program (ARP) wells to the NDF. The pipeline construction was completed in two phases. Phase 1 of pipeline construction was completed in 2003, connecting two existing ARP wells to the NDF. The subject of this paper is Phase 2 of pipeline construction which connected two additional ARP wells (Farwell and Bellflower) to the Phase 1 pipelines.

The District initially retained the services of Winzler & Kelly and DCM/GeoEngineers in January 2007 to assist with the planning and design of the Phase 2 project. Three different alignment alternatives for connecting the Farwell and Bellflower ARP wells to the existing Phase I pipelines were evaluated for necessary easement and/or license agreement acquisition, permits required, constructability and special construction considerations, and cost. The final Phase 2 project alignment consisted of the installation of approximately 5,900 linear feet of 22-inch and 3,200 linear feet of 16-inch diameter high density polyethylene (HDPE) pipe within the cities of Fremont and Newark, California.

1.3 Key Project Undercrossings

The majority of the pipeline construction for the Phase 2 project was completed by open-cut trenching at relatively shallow depths. However, the final Phase 2 project alignment included several key undercrossings, including undercrossings of Interstate 880 (an 8-lane, highly travelled highway), major arterial roadways, flood control channels, and critical utilities. At these key undercrossing locations, open-cut trenching was either highly discouraged or prohibited by governing agencies, or considered too costly or risky given site-specific design constraints and geotechnical conditions. As a result, trenchless construction methods were evaluated and used for each of the key project undercrossings.

1.4 Geologic Setting

The project area is located on the western downslope side of the East Bay Hills and just east of San Francisco Bay. The East Bay Hills are part of California’s north-central Coast Ranges, a northwest trending belt of actively faulted and folded hills and valleys. The project alignment is located approximately 3.5 miles east of the eastern shore of San Francisco Bay and 3.5 miles west of the East Bay foothills and specifically Niles Canyon. Topography varies from Elevation 100 at the mouth of Niles Canyon to Elevation 0 (i.e., sea level) at the Bayshore margin. The ground surface along the project alignment is at an average of Elevation 34. Soils along the project alignment were deposited near the distant end of a several hundred foot thick alluvial fan known as the Niles Cone. The Niles Cone is a broad alluvial fan deposited by Alameda Creek over thousands of years.

This alluvial sequence was deposited in a combination of floodplain deposits (typically clays) and alluvial fan deposits (typically sands). Over time, Alameda Creek has migrated back and forth across the broad alluvial fan located between the East Bay Hills and the San Francisco Bay in response to sea level changes. Consequently, the subsurface profile along the project alignment consists of a laterally variable, interbedded series of floodplain and alluvial fan soil deposits. Therefore, soil and groundwater conditions along the project alignment were expected to vary with depth and over short distances from predominantly cohesive clay to non-cohesive sand.

Groundwater levels along the project alignment were known to be shallow, typically on the order of 7 to 10 feet below ground surface. Groundwater levels were also known to fluctuate seasonally in the project area, with groundwater levels on the order of 5 feet below ground surface not uncommon during the winter rainy months.

1.5 Trenchless Methods Considered for Key Project Undercrossings

Trenchless methods that were considered for the key project undercrossings included microtunnel pipe jacking (microtunneling), horizontal directional drilling (HDD), conventional (unguided) auger bore and jack tunneling (ABJ), and pilot tube guided boring (PTGB). All four of these methods have a proven track record in the San Francisco Bay Area, with many local, experienced contractors. Of the four methods, only HDD allowed direct installation of the fused HDPE water pipeline. All of the other trenchless methods considered required the installation of a steel casing pipe within which the water pipeline was installed.

2.0 UNDERCROSSING CASE HISTORIES

In the following sections, brief case histories will be presented for four of the key project trenchless undercrossings. Each case, whether due to design constraints, geotechnical conditions or other factors (e.g., cost, construction issues), used a different trenchless construction method. For each case history, the general crossing parameters will be summarized and key design and geotechnical constraints and challenges will be discussed providing the rationale for the initial trenchless method selected for design. Finally, construction challenges will be detailed and the construction costs and schedule will be presented.

2.1 Interstate 880 Undercrossing

The Interstate 880 (I-880) undercrossing required the installation of approximately 282 linear feet of 36-inch diameter steel casing pipe by microtunneling. Following completion of the casing installation by microtunneling, the 22-inch diameter HDPE water pipe and a 2-inch diameter fiber optic conduit was installed within the casing.

2.1.1 Design Constraints and Challenges

Caltrans permitting requirements typically prohibit any open-cut construction within their right-of-way, require pipelines to make perpendicular crossings, require pressurized pipelines to be installed within casings, and require pipeline installations greater than 25 inches in diameter to have a minimum of 15 feet of cover.

Caltrans constraints aside, the major design challenge at this crossing was the tight working area. The pipeline traversed along a flood control channel and was bounded by a residential neighborhood on one side of I-880 and an industrial area on the other side (see Figure 1). Site constraints prevented the District from providing a staging or laydown area for the undercrossing. All work was to be completely within the limits of the flood control channel right of way. It was the responsibility of the Contractor to determine the extent of their needs and then approach the adjacent property owners for access. The Contractor was able to negotiate an agreement with an adjacent equipment rental company to use some of their property as a laydown and staging area for the microtunnel equipment.

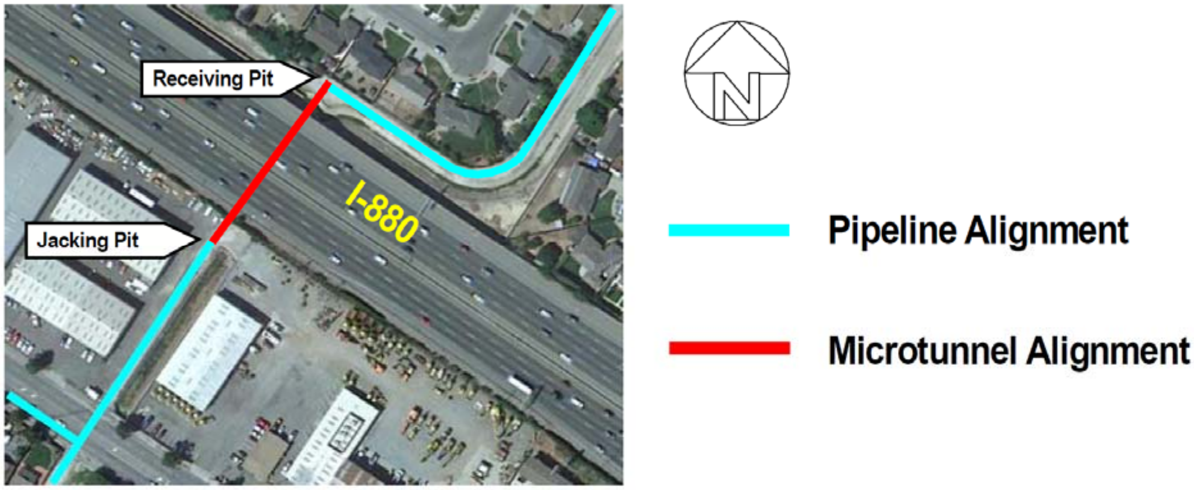

FIGURE 1 - I-880 Undercrossing Alignment (Image: Google Earth Pro, 2009)

2.1.2 Geotechnical Conditions and Challenges

Soil conditions at the I-880 undercrossing consisted of saturated medium stiff to stiff lean clay (CL), stiff sandy silt (ML), loose to medium dense and dense to very dense silty sand (SM), and loose clayey sand (SC). Groundwater levels were approximately 8 to 10 feet above the anticipated casing invert. Tunnel zone soils were anticipated to exhibit a wide range of behaviors, including firm, raveling, fast raveling and flowing, with flowing ground conditions being the most problematic.

2.1.3 Trenchless Method Selection

Given the presence of flowing ground conditions within the anticipated tunnel zone and the inability to dewater the tunnel zone due to the overlying highway, both ABJ and PTGB were not considered feasible. ABJ and PTGB are open-face tunneling methods which cannot control flowing ground. The requirements from Caltrans for a cased and perpendicular crossing eliminated HDD from consideration as the minimum required length for an HDD crossing (due to minimum bending radius constraints for the casing pipe) would have been in excess of 1,500 feet, and a maximum of 650 feet of alignment was available for the crossing. By comparison, microtunneling could easily operate within the site space restrictions and with its ability to exert positive pressure at the tunnel face and control flowing ground, microtunneling was ideally suited to the crossing and was therefore selected.

2.1.4 Construction Challenges

One of the most significant challenges for the I-880 undercrossing was construction of the jacking and receiving pits. Although advised about high groundwater levels and flowing ground conditions, and the associated need for jacking and receiving pits to be either water-tight or externally dewatered in advance of construction, the Contractor attempted to construct the jacking pit using a non water-tight slide rail shoring system with an internal (sump pump) dewatering system. While excavating the jacking pit, the Contractor encountered significant difficulties with pit bottom boiling, and was forced to backfill the pit. Subsequently, the jacking pit was redesigned to be water-tight (that is, the pit was redesigned using fully interlocked steel sheet piles with toe embedment for groundwater cutoff), and was successfully completed.

Despite the success of the water-tight sheet pile shoring system at the jacking pit, the Contractor subsequently attempted to construct the receiving pit using a non water-tight slide rail shoring with an internal (sump pump) dewatering system. While the contractor was able to successfully install the slide rail shoring to the intended depth, the bottom of the pit immediately began to develop sand boils (see

Figure 2A), and groundwater with sand and fines was observed coming in through the corners and seams of the pit sidewalls. Extensive pit bottom compaction grouting eventually eliminated the major boils and slowed the inflows of water into the pit enough that it could be used to receive the microtunnel boring machine (MTBM). However, delays associated with compaction grouting caused tunneling operations to be temporarily halted. In addition, an estimated 20+ cubic yards of sand and fines was lost into the pit, resulting in a settlement trough around the perimeter of the pit (see Figure 2 B). As stated above, the Contractor performed compaction grouting to fill the voids and restored the area to its original condition.

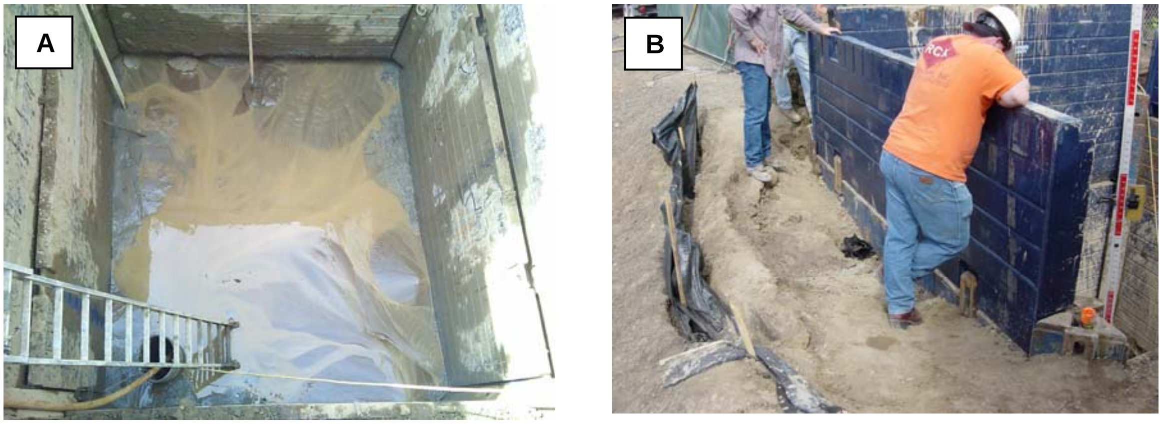

FIGURE 2 - A) Sand Boils in the Receiving Pit Base and B) Settlement at the Surface of the Receiving Pit

Another challenge that arose during microtunnel construction was the apparent settlement of a subsurface settlement monitoring point established over the center of the tunnel alignment, approximately 20 feet from the jacking shaft. The monitoring point had been established to verify that the MTBM was not overmining soils and possibly causing systemic surface settlement before the MTBM entered underneath the travelled portion of I-880. Before launching the MTBM, the position of the subsurface settlement monument was surveyed, establishing a baseline reading. The day after launching the MTBM and trailing can sections, the subsurface monitoring point was again surveyed and had apparently settled on the order of 12 inches. Based on review of MTBM records, the microtunneling contractor did not think the MTBM was overmining, and suggested that the subsurface monitoring point had either been incorrectly installed (that is, had settled due to improper installation) or had been incorrectly surveyed. After independently reviewing the MTBM records and spoils truck weigh tags and not observing any evidence of overmining, the microtunneling contractor was authorized to proceed. The volume of spoils being removed from the tunnel zone was carefully monitored and compared to the volume of the tunnel for the remainder of the installation with no evidence of overmining. The subsurface monitoring point was also surveyed daily, with no further evidence of movement.

2.1.5 Construction Cost and Schedule

The construction cost for the I-880 undercrossing, including change orders, was approximately $720,000. Of this, $464,653 was the cost for the casing installation by microtunneling. Casing installation was completed in 9 days, not including excavation of the pits, water pipe and fiber optic conduit installation or backfill of the pits.

2.2 Hetch Hetchy Aqueducts Undercrossing

The Hetch Hetchy Aqueducts undercrossing required the installation of approximately 160 linear feet of 30-inch diameter steel casing pipe by ABJ. Following completion of the casing installation by ABJ, the 16-inch diameter HDPE water pipe and a 2-inch diameter fiber optic conduit was installed within the casing.

2.2.1 Design Constraints and Challenges

The 60-inch and 66-inch diameter Hetch-Hetchy Aqueducts deliver the major water supply for San Francisco and surrounding communities, and therefore any disruption to these pipeline could not be tolerated. The San Francisco Public Utilities Commission (SFPUC) did not require that trenchless construction be utilized within their right-of-way, but the depths of the existing pipelines did not provide enough cover to allow for open-trench construction over the top of the pipelines (see Figure 3). As a result, a trenchless undercrossing was necessary.

Another significant challenge was the proposed new SFPUC Bay Division Pipeline #5 (BDPL#5) to be constructed at this crossing. During the design phase, SFPUC's final design plans were not completed, and the District's pipeline alignment was established based on verbal information provided by SFPUC.

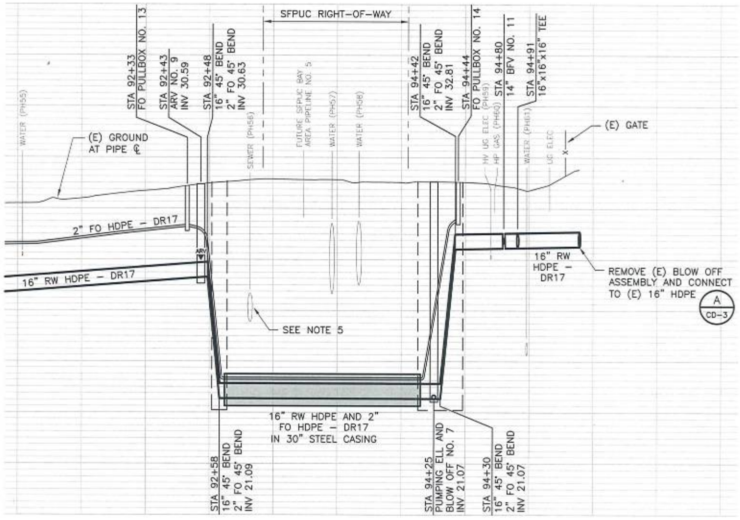

FIGURE 3 - Hetch Hetchy Aqueduct Undercrossing Profile

2.2.2 Geotechnical Conditions and Challenges

Soil conditions at the Hetch Hetchy undercrossing consisted of soft to medium stiff lean clay (CL). Groundwater levels (measured during the dry summer months) were approximately at or slightly below the anticipated casing invert. Tunnel zone soils were anticipated to exhibit firm to squeezing behavior.

2.2.3 Trenchless Method Selection

Of the trenchless methods considered, microtunneling was not considered practical or cost effective for this crossing due to its short length, and the likelihood that the tunnel zone would be at or above the groundwater level. HDD, while feasible from a geotechnical standpoint, was not considered practical or cost effective due to the need to significantly increase the overall length of the crossing in order to obtain the necessary setbacks to be able to achieve the required bore depth beneath the aqueducts. In addition, at the time a trenchless method was selected for design, it was uncertain whether SFPUC would require the crossing to be cased within their right of way. The need to case the installation would have further increased the length of the HDD installation, making it even less practical/cost effective.

Given the short length of the crossing at approximately 160 feet, the presence of firm to squeezing soils, and the likelihood that the tunnel zone would either be at or above the groundwater table (or could be relatively easily dewatered), ABJ and PTGAB were considered the two most appropriate trenchless methods. Of the two methods, ABJ was selected over PTGB based mainly on an assessment that more contractors would be available to bid the crossing, and that it would be the lower cost alternative.

2.2.4 Construction Challenges

During construction, plans were received by the District from SFPUC that unexpectedly showed the invert of the new BDPL#5 to be approximately 2 feet above the top of the new 30-inch casing. It was decided to lower the District's pipeline 1 foot to allow more clearance between the ACWD casing and SFPUC pipeline. This resulted in a change order for additional time and material for the excavation of the jacking and receiving pits 1 foot deeper than shown on the original drawings. This change did not affect the cost of the ABJ as the installation length did not change. Casing installation by ABJ proceeded without incident.

2.2.5 Construction Cost and Schedule

The construction cost for the Hetch Hetchy undercrossing was approximately $220,000. Of this, $79,560 was the cost for the casing installation by ABJ. Casing installation was completed in 5 days, not including excavation of the pits, water pipe and fiber optic conduit installation or backfill of the pits.

2.3 Central Avenue Undercrossing

The Central Avenue undercrossing required the installation of approximately 378 linear feet of 22-inch diameter HDPE water pipe and 2-inch diameter fiber optic conduit by HDD.

2.3.1 Design Constraints and Challenges

The City of Newark prohibited open-cut construction along Cedar Boulevard at the Central Avenue intersection because it is a major arterial road and they wanted to minimize disruption to traffic flow. The street had also been overlaid approximately 6 years prior to the project, so pavement condition was also a factor in the trenchless requirement.

There were several existing utilities in Central Avenue including gas, water, storm drain, sanitary sewer, fiber optic, telephone, cable, and electric, all which needed to be avoided by the new pipeline. As a result, the depth of the undercrossing was initially set at approximately 15 feet below the ground surface.

2.3.2 Geotechnical Conditions and Challenges

Soil conditions at the Central Avenue undercrossing consisted of soft to stiff lean clay (CL) with varying amounts of sand and silt, and very loose to medium dense silty and clayey sands (SM and SC). Groundwater levels were approximately 5 to 6 feet above the anticipated water pipeline invert. Alignment soils were anticipated to exhibit firm to squeezing (clays) and flowing (sands) behavior.

2.3.3 Trenchless Method Selection

Given the presence of flowing ground conditions within the anticipated tunnel zone, and the inability to dewater the tunnel zone due to the overlying roadway, both ABJ and PTGB were not considered feasible. ABJ and PTGB are open-face tunneling methods which cannot control flowing ground. Microtunneling, while ideally suited to flowing ground would have required the installation of water-tight or dewatered shafts, as well as the use of a casing pipe, and was not considered cost-effective. HDD, like microtunneling, can be completed under flowing ground conditions and has the advantage of not requiring deep shafts or casing pipe, and was therefore selected for the crossing.

2.3.4 Construction Challenges

Prior to beginning the HDD, the contractor potholed the existing utilities and found several that were in conflict with the proposed pipeline alignment. The information was provided to the District and the drawings were changed to lower the alignment by approximately 6 feet to clear the utilities. There was no cost impact associated with this change.

During drilling of the HDD pilot hole, difficulties were encountered with the sonde-based downhole survey tool. Specifically, survey readings were lost in the vicinity of traffic loops overlying the bore path. Given that the traffic loops overlaid key points of curvature in the HDD alignment, this was a significant concern. The contractor initially tried switching sonde and survey tools to a different model without any significant improvement. The City then agreed to temporarily turn off the traffic loops during pilot hole drilling operations, which corrected the problem. The rest of the HDD installation went relatively smoothly, with only one minor instance of hydraulic fracturing (release of HDD drilling fluids to the ground surface) noted during pilot hole drilling.

2.3.5 Construction Cost and Schedule

The construction cost for the Central undercrossing was approximately $126,000. Of this, $60,270 was the cost for the water pipeline and fiber optic conduit installation by HDD. HDD installation was completed in 7 days, not including excavation or backfilling of the pits.

2.4 Mowry Avenue Undercrossing

The Mowry Avenue undercrossing initially required the installation of approximately 770 linear feet of 16-inch diameter HDPE water pipe and 2-inch diameter fiber optic conduit by HDD. Due to issues that arose during construction and which are described below, the undercrossing was modified to require the installation of approximately 260 linear feet of 28-inch steel casing pipe by PTGB. Following completion of the casing installation by PTGB, the 16-inch diameter HDPE water pipe and a 2-inch diameter fiber optic conduit was installed within the casing.

2.4.1 Design Constraints and Challenges

Mowry Avenue is a major arterial road and construction impacts to traffic were anticipated to be significant. The City of Fremont did not specifically require that trenchless construction be used for this crossing along Farwell Drive; however, any open trench installation would have to be completed at night and no trench plates would be allowed to be left in the intersection. This meant that production would be extremely slow through the intersection due to other existing utilities that would need to be crossed, and the requirement for no trench plates meant that any excavations would need to be completely backfilled, including temporary hot mix asphalt concrete, by the end of the day. This approach was determined to be extremely inefficient and costly so a trenchless option was selected.

Similar to the Central Avenue undercrossing, Mowry Avenue had numerous utilities of the same type to avoid, and an invert depth of 14 feet was established during design. A deeper invert depth was not possible due to the presence of contamination at depths greater than approximately 18 feet (see 2.4.2 below). The beginning and ending of the trenchless construction in this area was set far enough back from the intersection to avoid disruption to traffic, and the traffic loops controlling the traffic signals.

2.4.2 Geotechnical Conditions and Challenges

Soil conditions at the Mowry Avenue undercrossing were very similar to the conditions at the Central Avenue undercrossing, consisting of soft to stiff lean clay (CL) with varying amounts of sand and silt, and very loose to medium dense clayey sand (SC). Groundwater levels (measured during the dry summer months) were approximately at the anticipated water pipeline invert. Alignment soils were anticipated to exhibit firm to squeezing (clays) and running to flowing (sands) behavior.

In addition, during the geotechnical field investigation the presence of a hydrocarbon plume was noted on the north side of Mowry Avenue, at a depth of approximately 18 feet below ground surface. The pipeline alignment needed to stay above this plume to prevent any possible movement of the contamination and/or exposure of the HDPE pipe to hydrocarbons.

2.4.3 Trenchless Method Selection

The Mowry Avenue undercrossing was very similar to the Central undercrossing, with the exception of the groundwater level relative to the water pipeline invert. Due to the presence of the groundwater table at approximately the water pipeline invert level, ABJ and PTGB methods were considered feasible if the contractor could demonstrate that the groundwater level at the time of construction was below the tunnel zone. Dewatering of the tunnel alignment was not considered feasible due to the overlying roadway.

Microtunneling was also considered technically feasible for the Mowry undercrossing, and had the advantage over ABJ and PTGB of being insensitive to the position of the groundwater table. However, microtunneling, ABJ and PTGB would have required the construction of shored launch and receiving pits and the installation of a casing pipe, significantly impacting their cost effectiveness.

HDD was initially selected for the Mowry undercrossing due to its ability to directly install the water pipeline (no casing required), without deep shafts and at a relatively low cost compared to microtunneling, ABJ and PTGB.

2.4.4 Construction Challenges

Due to the high traffic volume, HDD pilot bore drilling was to be completed at night to allow for walkover tracking of the sonde-based downhole survey tool through the intersection. This was approved by the City but the request to have the traffic loops placed in the time mode (that is, turned off) was not approved. The Contractor would have to work through any potential interference between the sonde-based downhole survey tool and the traffic loops.

On the night of April 7th, when the pilot bore had been drilled approximately 250 feet, hydraulic fracturing was noted at the seam between the asphalt concrete and concrete gutter pan of the overlying roadway. The drill rods were retracted back to the drill rod, and the drilling fluid formulation was changed. The HDD contractor then re-drilled the pilot bore, with hydraulic fracturing occurring at approximately the same location. After several unsuccessful attempts to clean the bore hole and pass the zone of hydraulic fracturing, the drill rods were retracted and operations were stopped. There was an existing AC water main in the area of the hydraulic fracturing, so the District had the contractor place steel trench plates over this area as a precautionary measure. The plates were removed several months later and the pavement showed no signs of impacts or issues due to the hydraulic fracturing.

Upon learning of the hydraulic fracturing, the District met with the City to discuss options for proceeding with the crossing. The District had received a very good bid price for the HDD and was hoping to take advantage of the cost savings. At first, it was proposed to move the HDD entry pit closer to the intersection to try to bypass the zone of repeated hydraulic fracturing. The City was initially receptive to this idea, but then decided they could not risk any further impacts to the street or any potential issues within the intersection. The District proposed several countermeasures to minimize the risk of future hydraulic fracturing, but could not guarantee that future HDD attempts would be completed without hydraulic fracturing. Because a guarantee could not be given, the use of HDD was effectively prohibited by the City. This left the District, Winzler & Kelly and DCM/GeoEngineers looking at other trenchless options for this undercrossing. Not completing this undercrossing was not an option due to the fact that connecting sections of pipeline had already been installed at either end of the undercrossing.

Returning to the initial evaluation of trenchless methods, both ABJ and PTGB had been considered feasible, but less attractive than HDD in terms of cost and traffic impacts. After a site visit to investigate potential ABJ or PTGB jacking and receiving pits, it was determined that the pits could be located in such a way as to minimize traffic impacts, but would require the undercrossing length to be approximately 260 feet. At a length of approximately 260 feet, there was concern about the accuracy of ABJ, which is typically on the order of 1% of length. As a result, it was recommended that the pipe be installed using the PTGB method within a 28-inch steel casing. Through the use of a LED target/theodolite and camera guidance system, the pilot tubes for a PTGB installation can be installed to very precise tolerances (typically within one to two inches over distances up to approximately 300 feet), with similar accuracy obtained on subsequent casing installation. No significant issues were encountered during PTGB construction and overall, the undercrossing had only a slight impact on traffic in that one of the two left turn lanes onto Mowry Avenue was closed for approximately one month for casing and pipe installation.

2.4.5 Construction Cost and Schedule

Due to circumstances detailed above that prevented the HDD from being completed, a claim was submitted and subsequently paid by the District for delay and standby time for the HDD Contractor. The switch to PTGB installation also resulted in a significant change order to the contract, since the method required deep, shored pits and casing pipe. The construction cost for the Mowry Undercrossing, including the change order for the PTGB and claim, was approximately $510,000. Of this, $141,250 was the cost for casing installation by PTGB. The original cost for water pipeline and fiber optic conduit installation by HDD (direct installation, no casing) was $79,310. The casing installation was completed in 9 days, not including excavation of the pits, water pipe and fiber optic conduit installation and backfill of the pits.

3.0 CLOSING

The ARP Wells to Desal Pipelines Phase 2 project was unique from the perspective that despite its relatively short length (approximately 9,100 linear feet of pipeline), design and geotechnical constraints required the use of four different trenchless construction methods. In successfully completing the project, the design team leaned many valuable lessons, including the following:

1. For HDD installations, the possibility of hydraulic fracturing must be discussed and emphasized with all stakeholders as an inherent risk with this method. While good geotechnical information, proper bore path design and careful execution by the contractor minimizes the risk of hydraulic fracturing, the risk can never be completely eliminated.
2. For HDD installations using sonde-based “walkover” survey tooling, arrange to have all traffic loops turned off during pilot bore drilling ahead of time. While many HDD contractors and survey tool manufacturers may claim the ability to work beneath these loops, our experience on this project is that it is best to have the loops turned off whenever possible.
3. For microtunneling installations, do not allow tunneling to start before both the jacking and receiving pits have been completed. For this project, the microtunneling contractor started tunneling before the general contractor completed the receiving pit. When problems were encountered completing the receiving pit, tunneling had to be stopped until the problems were resolved and the receiving pit made ready. Halting the progress of tunneling is always risky as the tunneled jacking pipe sections tend to “freeze up” as the overcut collapses against the jacking pipes, greatly increasing the skin friction acting on the jacking pipes.
4. For microtunneling installations, it may be a worthwhile to independently survey the positions of all surface and subsurface monitoring points, rather than leaving this responsibility to the Contractor alone. For this project, it is suspected that the baseline survey reading for the subsurface settlement monument was incorrect, causing it to appear to have settled.
5. Finally, have a “Plan B”. Even with good geotechnical information, a conservative design and a careful contractor, there are inherent unknowns associated with underground construction, and especially trenchless construction where the excavation is largely sight unseen. For this project, each undercrossing was evaluated separately, and alternative methods of construction were ranked in order of preference. As was the case for the Mowry crossing, when the preferred alternative encountered difficulties, the Design team was able to quickly modify the design to the second ranked construction method.

The success of this project was due, in part, to the good working relationship by all parties: the District, Winzler & Kelly and DCM/GeoEngineers from design through construction, and the Contractor during construction. When challenges were encountered, they were resolved in a collaborative manner, with an emphasis on moving quickly from the identifying the problem to finding a solution.