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**PILOT TUBE METHOD OF GUIDED BORING
AS THE CONSERVATIVE OPTION**

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1. NO-DIG 2021 ABSTRACT:

The communities of Mission Bay and Pacific Beach, in San Diego, CA are much like many other ocean-front areas with high tourism, an expectation of uninterrupted services and high-water tables. However, the environmental regulations within the state of California present additional challenges.

The Sewer Group 786 project in this area of San Diego (the City) included replacing, rehabilitating or realigning approximately 15,145 linear feet (LF) of sewer mains in areas adjacent to Sea World and other tourist traffic. The project was planned for depths ranging from 4 – 21 feet with ground water present at 8 – 14 feet. As an added challenge, many of the slopes on this gravity flow sewer project were very flat ranging from 0.25 – 0.75 percent.

As a knowledgeable general contractor with extensive experience in the area, Ortiz Corporation (Ortiz) worked with the city's plan calling for a blend of open trench installation and trenchless technology to upgrade a portion of the collection system in the Mission Bay area. They also recommended consideration of planning the full project as a Pilot Tube Method of Guided Boring (PTM) project. The city opted for the blend of installation methods approach.

Although soil samples were field-screened for the presence of volatile organics prior to any digging, the contractor had concerns due to the proximity of other known contaminants and the tidal influence. Soon after dewatering began, the contractor's fears were realized.

After experiencing the PTM trenchless method in comparison to the first 700-feet of open trench installation, the owner reevaluated their original decision. They opted for PTM over open trench for the remainder of the project as well as adding five PTM drives which were not included in the original contract.

This paper will be a case study with presentation of the original thinking, the significant learning along the way that impacted decision-making and led to changes, a review of techniques and tools used, and a look back at lessons learned.



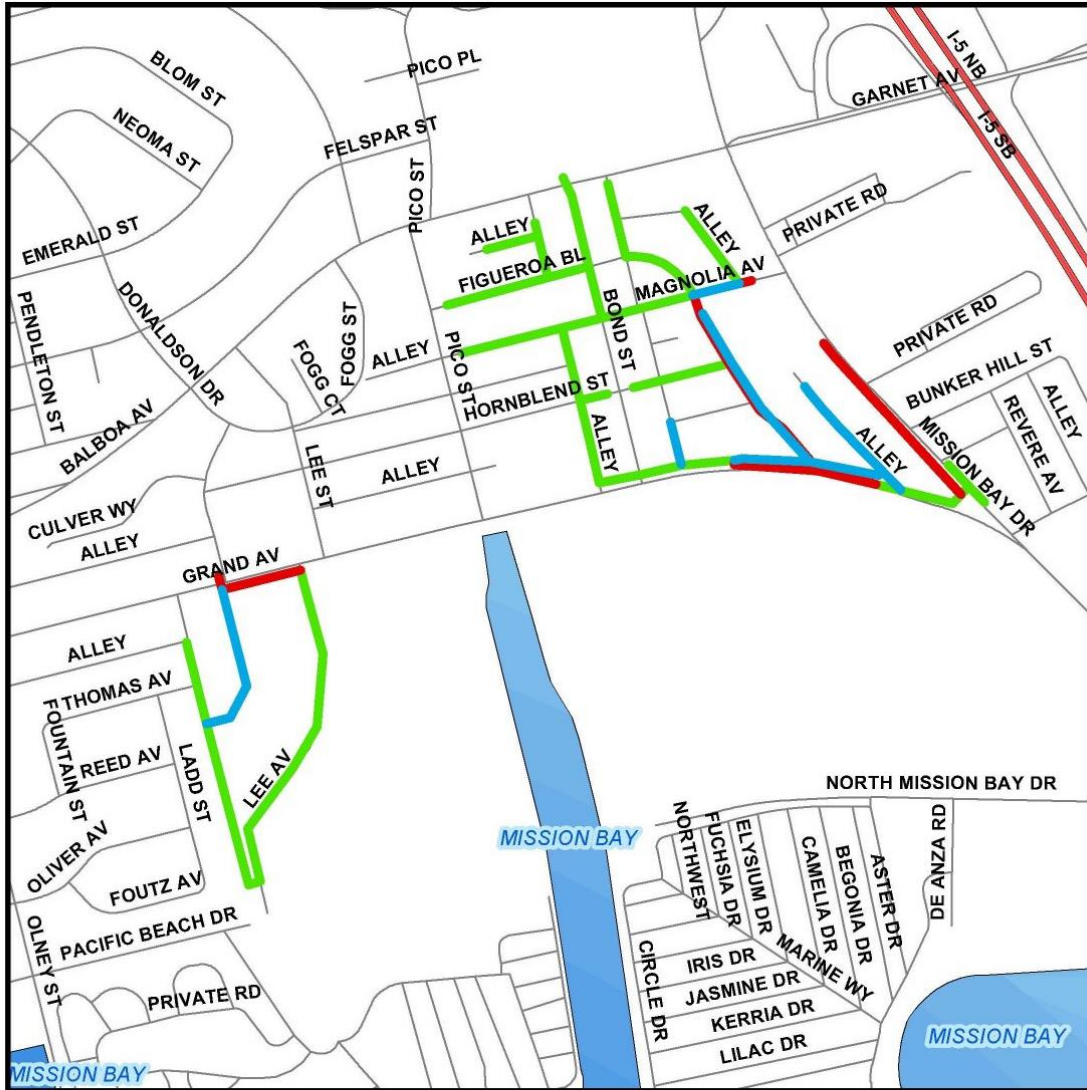
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Legend

- Sewer Main to be Abandoned
- Sewer Main Replace-In-Place
- New Sewer Main



COMMUNITY NAME: PACIFIC BEACH
Sewer Group 786
Date: December 14, 2016

COUNCIL DISTRICT: 2
Appendix E - Location Map



SAP ID: B00421 (S)
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Figure 1: The planned site map with color-coded installation methods.

2. INTRODUCTION

The original plan for the Sewer Group 786 project included the replacement of existing 8- and 12-inch sewer mains via the following construction methods (see Figure 1):

- **replace-in-place** approximately 7,973 linear feet (LF) within existing trench alignments via open trenching (4-21 feet deep)
- **rehabilitate** approximately 3,500 LF using trenchless technology (4-21 feet deep)
- **realign** approximately 3,672 LF of sewer main within new trenches via open trenching (11-21 feet deep).

In addition to the 15,000+ linear feet of sewer, the plan called for the replacement of 50 existing manholes, pedestrian curb ramps, new sewer laterals, and replumbing several existing sewer laterals. Construction Best Management Practices and a Traffic Control Plan were important parts of the planned implementation during construction.

The project footprint was located entirely within the public right of way (including alleys), easements on private property and streets within the communities of Pacific Beach and Mission Bay (see Figure 2) with an average surface elevation of just 14 feet above sea level and unstable soils. This area has a great deal of tourist traffic with beautiful beaches, numerous aquatic sports and Sea World San Diego. Any lane closures would cause backups in all directions on major arterial roadways and the unstable soils would necessitate closure of multiple lanes of traffic on those roads in the case of open trench installations.

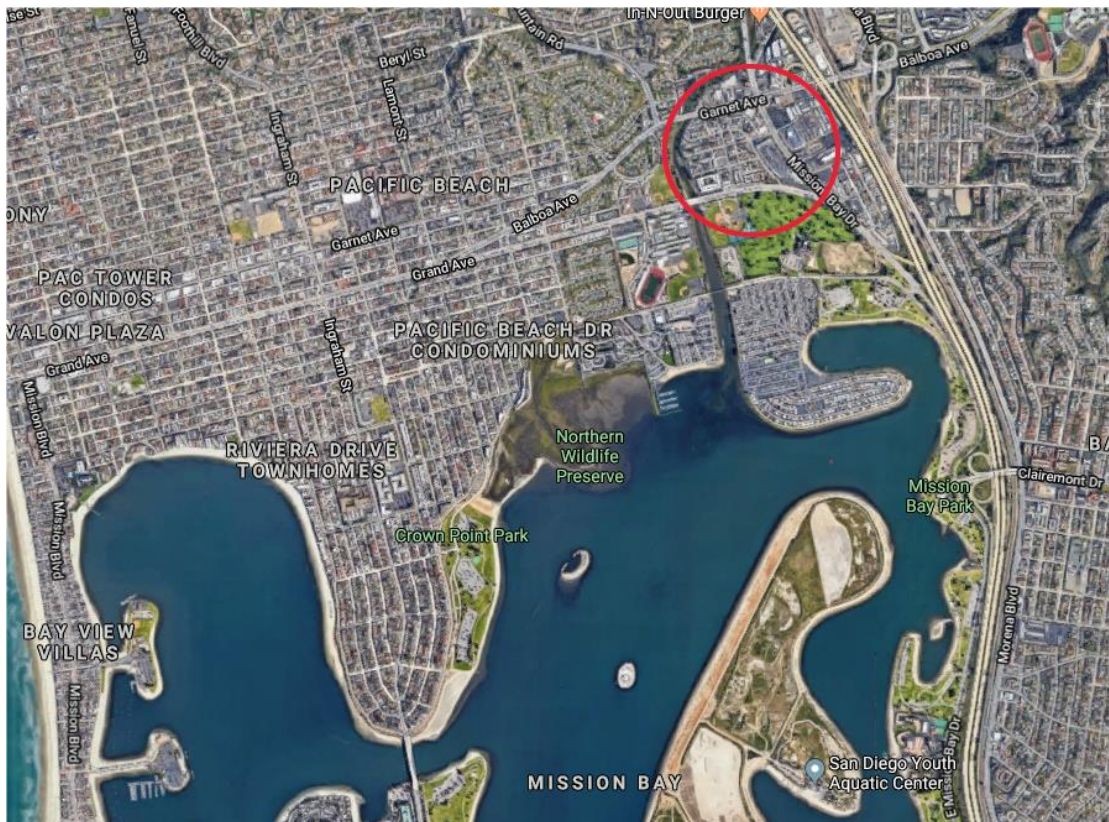


Figure 2: The project (located in the red circle above) was affected by tidal influence and needed to be managed entirely within the public right of way.

3. THE BIDDING PROCESS

This project originally bid in the Spring of 2017. After bids were opened, the City, as project owner, explored ideas for reducing costs with the bidding contractors. The original bids all far exceeded the engineers estimate. As a result, the City explored many options and was open to consideration of alternate methods of construction.

Before the project was awarded, the City elected to rebid in late Summer, 2017. This time Ortiz Construction (Ortiz) provided the lowest bid and was awarded the contract.

The bid documents specified the use of Horizontal Direction Drilling (HDD) on approximately thirty percent of the project, however, they also specified extremely low slopes (just 0.25 to 0.75 percent) on these gravity flow pipeline installations. To maintain such exacting slopes in unstable soils with concerns about contaminants and maintaining traffic flows, Ortiz based their bid on a plan to use PTM and the Akkerman Guided Boring Machine (GBM) 240A system. This system is applicable for gravity flow installations and includes a theodolite guidance system, pilot tubes, jacking frame, power pack, and lubrication pump.

There were several considerations that led to the selection of PTM as the installation method of choice, but the primary concerns were the extreme precision required by the flat slopes, the desire to maintain traffic flows in a tourist area, and the probable spread of contamination plumes based on the state's GeoTracker program.

4. PREPARATION

Prior to starting the project, Ortiz conducted research to identify any environmental concerns in the area. GeoTracker is the California Water Board's data management system for sites that impact, or have the potential to impact, water quality in the state. The emphasis of the system is on groundwater. One of the benefits of the program is a user-friendly map very similar to Google Maps. The map is labeled with boxes that use different colors to identify spills, by type and status. If the boxes are solid, it indicates an active site. Inactive cases have X's over the box and the remediation documents are attached to the properties (See Figure 3).

The City also hired Allied Geotechnical (Allied) to perform an additional geotechnical exploration. The scope of Allied's investigation did not include the performance of a Phase I Environmental Site Assessment to evaluate the possible presence of soil and/or groundwater contamination beneath the project alignment. During the subsurface investigation soil samples were field screened for the presence of volatile organics using a RAE Systems Mini-RAE 3000 organic vapor meter (OVM). The field screening did not reveal elevated levels of volatile organic compounds in the samples.

Regardless of the Geotechnical findings, Ortiz had concerns. Many of the closed cases on GeoTracker revealed that significant tidal influence may have pushed the plumes around. There was a concern the dewatering system would pull any latent contaminants into the work zone.

5. THE PROJECT START

The first five PTM trenchless drives progressed as planned, with all drives being “on-target” and within the constraints of the exacting design slopes.

The first open cut section began after the fifth trenchless drive and involved the following:

- 395 feet of open trench with cuts up to 15 feet deep
- 2,204 square feet of pavement replacement with widths in excess of the trench width
- 1,484 tons of contaminated soils
- 1,636 tons of imported backfill materials to replace contaminated and unsuitable soils.

Soon after the dewatering system was initiated, the contractor’s concerns were validated. Once the contaminant was identified, granulated, activated carbon (GAC) system vessels were put in place to pull the hydrocarbons out of the groundwater prior to disposal (see Figure 4).



Figure 4: Onsite GAC treatment plant

The installed cost per linear foot of pipe in this open-cut section of the project was \$1,267. The installed cost per linear foot of pipe installed using PTM was approximately \$570.

Because of dewatering, environmental concerns and cost overruns, the City requested that Ortiz use PTM for installation whenever practical for the remainder of the project. At the start of the project, the City had concerns that PTM installation may not be economically feasible because it was perceived to be more expensive than an open cut project. The disposal of contaminants, the need to import additional backfill materials, and the cost of surface remediation all combined to make trenchless installation the more fiscally responsible choice.

6. THE CHALLENGES

Given the location on the coast, groundwater was anticipated. Groundwater depths ranged from 8 to 14 feet below the surface. Riparian and tidal influence on these levels was also an important consideration. Open

cut installations, with trenches extending below the level of the groundwater would require extensive dewatering. The planned method of dewatering varied based on soil type, depth of trench and rate of water inflow. In most of the project area, well systems were sufficient with over 250 dewatering wells installed at 40 – 50 foot on center intervals and depths of 35 – 40 feet (Figures 5 & 6). But in some areas, the presence of clay resulted in perched water in the trenches. In areas where the alignments are underlain by sandy material, high rates of transmissivity were experienced. Pump volumes varied from 5 gpm (gallons per minute) to as much as 50 gpm.



Figure 5: Over 250 wells were drilled at depths ranging from 35 to 40 feet.



Figure 6: Riparian and tidal influence on ground waters made dewatering wells a key component of the construction plan.

The rich clays on the project created obstacles for the dewatering filtration and treatment system. The primary issue was clogging of the GAC system. Bag filters were installed to prolong the life of each carbon filter, and bags were replaced one to three times per week with a single change of the GAC filters costing more than \$12,000.

The filtration and treatment system has been active for approximately two years. Project completion is scheduled for June of 2021.

7. THE PILOT TUBE METHOD

Ortiz Construction excavated the jacking pits and receiving shafts and maintained them using a sheet piling and whaler system (for a rectangular structure).

Once the shaft construction was complete, the jacking frame was set to the desired height, grade, and line from control points established using conventional surveying techniques. As in all pilot tube installations, the guidance system consisted of a digital theodolite with an integrated camera mounted independent of the jacking frame, a battery-powered LED illuminated target housed in the slant faced steering head (see Figure 7) and a computer monitor screen. This guidance system provides the operator with a “real-time” view of the location and steering head orientation of the pilot tubes together with the ability to adjust accordingly during the entire installation resulting in pinpoint accuracies.



Figure 7: Pilot tube theodolite with integrated camera and visible LED illuminated target.

The **First Step** (see Figure 8) of the PTM process is installation of the 4-inch pilot tubes on line and grade. During installation of the pilot tube, the ground was displaced by the slant-faced steering head and no spoil was removed. The pilot tube was directed on line and grade by rotation during advancement. The hollow stem of the pilot tube provided an optical path for the camera to view the LED target displaying the head position and steering orientation. This step established the centerline of the new sewer installation. All remaining steps followed the path established by the pilot tube. Once the pilot tubes reached the reception shaft, the theodolite, video camera, and monitor guidance system were no longer needed and were removed from the jacking pit.

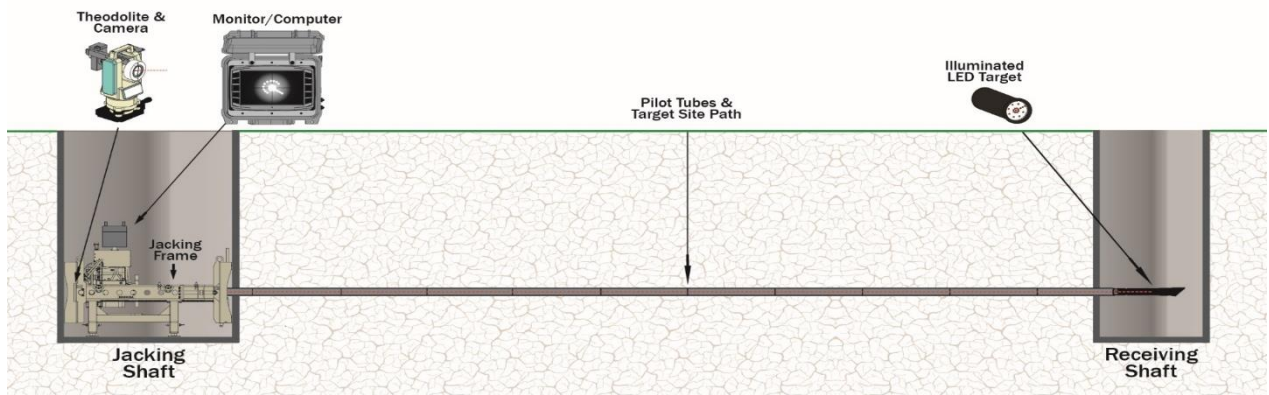


Figure 8: PTM Step 1 – Illustration of the GBM frame installing the pilot tubes. (Illustration provided by Akkerman)

The **Second Step** (see Figure 9) was to follow the path of the pilot tube with a reaming head that matched the pipe O.D. (Outside Diameter). The front of the reaming head fastened to the last pilot tube in the same manner the pilot tubes fasten to each other. Thrust (auger) casings advanced the pilot tubes and reaming head and transported the spoil (displaced ground around the pilot tubes) to the jacking shaft for removal. Once removed from the jacking shaft the spoils were transported off-site. During the installation of the casings, the previously installed pilot rods were advanced into the reception shaft for disassembly and removal. This

step was complete when the reaming head reached the reception shaft and all spoils were removed. Once removed from the jacking shaft, spoils were transported off-site. When using the PTM, spoils are limited to just the area occupied by the pipe, dramatically reducing the cost of transport and disposal.

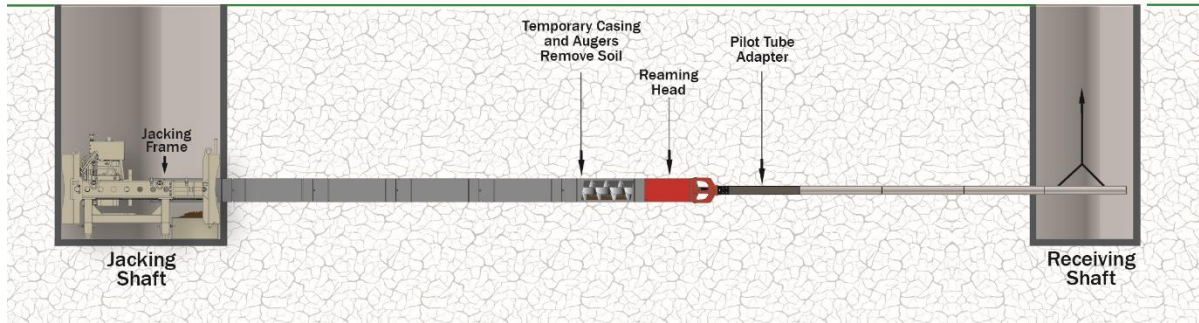


Figure 9: PTM Step 2 – Installation of 11-inch OD auger (thrust) casings. (Illustration provided by Akkerman)

Step Three was installation of the product pipe behind the auger casings - both advanced by the product pipe (see Figure 10). This step is complete when the first product pipe reaches the receiving shaft and all casings are removed.

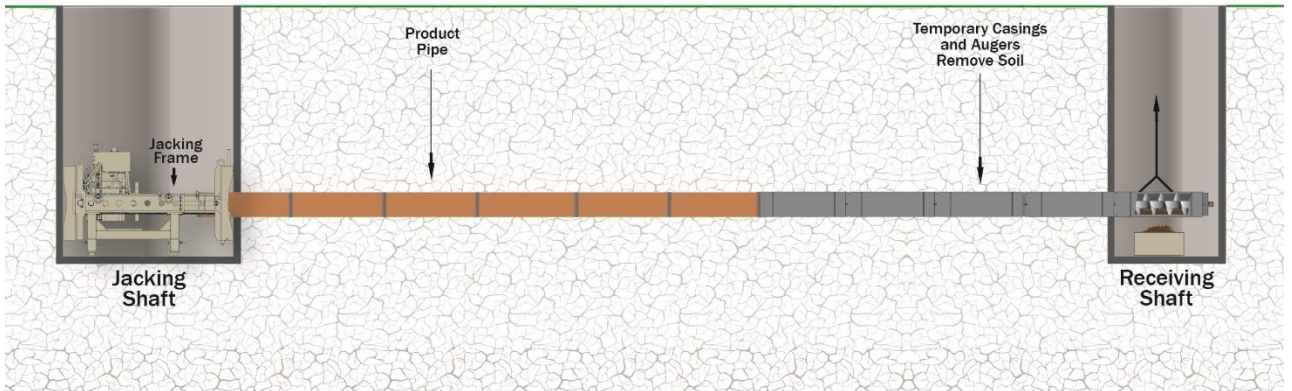


Figure 10. PTM Step 3 – Installation of product pipe. (Illustration provided by Akkerman)

Because the average compressive strength of VCP-J (Vitrified Clay Jacking Pipe) is 18,000 psi, the pipe itself can resist the high jacking forces generated as the pipe is pushed through the ground, eliminating the need for an external casing pipe. When using PTM for installation, Vitrified Clay Pipe (VCP) is the practical option for pipe material. The high compressive strength, low-profile, zero-leakage joints of VCP-J make it the cost-effective choice.

VCP-J has the same material benefits as all VCP. The proven lifecycle and greater range of options for long term operations and maintenance are prime considerations for more municipalities as they evaluate the choice for the premium pipe.

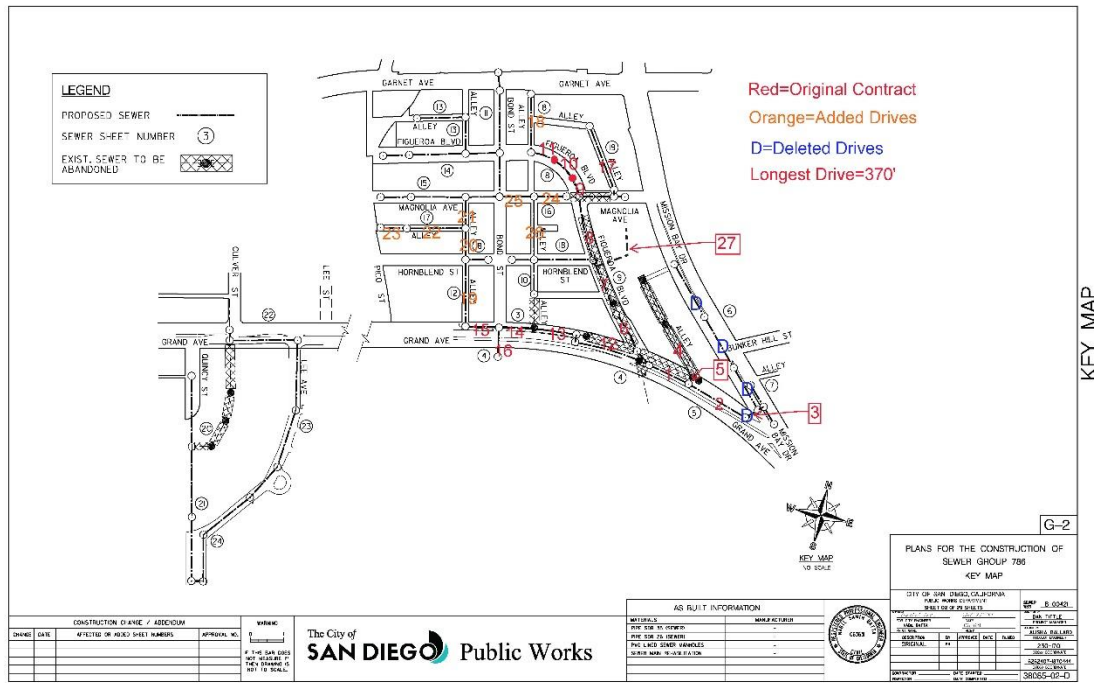


Figure 11: As a result of successful PTM installations, parts of the project were redesigned with a few planned drives redesigned and a few additional drives added.

8. THE PLAN - ADJUSTED

Plans were adjusted as the project progressed to limit the impact of contaminants and to minimize disruption to traffic flows. Actual conditions were not consistent with conditions indicated on the plans. Modifications and new alignments were necessary to maintain gravity flow. In the adjusted project map (Figure 11), new alignments caused deletions of planned drives. Those deletions were replaced by the rerouted drives (#4 and #27). In most cases, grade differentials were non-existent, requiring the team to find new routes for the pipeline while maintaining proper slopes.

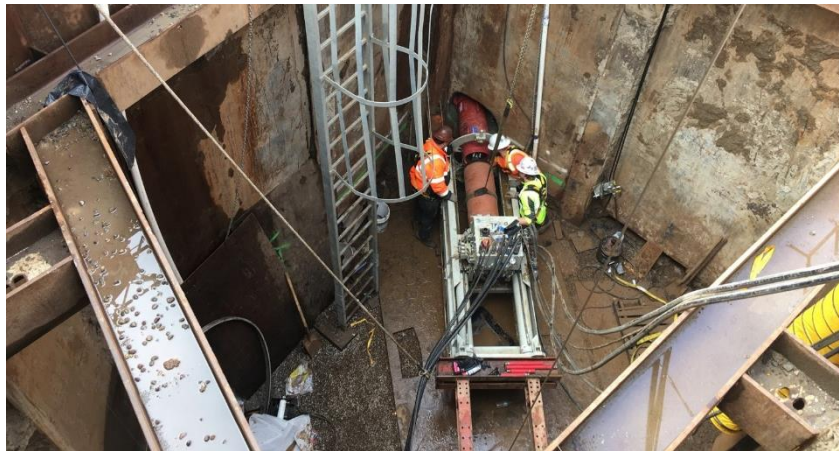


Figure 12: The small equipment footprint of the GBM and ability to use shorter pipe lengths allows contractors greater latitude when locating shafts.

9. THE RESULTS & LESSONS LEARNED

As of the date of this paper submission, 24 runs have been completed and just one remains. All runs with the exception of the first open trench run were completed using the Pilot Tube Method. The final drive is projected to be completed before the 2021 No-Dig Show.

PTM can be significantly more cost effective than open trench installation, especially where unstable soils create concerns. The owners are now asking contractors to consider doing more trenchless installations when feasible. This is becoming a win-win for the community in reducing both the total cost of the installation and the disruption to both traffic and area businesses this kind of project can create.