Primoris Services Corporation
Vadnais Trenchless

PG&E R-134 L-101 San Francisquito Creek Microtunnel Boring Plan

MICROTUNNEL INSTALLATION:

Microtunneling is a remotely controlled, guided, pipe-jacking process that provides continuous positive control of earth and groundwater pressures at the face of the excavation. The microtunneling machine (MTBM) and jacking pipes are pushed into the ground from a jacking shaft to a reception shaft on opposite sides of a crossing. The carrier or product pipe may be jacked directly or installed inside an oversized casing in a separate operation. Pipe materials that can be jacked directly into place are similar to those used for open-shield pipe-jacking and include steel casing pipe (SCP), reinforced concrete pipe (RCP), polymer concrete pipe (PCP), vitrified clay pipe (VCP), and centrifugally cast fiberglass reinforced polymer mortar pipe (CCFRPMP).

For this application, Vadnais will be utilizing the sacrificial case-and-displace method with steel casing pipe to install the 24" steel gas pipe, as specified.

The proposed elevation of the top of the pipeline at the microtunnel crossing beneath San Francisquito Creek is at approximately Elevation -10.00. This provides a minimum depth of cover of 10 feet below the creek bottom and 14 feet of cover on the East side and 21 feet of cover on the West side. The length of the proposed crossing is 300 lineal feet. Based on soil borings on either side of the Creek, performed by Kleinfelder in 2014, the crossing will be bored through primarily favorable soil conditions consisting of silty sand and sandy lean clay beneath the groundwater table. The anticipated soil conditions are well-suited to the Iseki TCC500 (24-inch OD) microtunnel boring machine that will be utilized for the crossing.

We anticipate approximately 7 days of tunneling in order to complete the crossing, followed by an additional 3 days to install the gas pipeline. A microtunnel schedule is attached at the end of this plan.

The excavation and construction of the tunnel will proceed generally by:

- Excavate, shore and dewater the launching shaft to the size required to accommodate the Microtunnel Boring Machine (MTBM) and the pipe sections to be jacked.
- Excavating, shore, and dewater the reception shaft at the tunnel terminus.
- In the launching shaft, set-up the jacking frame and tunnel entry portal with a watertight entrance ring. No dewatering is required along the tunnel route for the microtunneling process.
- The MTBM is an earth pressure balance machine, which insures that the tunneling face is stable throughout the excavation process. The end result is the tunnel will be installed with no subsidence to structures or utilities above the tunnel horizon. The machine is remotely controlled in a control center above the ground surface. Barring unforeseen obstructions, the operation will install the tunnel within inches of its designed grade and alignment.

- The MTBM will be installed into the jacking shaft. Once the system is pretested, the MTBM will be launched through the entrance seal and begin tunneling.

- The removal of soils in accomplished via slurry. The excavated material is transported to the surface through slurry pipes in the tunnel. The slurry is processed in a slurry separation plant on the surface. At the separation plant, the solids are removed and loaded in a drier condition directly into dump trucks to be removed from the site. The clean slurry is returned to the tunnel and completes the slurry loop.

- As the advancement of the MTBM continues, sections of sacrificial steel casing tunnel pipe are set and installed behind the MTBM. The sections are hydraulically jacked behind the advancing MTBM and the process repeats itself until the tunnel reaches its terminus, at the reception shaft. Once "holed-out" at the reception shaft, the MTBM is removed and sections of 24" steel Gas Pipe are placed one at a time in the Launch Shaft. As each section of gas main is welded together and pushed forward, with the same jacking frame that initially installed the tunnel, the sacrificial casing is displaced into the reception and removed to the surface. This process continues until all sacrificial casing has been removed and the final, fully welded, coated and x-rayed gas main completes the crossing.

MICROTUNNEL OPERATION:

Vadnais Trenchless Services, Inc. (VTS) will perform the microtunnel for this project. VTS is extremely familiar with this type of work and has been performing microtunneling projects for the past 23 years. VTS will work a 6 day a week, 10-hour per day schedule to install the microtunneled portion of the project. Due to the nature of the work, VTS may often exceed a 10 hour day due to unforeseen issues in excavation rate, separation processing, or other items that may prevent the completion of a given joint of pipe during the shift.

We will take care to plan safe routes for material and equipment delivery to our set-up area (jacking shaft) and minimize public and environmental impact. Management staff will be onsite and we will utilize a standard crew of operators and laborers to complete the micro tunneling portion of the L-101 San Francisquito Creek Pipeline Relocation Project. Personnel and equipment may be added and removed as needed.

Project staff will consist of:

(1) Project Manager	Brian McCahon (916) 416-6616
(1) Superintendent / Monitor	Jeff Rager (308) 995-1000
(1) Foreman	
(1) MTBM Operator	
(1) Equipment Operator	
(4) Laborers	

Equipment:

1. Tool Sheds
2. Iseki TCC500 (24") MTBM
3. Microtunnel Control Cabin
4. Slurry Separation Plant
5. Generator
6. Light Plants
7. Pickup Trucks
8. 1-Ton Truck
9. Air Compressor
10. Crane
11. Loader

VTS's equipment fleet is 100% tier 3 compliant and certified by the California EPA Air Resources Board. We continue to upgrade the fleet to meet future requirements prior to any regulatory mandates.

The Microtunnel Work Plan will proceed as follows:

SECTION 1 – MICRO TUNNELING METHODS

The construction of a pipe installation using the microtunnel method proceeds in the following order:

1) The jacking shaft is constructed together with a concrete base slab. The size of the jacking shaft will be determined by the pipe length and the jacking rig to be used. Then a concrete or steel thrust block is built for transmitting and dispersing the jacking reaction force to the ground in the jacking shaft. A pump will be provided at the bottom of the shaft in order to sump out any groundwater that may have gathered in the shaft and to remove the water that escapes from the slurry lines during pipe changes. If required, the ground at the exit eye will be stabilized to allow for the exit of the MTBM.

2) The jacking equipment, the laser, the pit by-pass unit, and the discharge pump are set up in the jacking shaft.

3) An entrance ring with a rubber seal is fitted to the inside of the shaft wall around each bore location to form a seal against both groundwater, if present, and slurry ingress into the shaft.

4) The slurry separation plant is installed near the jacking shaft on the surface. The slurry system is a closed-loop system where the water is used over and over again to transport the spoils. The spoil is separated from the slurry at the separation plant using a combination of shaker screens, and hydrocyclones. All of this material is conveyed out of the separation plant into end dumps, or another type of containment device, to be disposed of at an approved location. Piping from the separation plant to the jacking shaft is placed to form a slurry circuit.

5) The control cabin containing the operation board of the MTBM and the distribution board for the electrical equipment is set up, and power and control cables are connected to the operation board, the main power supply, and other ancillary equipment.

6) Hydraulic hoses between the power pack and the jacking equipment are connected.

7) The MTBM is lowered into the jacking shaft and set on the guide rails. The MTBM is checked to make sure it is positioned correctly on line and grade utilizing the survey points provided by the general contractor.

8) Flexible slurry lines are connected to the MTBM from the pit by-pass unit, the power and control cables are connected to the machine, and the separation plant is filled with water and any admixture required in the slurry. We DO NOT anticipate the need for any slurry additives on this project. However, if conditions dictate, bentonite may be added to the slurry. Information on the proposed bentonite is located within the Spill Response Plan.

9) The functions of the system are then tested to ensure that the whole system is ready for operation.

10) Proper soil stabilization is confirmed outside the shaft, and the interfering portion of the shaft wall is removed.

11) The hydraulic jacks are the engaged to push the MTBM close to the work face through the rubber entrance seal.

12) The pit by-pass unit and the slurry pumps are operated to circulate the slurry between the MTBM and the separation plant.

13) The cutter head of the MTBM is rotated, and the jacks extend to push it forward and start the excavation.

14) During the installation process, the MTBM operator controls the jacking speed, the torque of the cutter head, the slurry flow rate, the slurry pressure at the work face, the earth pressure, and the inclination of the MTBM. The operation board contains the gauges for the discharge and charge pumps. These gauges allow the MTBM operator to balance earth pressure/groundwater pressure with the slurry pressure. The charge and discharge pumps are monitored by sensors located in the slurry chamber (face pressure) and in the slurry line (charge pressure) and kept as equal as possible.

15) After the MTBM is driven into the ground, the operation of the machine and slurry pumps is stopped and the jacks are retracted. The electric cables, control cables and the slurry lines are disconnected in the jacking shaft to allow the placement of the first pipe (or lubrication pipe if applicable) onto the guide rails.

16) The hydraulic jacks are extended to push the pipe forward until it fits to the tail of the MTBM.

17) After making sure that the pipe is joined properly to the tail of the MTBM, the electric cables, control cables, and the slurry lines are reconnected.

18) The slurry pumps are restarted, the pit by-pass unit operated, the cutter head of the MTBM is rotated and the hydraulic jacks extend to resume the micro tunneling operation.

19) The micro tunneling operation is repeated as a cycle to jack the pipes one after another into the ground.

20) While the pipe jacking operation is carried out, a lubricant is pumped continuously to the periphery of the jacking pipe to reduce the jacking friction. The lubricant is a mixture of water and bentonite or polymer.

21) Before the micro tunneling operation starts, the reception shaft is also constructed for the recovery of the MTBM upon completion of each drive.

22) When the MTBM is about 12 inches away from the reception shaft, the jacking operation is stopped. A small hole is cut through the shaft wall of the receiving pit in order to confirm the position of the machine, and to confirm proper soil stabilization.

23) The exit ring and rubber seal are attached to the shaft wall and the guide rails are set to receive the MTBM.

24) The interfering portion of the reception shaft wall is cut and the jacking operation is resumed to push the MTBM into the reception shaft.

25) After it is completely driven into the reception shaft, the MTBM is removed and lifted to the surface.

26) At the completion of the jacking operation the shield is cleaned, checked and returned to the jacking shaft to start the next drive (if applicable). The slurry lines control and power cables are removed and prepared for reuse on the next drive.

For this project we are using an Iseki TCC 500. General dimensions of this machine have been provided on the following page. This machine is capable of balancing the anticipated hydrostatic and earth pressures anticipated on this project in order to minimize ground movement, and

prevent inadvertent return of slurry.

Iseki TCC 500	
Excavation Diameter	26.0"
Length	8'-2"
Weight	4,000lbs

SECTION 2 – ALIGNMENT CONTROL SYSTEM

The Iseki TCC 500 has an articulated steering head controlled by a set of three hydraulic positioning jacks. A laser securely mounted in the jacking shaft sends a beam through the jacking pipe to the target mounted in the tail of the MTBM. A camera located in the MTBM shows the laser's position on the target. The operator uses this information to continuously steer the shield on line and grade within the required tolerances. When the excavation is observed to be off line or grade, all corrections will be made at a rate of not more than 1 inch per 25 feet until it has been returned to design line and grade.

The laser will be mounted on a laser stand that will be installed independently inside the jacking shaft so movements of the jacking equipment or other objects don't affect the accuracy of the laser. Survey marks will be provided on both sides of the jacking shaft to allow a string line to be set up with vertical plumb bobs to align the laser beam reference accurately.

SECTION 3 – JACKING EQUIPMENT

The jacking equipment we will be using for this project has a compact design utilizing two-piece construction for fast set-up and handling along with a 3-stage mechanic lock push system and curved back plate to minimize required shaft dimensions. The jacking equipment also features a bolted, interchangeable push ring for simple adaptation to different pipe diameters, and individually controlled hydraulic cylinders for frame alignment. Additional information regarding the jacking equipment is listed below.

Iseki TCC 500 Jacking Frame	
Length (without frame extension)	16'-9"
Width	7'-9"
Weight	31,000lbs
Maximum Jacking Force	400-tons

Jacking Equipment Set-Up - Typically, the entire assembly is erected at the ground surface and hoisted into the shaft in one piece, when ample space is available. It is just as easy to assemble in the shaft once the shaft floor has been poured, and elevations are checked. Given the elevation of the floor, we utilize several reference points on the jacking frame to set it to proper line and grade. Line is easily achieved by landing the frame in the proper location. Fine-tuning of grade at the various reference points is accomplished via adjustable screw jacks.

A photo showing the jacking equipment can be found on the following page.

SECTION 4 – SLURRY HANDLING

As the micro tunnel boring machine (MTBM) excavates the spoil, the dirt is mixed with water, forming slurry. By the use of two or three pumps, the slurry is transported via steel slurry lines from the MTBM to separation equipment on the surface where the dirt (spoil) is removed and the water is returned to the MTBM to form more slurry. The separation equipment includes mechanical shakers, and hydrocyclones. The primary shaker screens the larger particles from the slurry. Further separation occurs in the hydrocyclones, and the secondary shaker that remove the smaller particles. Photos of the separation equipment are included on the following page. All spoils are conveyed from the separation plant directly into dump trucks, or another type of containment device, that will be taken to an approved location for disposal. At the conclusion of tunneling operations, the remaining slurry water will be pumped from the separation plant into vacuum / pump trucks to be disposed of at an approved location off-site.

Quantity of Excavation - Given a 26.00" excavation, based on a 24.00" OD steel casing pipe with an allowable 1-inch overcut measured radially:

$A = \pi r^2$, r = d/2, and 1 cy = 27 cf

r = 26.00" / 2 = 13.00" or r = 1.083' for the excavation

Area of Excavation = $\pi(1.083')^2$ = 3.69 sf x 1 lf = 3.69 cf

3.69 cf / (27 cf / cy) = 0.137 cy / linear foot of tunnel

Assuming fluffing of the soil (25%) .28 cy / lf x 1.25 = **0.17 cy / lf**


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MICROTUNNEL CONTINGENCY PLANS

***Machine Unable To Advance*:**

- **Possible Obstructions** – Our machines are designed to chew up items that are fairly large in size. The largest possible sized object that will fit in the cutting wheel is approximately 30% of the diameter of the machine. However, if an obstruction was encountered larger than 30% of the diameter of the machine and was unable to be broken up and swallowed by the microtunnel machine, we would slightly pull the face back and allow the material to be slowly chipped at until fully ingested. Finally, if the machine were indeed unable to break-up and ingest such an object, pulling back or retrieving the machine (911 shaft) would be our only alternative. Should an obstruction require a pull-back, or a 911 shaft, further discussions will be required by all stakeholders and plans will be developed and submitted for approval at that time. In the event that an obstruction was hit beneath San Francisquito Creek that we were not able to pass, pulling back the MTBM into the jacking shaft would be our only option. We would utilize the attachment points on the rear of the MTBM and run pull-back rods back through the pipeline into the jacking shaft. The pull-back rods would then be attached to the jacking frame (or specifically designed hydraulic cylinder), and an attempt to pull the machine back would be made. The void created by removing the MTBM and steel casing would be filled with a thickened bentonite mixture.

- **Insufficient Jacking** – We have little reason to believe that this scenario will occur. Previous tunnels in similar ground conditions have shown relatively low jacking loads. For this project we will have an allowable jacking force of approximately 300 tons. In the event that jacking pressures start to rise at a level greater than we were anticipating, we will add a soil support polymer to the lubrication. If that doesn't stabilize the jacking pressures, we can provide additional lubrication at injection ports throughout the tunnel alignment.

- **Machine Malfunction** – Immediately, upon any evidence of machine malfunction, the jacking operation will cease. The technician and crew will troubleshoot the problem, seek assistance from a factory representative if necessary, and perform the required repairs. When all functions of the machine test-out successfully, the jacking operation will continue.

- **Soil Unable to Support the MTBM** – Based on the information provided in the geotechnical report, it's unlikely that we will run into this problem on this project. However, if this problem does arise, jet grouting or other means of ground improvement to allow the machine to be supported by the soil would be required.

- **MTBM "Freezes"** – If after implementing the contingency plans listed above, we were still unable to advance the machine, we would have to pull the MTBM back into the jacking shaft.

***Settlement & Subsidence*:**

- **Surveyed Surface Deformations** – If heave is encountered, tunnel advancement will be slowed or slurry pressure and earth pressure decreased. Typically, heave occurs during a change in material (i.e. from stiff clay to loose sand). If settlement occurs, tunnel advancement would be increased or slurry pressure and earth pressure increased. The slurry could also be thickened to add additional support at the face of the tunnel.

- **Excess Excavated Volume** – When excavated volumes exceed calculated volumes the tunnel progress will be increased. A slow advancement rate and high slurry pressure typically cause over-excavation. Thickening of the slurry can help to counter such an occurrence.

- **Sudden Face Pressure Decrease** – If we observe a sudden decrease in face pressure while tunneling we would immediately activate the slurry bypass mode and check the surface for signs of a frac-out. If slurry was being lost at the surface we would definitely see a drop in face pressure. If no signs of a frac-out are visible we would check the separation plant for a change in the material being excavated to look for sign of unstable material. A change in material conditions from rock to sand could cause a sudden face pressure decrease. If the drop in face pressure was due to a change in the type of material we are excavating we thicken up the slurry by adding bentonite. We would also increase the advancement rate and decrease the slurry pressure to balance the pressures at the tunnel face.

***Slurry Separation Problems*:**

- **Excavated Material not Separated at Separation Plant** – If the separation plant is not providing adequate separation of the excavated material from the slurry we would check the following; proper screens on the primary and secondary shakers, hydrocyclones functioning properly, centrifuge functioning properly, proper flocculant injection rate.

- **Excavated Material Settles Out in Slurry Lines** – If the excavated material settles out in the slurry lines, the lines will be disconnected and cleaned or flushed out. This will typically occur at the booster pump raising the slurry out of the shaft. If the problem persists, bentonite will be added to the slurry to keep the excavated material suspended in the slurry.

- **Accumulation of Material in Separation Plant Tanks** – If we observe an accumulation of material in the separation plant tanks we would trouble shoot the paddle mixers in the tank to make sure they are functioning properly. If the mixers are working we would make changes to the screens, or flocculant injection rate to make sure we are removing as much material from the slurry as possible. If required, we would have a vacuum truck remove the material from the tanks.

***Slurry Losses*:**

- Slurry losses from the tank will be minimized. Slurry water that escapes will be contained within the separation plant containment berm and returned to the separation plant. In the unlikely event of an inadvertent slurry return during tunneling, we will follow our Spill Response Plan (attached).

***Groundwater Inflows to Shaft*:**

- The entrance seals will prevent much of any groundwater inflows. Any water and/or fines that do enter the shaft will be removed via a submersible sump pump that stays at the bottom of the shaft. If flows are excessive, chemical grouting will be performed through ports around the entrance ring to cut-off the inflow.

***Steering Difficulties*:**

- Steering and alignment of both line and grade are closely watched and corrected at all times by the tunnel technician. Any corrections to line or grade will be done at a return rate of not more than 1-inch per 10 feet. Advancement rates will be slowed if it is found that steering is difficult.

***Laser Distortion*:**

- **Due to Heat & Humidity** - If we observe laser distortion due to temperature or moisture levels in the shaft or tunnel we would troubleshoot our ventilation system to make sure it is functioning properly. We would also check to make sure that the laser is kept out of the direct sunlight. Temperature and moisture levels would be checked between the laser and the target to check for variations. If variations are found additional ventilation equipment may be required. If the laser is still moving while adequate ventilation and protection of the laser is provided we would have the operator closely monitor the movement and use the average reading as the center. If the movement is severe enough that we are not confident that we know the exact location of the MTBM at all times we would have to use a qualified surveyor to provide our exact location every morning.

- **Due to Physical Disturbance** - If we observe laser distortion due to a physical disturbance we would have to perform a laser check to be sure the laser is set to the design line.

***Damaged Pipe*:**

- Pipe to be found out of compliance prior to installation would be brought to the owner/engineer's attention. A decision would be made as to the acceptability of the product prior to us handling it. A similar discussion would take place if damage occurred during installation. If the pipe were damaged after installation, another conference would be held to discuss repair procedures and feasibility of repair. If it is determined that the pipe cannot be fixed in place it would have to be cycled out through the reception shaft, or the MTBM and pipe would have to be pulled back into the jacking shaft.

***Thrust Block Deformation*:**

- The design of the jacking shaft and thrust block should provide sufficient bearing to handle the anticipated jacking loads, and due to the low anticipated maximum jacking loads, there should not be a problem with thrust block deformation. In the event that we are experiencing thrust block deformation it is usually possible to observe it visually. If required, thrust block deformation can be verified using a fixed point located in the shaft, and taking measurements to see if it has moved. If thrust block deformation is observed the soil behind the thrust block would have to be stabilized.

***Possible Shaft Flooding*:**

- If floods were predicted, all power cables and the laser would be removed from the shaft and stored in a safe, dry location at the surface. The rear of the microtunnel machine will be bulk-headed off to prevent water damage to the electronics inside the MTBM. When floodwaters subside, the shaft as well as all installed pipe will be dewatered, the bulkhead will be removed, all electrical connections will be re-established and the tunneling process will continue.

***Loss of Control Signal*:**

- If, for any reason, the control signal is lost during the advancement of a drive, the forward progress will be immediately stopped. An investigation into the cause for the loss of signal will commence and repairs will be made to restore the signal. The drive will then re-commence. Under no circumstances will the tunnel drive continue to advance without a solid control signal in the operations center.

***Excessive Pipe Separation at Joints or Pipe String Movement*:**

- If, for any reason, we encounter excessive pipe separation or pipe string movement when the jacks are retracted we will have to carefully restrain the pipe using a chain and a come-a-long to apply pressure to the pipe until the next section of pipe has been installed.

***Presence of Contaminated Ground*:**

- If the presence of contaminated ground is observed we stop all activities and determine the exact nature of the contamination. Once all crewmembers are made aware of the hazards associated with the contaminant(s), we would make sure all crewmembers that are required to be near the contaminated soil are equipped with gas detection equipment, and the proper PPE. We would also make sure that all work areas are properly ventilated to prevent the accumulation of harmful gasses. Atmospheric testing would be administered prior to and during any hot work activities that could potentially provide a source of ignition.

SPILL RESPONSE PLAN

For the pipeline installation required on this project, a slurry microtunnel boring machine (MTBM) will be utilized. A slurry MTBM utilizes fluid (occasionally containing bentonite) that is mixed with the soils as the cutterhead excavates the soils away from the tunnel face. In the event that bentonite needs to be added to the slurry, the Data Sheet and SDS for Baroid Bore-Gel have been attached following this plan. The slurry provides two important functions: (1) Pressure Balance – the slurry provides a positive hydraulic pressure to the face of the tunnel that balances the in-situ soil and groundwater pressures; and (2) Spoil Transportation – the slurry allows the excavated soils to remain in a fluid-state to facilitate pumping away from the head back to a separation plant. The function of Pressure Balance is one of the many tremendous benefits of microtunneling as it eliminates the need for dewatering, which is extremely beneficial in environmentally sensitive areas.

A potential disadvantage to this method is that slurry pressure applied to the tunnel face could (if excessive pressures are applied) release slurry to a waterway/roadway by fracturing the soil. Realistically, slurry releases can occur anywhere along the microtunnel alignment; however, most releases occur where the vertical cover above the MTBM is at its least.

With our highly experienced crew, well-trained in all aspects of microtunneling, we greatly decrease the potential for inadvertent return of slurry. Nevertheless, unforeseen conditions and circumstances can lead to situations where inadvertent returns and/or surface spills may occur. To this end, VTS has developed a plan to control inadvertent slurry releases during microtunneling. The specific objectives of this plan are:

- Minimize the potential for slurry releases.
- Monitor all activities to detect slurry releases in a timely manner.
- Protect all environmentally sensitive areas.
- Ensure an organized, quick response to any releases.
- Contain any releases to the smallest possible area.
- Ensure that any required notifications and reports are completed.

The following pages provide specifics for VTS' Spill Response Plan.

1. Microtunneling "Rules"

A) All tunnel sites will have an on-site monitor of the tunneling operations.

B) The monitor will be equipped with a radio/cell phone to remain in contact with all equipment operators on the site.

C) At no time shall tunnel cuttings, mud, and/or materials or water contaminated with bentonite or other substances be allowed to enter the stream/water body/roadway or be placed where they may be washed into a stream/water body/roadway.

D) In the unlikely event of spills or inadvertent returns, the monitor shall immediately notify the Owner, the Engineer and the Project Manager and request that the problem be addressed. All work shall stop, and will not resume until the cleanup is completed.
E) Any inadvertent return that may occur will be immediately contained, cleaned up and all recovered material will be disposed of off-site.

2. **On-Site Response Equipment:** At a minimum, the following equipment will be available at, or near, the tunnel site:
   A) At least 50 heavy weight sealable sand bags (to be filled with gravel).
   B) Two large rolls of heavy weight plastic sheeting.
   C) Several 5-gallon hard plastic pails.
   D) Three heavy-duty push brooms.
   E) Three flat-blade shovels.
   F) T-posts and enough silt fence to encapsulate the work area.
   G) Absorbent pads.
   H) Vacuum Trailer.

3. **Best Management Practices (BMPs) for Microtunnel Operations:** The following sets of BMPs have been established by VTS to prevent tunneling operations from releasing tunnel fluids to the environment. The on-site monitor shall inspect and request repairs or replacement of the materials used to meet these BMPs throughout the tunnel process.
   A) A containment unit, fiber roll, straw wattle or silt fence will be installed between the Separation Plant and any water body/roadway. This protection is meant to prevent seepage occurring outside of the work area from reaching any water body/roadway. Excess supplies of containment materials, as listed above as Response Equipment, (i.e. silt fence, shovels, etc.) will be available for use as needed. A vacuum trailer of sufficient size, at least 2000 gallons, will be readily available in the unlikely event that a spill or inadvertent return occurs.

   B) In the event that an inadvertent return does occur, the response sequence will be to:
      i) Immediately stop all microtunneling operations and make the proper notifications.
      ii) The face pressure at the head of the MTBM will be reduced to avoid further discharges of slurry.
      iii) Determine the source or cause of the inadvertent return and coordinate with the microtunneling machine operator to eliminate or minimize further discharges, as feasible.
      iv) Completely contain the inadvertent return.
      v) Clean up the inadvertent return. If required, the vacuum trailer should immediately begin recovering the tunneling fluid.
      vi) Divert all tunneling fluids from entering any water body/roadway.
      vii) The cause of the inadvertent return will be corrected.

viii) Microtunneling will resume in accordance with this contingency plan and the personnel will continue to closely monitor the water body/roadway.

4. **Clean-up of Inadvertent Returns:** Any cleaning activity will be done with the approval of the Owner/Engineer/Contractor. When the inadvertent return clean-up activities have been completed, the collected material shall be properly disposed of off-site. The clean-up effort shall include removal of all materials, rubbish and construction debris.

5. **Upon Completion of Microtunneling Operations:**
   A) The launching and receiving shafts will be backfilled and returned to natural grade after completion of the tie-ins by the Prime Contractor.
   B) All tunneling fluids will be removed from the construction area and properly disposed of at an accepting off-site location.
   C) All protective measures (containment units, silt fence, plastic sheeting, etc.) will be removed unless otherwise recommended by the Owner/Engineer. In the event that the protective measures are left in place after microtunneling operations have ceased, provisions shall be made by the Owner/Engineer for their removal.

BORE-GEL®

Boring Fluid System – U.S. Patent Number 5,723,416

Description

BORE-GEL® single sack, boring fluid system is specially formulated for use in horizontal directional drilling (HDD) applications. BORE-GEL fluid system is a proprietary blended product using high-quality Wyoming sodium bentonite. When BORE-GEL system is mixed with fresh water, it develops an easy-to-pump slurry with desirable fluid properties for HDD.

Applications/Function

- Provide optimum gel strength with minimum viscosity for cuttings suspension and transport
- Improve borehole stability in poorly consolidated/cemented sands and gravel formations
- Reduce filtration by forming a thin filter cake with low permeability
- Lubricate pipe in microtunneling operations
- Produce a pumpable slurry with maximum amount of reactive solids for borehole stability

Advantages

- Minimizes the number of boring fluid products required
- Easy to mix and fast to yield
- Low viscosity minimizes pump pressures
- Provides lubricity for pulling product line
- NSF/ANSI Standard 60 certified
- Can be used in Water Wells in unconsolidated formations or when additional gel strengths are required to compensate for low annular velocity

Typical Properties

Appearance	Tan to gray powder
pH (4% slurry or 15 lb/bbl)	10.2
Bulk density, lb/ft^3	68 to 72 (compacted)

Rev. 5/2008 · IDP 032

Recommended Treatment

Add slowly and uniformly through a high-shear, jet-type mixer over one or more cycles of the volume of slurry. Continue to circulate and agitate the slurry until all unyielded bentonite is dispersed.

Recommended application amounts

Boring Application	lb/100 gal	kg/m^3
Normal boring conditions	25 – 35	30 – 42
Poorly consolidated sand/gravel	35 – 60	42 – 72
Lubrication fluid for microtunneling	50 – 60	60 – 72

Packaging

BORE-GEL fluid system is packaged in a 50-lb (22.7-kg) multiwall paper bag. The bag is sturdy, moisture resistant and easy to handle, store and transport.

Availability

BORE-GEL fluid system can be purchased through any Baroid Industrial Drilling Products Retailer. To locate the Baroid IDP retailer nearest you contact the Customer Service Department in Houston or your area IDP Sales Representative.

Baroid Industrial Drilling Products
Product Service Line, Halliburton
3000 N. Sam Houston Pkwy. E.
Houston, TX 77032

Customer Service	(800) 735-6075 Toll Free	(281) 871-4612
Technical Service	(877) 379-7412 Toll Free	(281) 871-4613

HALLIBURTON

SAFETY DATA SHEET

Product Trade Name: **BORE-GEL®**

Revision Date: 02-Apr-2015 **Revision Number:** 14

1. Identification

1.1. Product Identifier

Product Trade Name: BORE-GEL®
Synonyms: None
Chemical Family: Mineral
Internal ID Code HM003576

1.2 Recommended use and restrictions on use

Application: Viscosifier
Uses Advised Against No information available

1.3 Manufacturer's Name and Contact Details

Manufacturer/Supplier Baroid Fluid Services
Product Service Line of Halliburton
P.O. Box 1675
Houston, TX 77251
Telephone: (281) 871-4000
Emergency Telephone: (281) 575-5000

Prepared By Chemical Stewardship
Telephone: 1-580-251-4335
e-mail: fdunexchem@halliburton.com

1.4. Emergency telephone number

Emergency Telephone Number (281) 575-5000

2. Hazard(s) Identification

2.1 Classification in accordance with paragraph (d) of §1910.1200

Carcinogenicity	Category 1A - H350
Specific Target Organ Toxicity - (Repeated Exposure)	Category 1 - H372

2.2. Label Elements

Hazard Pictograms

Signal Word Danger

Hazard Statements H350 - May cause cancer
H372 - Causes damage to organs through prolonged or repeated exposure

Precautionary Statements

Prevention	P201 - Obtain special instructions before use P202 - Do not handle until all safety precautions have been read and understood P260 - Do not breathe dust/fume/gas/mist/vapors/spray P264 - Wash face, hands and any exposed skin thoroughly after handling P270 - Do not eat, drink or smoke when using this product P280 - Wear protective gloves/protective clothing/eye protection/face protection
Response	P308 + P313 - IF exposed or concerned: Get medical advice/attention P314 - Get medical attention/advice if you feel unwell
Storage	P405 - Store locked up
Disposal	P501 - Dispose of contents/container in accordance with local/regional/national/international regulations

Contains

Substances	**CAS Number**
Sodium carbonate	497-19-8
Crystalline silica, quartz	14808-60-7
Crystalline silica, cristobalite	14464-46-1
Crystalline silica, tridymite	15468-32-3

2.3 Hazards not otherwise classified

None known

3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - US
Sodium carbonate	497-19-8	1 - 5%	Eye Irrit. 2 (H319)
Crystalline silica, quartz	14808-60-7	1 - 5%	Carc. 1A (H350) STOT RE 1 (H372)
Crystalline silica, cristobalite	14464-46-1	0.1 - 1%	Carc. 1A (H350) STOT RE 1 (H372)
Crystalline silica, tridymite	15468-32-3	0.1 - 1%	Carc. 1A (H350) STOT RE 1 (H372)

The exact percentage (concentration) of the composition has been withheld as proprietary.

4. First-Aid Measures

4.1. Description of first aid measures

Inhalation	If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.
Eyes	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.
Skin	Wash with soap and water. Get medical attention if irritation persists.
Ingestion	Under normal conditions, first aid procedures are not required.

4.2 Most important symptoms/effects, acute and delayed

Breathing crystalline silica can cause lung disease, including silicosis and lung cancer. Crystalline silica has also been associated with scleroderma and kidney disease.

4.3. Indication of any immediate medical attention and special treatment needed

Notes to Physician Treat symptomatically.

5. Fire-fighting measures

5.1. Extinguishing media

Suitable Extinguishing Media

All standard fire fighting media

Extinguishing media which must not be used for safety reasons

None known.

5.2 Specific hazards arising from the substance or mixture

Special Exposure Hazards

None anticipated

5.3 Special protective equipment and precautions for fire-fighters

Special Protective Equipment for Fire-Fighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment. Avoid creating and breathing dust.
See Section 8 for additional information

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up

Collect using dustless method and hold for appropriate disposal. Consider possible toxic or fire hazards associated with contaminating substances and use appropriate methods for collection, storage and disposal.

7. Handling and storage

7.1. Precautions for Safe Handling

Handling Precautions

This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposure below recommended exposure limits. Wear a NIOSH certified, European Standard En 149, or equivalent respirator when using this product. Material is slippery when wet.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Storage Information

Use good housekeeping in storage and work areas to prevent accumulation of dust. Close container when not in use. Do not reuse empty container. Product has a shelf life of 12 months.

8. Exposure Controls/Personal Protection

8.1 Occupational Exposure Limits

Substances	CAS Number	OSHA PEL-TWA	ACGIH TLV-TWA
Sodium carbonate	497-19-8	Not applicable	Not applicable

Crystalline silica, quartz	14808-60-7	$\frac{10\ mg/m^3}{\%SiO2 + 2}$	TWA: 0.025 mg/m^3
Crystalline silica, cristobalite	14464-46-1	1/2 x $\frac{10\ mg/m^3}{\%SiO2 + 2}$	TWA: 0.025 mg/m^3
Crystalline silica, tridymite	15468-32-3	1/2 x $\frac{10\ mg/m^3}{\%SiO2 + 2}$	0.05 mg/m^3

8.2 Appropriate engineering controls

Engineering Controls Use approved industrial ventilation and local exhaust as required to maintain exposures below applicable exposure limits.

8.3 Individual protection measures, such as personal protective equipment

Personal Protective Equipment If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection Not normally needed. But if significant exposures are possible then the following respirator is recommended:
Dust/mist respirator. (N95, P2/P3)

Hand Protection Normal work gloves.

Skin Protection Wear clothing appropriate for the work environment. Dusty clothing should be laundered before reuse. Use precautionary measures to avoid creating dust when removing or laundering clothing.

Eye Protection Wear safety glasses or goggles to protect against exposure.

Other Precautions None known.

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State: Powder **Color:** Light brown or Gray

Odor: Mild earthy **Odor Threshold:** No information available

Property Remarks/ - Method	Values
pH:	8-10
Freezing Point/Range	No information available.
Melting Point/Range	No data available
Boiling Point/Range	No data available
Flash Point	No data available
Flammability (solid, gas)	No data available
upper flammability limit	No data available
lower flammability limit	No data available
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	2.5
Water Solubility	Partly soluble
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available

Oxidizing Properties No information available

9.2. Other information
VOC Content (%) No data available

10. Stability and Reactivity

10.1. Reactivity
Not expected to be reactive.

10.2. Chemical Stability
Stable

10.3. Possibility of Hazardous Reactions
Will Not Occur

10.4. Conditions to Avoid
None anticipated

10.5. Incompatible Materials
Hydrofluoric acid.

10.6. Hazardous Decomposition Products
Amorphous silica may transform at elevated temperatures to tridymite (870 C) or cristobalite (1470 C).

11. Toxicological Information

11.1 Information on likely routes of exposure
Principle Route of Exposure Eye or skin contact, inhalation.

11.2 Symptoms related to the physical, chemical and toxicological characteristics
Acute Toxicity

Inhalation

Inhaled crystalline silica in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (IARC, Group 1). There is sufficient evidence in experimental animals for the carcinogenicity of tridymite (IARC, Group 2A).

Breathing silica dust may cause irritation of the nose, throat, and respiratory passages. Breathing silica dust may not cause noticeable injury or illness even though permanent lung damage may be occurring. Inhalation of dust may also have serious chronic health effects (See "Chronic Effects/Carcinogenicity" subsection below).

Eye Contact May cause mechanical irritation to eye.
Skin Contact May cause mechanical skin irritation.
Ingestion None known

Chronic Effects/Carcinogenicity Silicosis: Excessive inhalation of respirable crystalline silica dust may cause a progressive, disabling, and sometimes-fatal lung disease called silicosis. Symptoms include cough, shortness of breath, wheezing, non-specific chest illness, and reduced pulmonary function. This disease is exacerbated by smoking. Individuals with silicosis are predisposed to develop tuberculosis.

Cancer Status: The International Agency for Research on Cancer (IARC) has determined that crystalline silica inhaled in the form of quartz or cristobalite from occupational sources can cause lung cancer in humans (Group 1 - carcinogenic to humans) and has determined that there is sufficient evidence in experimental animals for the carcinogenicity of tridymite (Group 2A - possible carcinogen to humans). Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997) in conjunction with the use of these minerals. The National Toxicology Program classifies respirable crystalline silica as "Known to be a human carcinogen". Refer to the 9th Report on Carcinogens (2000). The American Conference of Governmental Industrial Hygienists (ACGIH) classifies crystalline silica, quartz, as a suspected human carcinogen (A2).

There is some evidence that breathing respirable crystalline silica or the disease silicosis is associated with an increased incidence of significant disease endpoints such as scleroderma (an immune system disorder manifested by scarring of the lungs, skin, and other internal organs) and kidney disease.

11.3 Toxicity data

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Sodium carbonate	497-19-8	4090 mg/kg (Rat) 2800 mg/kg (Rat)	2210 mg/kg (Mouse) > 2000 mg/kg (Rabbit)	2.3 mg/L (Rat) 2h
Crystalline silica, quartz	14808-60-7	500 mg/kg (Rat) >15,000 mg/kg (Human)	No data available	No data available
Crystalline silica, cristobalite	14464-46-1	500 mg/kg (Rat)	No data available	No data available
Crystalline silica, tridymite	15468-32-3	500 mg/kg (Rat)	No data available	No data available

Substances	CAS Number	Skin corrosion/irritation
Sodium carbonate	497-19-8	Non-irritating to the skin
Crystalline silica, quartz	14808-60-7	Non-irritating to the skin
Crystalline silica, cristobalite	14464-46-1	Non-irritating to the skin
Crystalline silica, tridymite	15468-32-3	Non-irritating to the skin

Substances	CAS Number	Eye damage/irritation
Sodium carbonate	497-19-8	Irritating to eyes.
Crystalline silica, quartz	14808-60-7	Mechanical irritation of the eyes is possible.
Crystalline silica, cristobalite	14464-46-1	Mechanical irritation of the eyes is possible.
Crystalline silica, tridymite	15468-32-3	Mechanical irritation of the eyes is possible.

Substances	CAS Number	Skin Sensitization
Sodium carbonate	497-19-8	Not classified
Crystalline silica, quartz	14808-60-7	Not regarded as a sensitizer.
Crystalline silica, cristobalite	14464-46-1	Not regarded as a sensitizer.
Crystalline silica, tridymite	15468-32-3	Not regarded as a sensitizer.

Substances	CAS Number	Respiratory Sensitization
Sodium carbonate	497-19-8	No information available
Crystalline silica, quartz	14808-60-7	No information available

Crystalline silica, cristobalite	14464-46-1	No information available
Crystalline silica, tridymite	15468-32-3	No information available

Substances	CAS Number	Mutagenic Effects
Sodium carbonate	497-19-8	In vivo tests did not show mutagenic effects.
Crystalline silica, quartz	14808-60-7	Not regarded as mutagenic.
Crystalline silica, cristobalite	14464-46-1	Not regarded as mutagenic.
Crystalline silica, tridymite	15468-32-3	Not regarded as mutagenic.

Substances	CAS Number	Carcinogenic Effects
Sodium carbonate	497-19-8	Not regarded as carcinogenic.
Crystalline silica, quartz	14808-60-7	Contains crystalline silica which may cause silicosis, a delayed and progressive lung disease. The IARC and NTP have determined there is sufficient evidence in humans of the carcinogenicity of crystalline silica with repeated respiratory exposure. Based on available scientific evidence, this substance is a threshold carcinogen with a mode of action involving indirect genotoxicity secondary to lung injury.
Crystalline silica, cristobalite	14464-46-1	Contains crystalline silica which may cause silicosis, a delayed and progressive lung disease. The IARC and NTP have determined there is sufficient evidence in humans of the carcinogenicity of crystalline silica with repeated respiratory exposure. Based on available scientific evidence, this substance is a threshold carcinogen with a mode of action involving indirect genotoxicity secondary to lung injury.
Crystalline silica, tridymite	15468-32-3	Contains crystalline silica which may cause silicosis, a delayed and progressive lung disease. The IARC and NTP have determined there is sufficient evidence in humans of the carcinogenicity of crystalline silica with repeated respiratory exposure. Based on available scientific evidence, this substance is a threshold carcinogen with a mode of action involving indirect genotoxicity secondary to lung injury.

Substances	CAS Number	Reproductive toxicity
Sodium carbonate	497-19-8	Did not show teratogenic effects in animal experiments.
Crystalline silica, quartz	14808-60-7	No information available
Crystalline silica, cristobalite	14464-46-1	No information available
Crystalline silica, tridymite	15468-32-3	No information available

Substances	CAS Number	STOT - single exposure
Sodium carbonate	497-19-8	None under normal use conditions
Crystalline silica, quartz	14808-60-7	No significant toxicity observed in animal studies at concentration requiring classification.
Crystalline silica, cristobalite	14464-46-1	No significant toxicity observed in animal studies at concentration requiring classification.
Crystalline silica, tridymite	15468-32-3	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	STOT - repeated exposure
Sodium carbonate	497-19-8	No information available
Crystalline silica, quartz	14808-60-7	Causes damage to organs through prolonged or repeated exposure if inhaled: (Lungs)
Crystalline silica, cristobalite	14464-46-1	Causes damage to organs through prolonged or repeated exposure if inhaled: (Lungs)
Crystalline silica, tridymite	15468-32-3	Causes damage to organs through prolonged or repeated exposure if inhaled: (Lungs)

Substances	CAS Number	Aspiration hazard
Sodium carbonate	497-19-8	Not applicable
Crystalline silica, quartz	14808-60-7	Not applicable
Crystalline silica, cristobalite	14464-46-1	Not applicable
Crystalline silica, tridymite	15468-32-3	Not applicable

12. Ecological Information

12.1. Toxicity

Ecotoxicity Effects

Product Ecotoxicity Data

No data available

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Sodium carbonate	497-19-8	EC50 242 mg/L (Nitzschia)	TLM24 385 mg/L (Lepomis macrochirus) LC50 310-1220 mg/L (Pimephales promelas) LC50 (96h) 300 mg/L (Lepomis macrochirus)	No information available	EC50 265 mg/L (Daphnia magna) EC50 (48h) 200 – 227 mg/L (Ceriodaphnia sp.)
Crystalline silica, quartz	14808-60-7	No information available	LL50 (96h) 10,000 mg/L (Danio rerio) (similar substance)	No information available	LL50 (24h) > 10,000 mg/L (Daphnia magna) (similar substance)
Crystalline silica, cristobalite	14464-46-1	No information available	LL0 (96h) 10,000 mg/L (Danio rerio) (similar substance)	No information available	LL50 (24h) > 10,000 mg/L (Daphnia magna) (similar substance)
Crystalline silica, tridymite	15468-32-3	No information available	LL0 (96h) 10,000 mg/L(Danio rerio) (similar substance)	No information available	LL50 (24h) > 10,000 mg/L (Daphnia magna) (similar substance)

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Sodium carbonate	497-19-8	The methods for determining biodegradability are not applicable to inorganic substances.
Crystalline silica, quartz	14808-60-7	The methods for determining biodegradability are not applicable to inorganic substances.
Crystalline silica, cristobalite	14464-46-1	The methods for determining biodegradability are not applicable to inorganic substances.
Crystalline silica, tridymite	15468-32-3	The methods for determining biodegradability are not applicable to inorganic substances.

12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow
Sodium carbonate	497-19-8	No information available
Crystalline silica, quartz	14808-60-7	No information available
Crystalline silica, cristobalite	14464-46-1	No information available
Crystalline silica, tridymite	15468-32-3	No information available

12.4. Mobility in soil

No information available

Substances	Mobility
Sodium carbonate	No information available

12.5 Other adverse effects

No information available

13. Disposal Considerations

13.1. Waste treatment methods

Disposal Method If practical, recover and reclaim, recycle, or reuse by the guidelines of an approved local reuse program. Should contaminated product become a waste, dispose of in a licensed industrial landfill according to federal, state, and local regulations.

Contaminated Packaging Follow all applicable national or local regulations.

14. Transport Information

US DOT

UN Number:	Not restricted
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

US DOT Bulk

DOT (Bulk)	Not applicable

Canadian TDG

UN Number:	Not restricted
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IMDG/IMO

UN Number:	Not restricted
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IATA/ICAO

UN Number:	Not restricted
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code: Not applicable
Special Precautions for User: None

15. Regulatory Information

US Regulations

US TSCA Inventory	All components listed on inventory or are exempt.
EPA SARA Title III Extremely Hazardous Substances	Not applicable
EPA SARA (311,312) Hazard Class	Chronic Health Hazard
EPA SARA (313) Chemicals	This product does not contain a toxic chemical for routine annual "Toxic Chemical Release Reporting" under Section 313 (40 CFR 372).
EPA CERCLA/Superfund Reportable Spill Quantity	Not applicable.
EPA RCRA Hazardous Waste Classification	If product becomes a waste, it does NOT meet the criteria of a hazardous waste as defined by the US EPA.
California Proposition 65	The California Proposition 65 regulations apply to this product.

MA Right-to-Know Law	One or more components listed.
NJ Right-to-Know Law	One or more components listed.
PA Right-to-Know Law	One or more components listed.

Canadian Regulations

Canadian DSL Inventory	All components listed on inventory or are exempt.

16. Other information

Preparation Information

Prepared By	Chemical Stewardship Telephone: 1-580-251-4335 e-mail: fdunexchem@halliburton.com
Revision Date:	02-Apr-2015
Reason for Revision	Update to Format SECTION: 2

Additional information
For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key or legend to abbreviations and acronyms
bw – body weight
CAS – Chemical Abstracts Service
EC50 – Effective Concentration 50%
ErC50 – Effective Concentration growth rate 50%
LC50 – Lethal Concentration 50%
LD50 – Lethal Dose 50%
LL50 – Lethal Loading 50%
mg/kg – milligram/kilogram
mg/L – milligram/liter
NIOSH – National Institute for Occupational Safety and Health
NTP – National Toxicology Program
OEL – Occupational Exposure Limit
PEL – Permissible Exposure Limit
ppm – parts per million
STEL – Short Term Exposure Limit
TWA – Time-Weighted Average
UN – United Nations
h - hour
mg/m^3 - milligram/cubic meter
mm - millimeter
mmHg - millimeter mercury
w/w - weight/weight
d - day

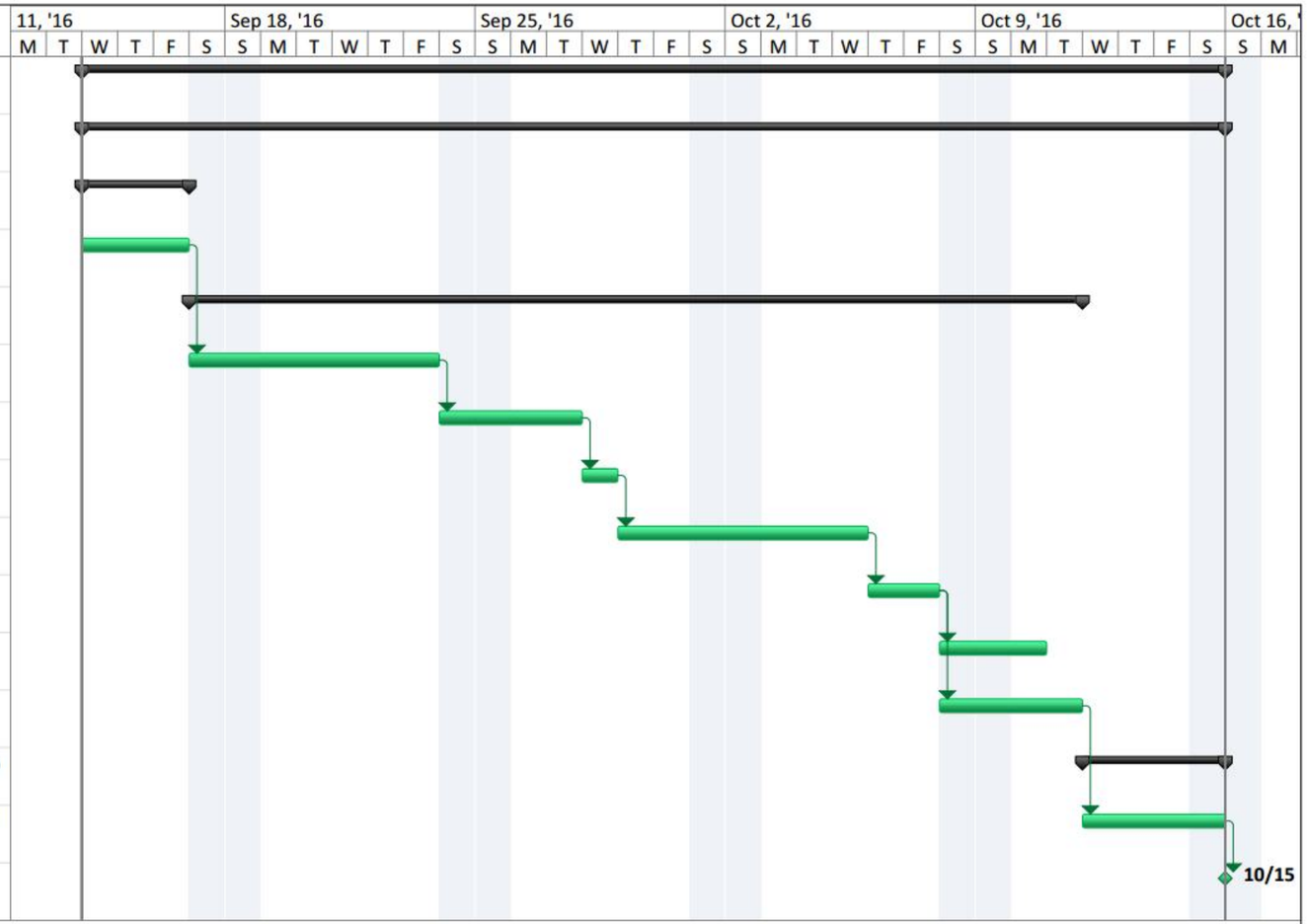
Key literature references and sources for data
www.ChemADVISOR.com/

Disclaimer Statement

This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

End of Safety Data Sheet

ID	Task Mode	Task Name	Duration	Start
1		**PGE L-101 San Francisquito Creek (10 hrs/day - 6 days/week)**	**28 days**	**Wed 9/14/16**
2		**24" Microtunneling**	**28 days**	**Wed 9/14/16**
3		**Mobilization**	**3 days**	**Wed 9/14/16**
4		Mobilize Micro Tunnel Equipment	3 days	Wed 9/14/16
5		**Microtunnel Drive No.1**	**21 days**	**Sat 9/17/16**
6		Setup Surface & Pit & Equipment	6 days	Sat 9/17/16
7		Thrust Block & Entrance Ring	3 days	Sat 9/24/16
8		Launch Tunnel Machine	1 day	Wed 9/28/16
9		Microtunnel 24 Steel Casing (300lf) Single Shift 10-hours	6 days	Thu 9/29/16
10		Retrieve MTBM & Slurry Lines/Cables	2 days	Thu 10/6/16
11		Breakdown Separation Plant	2 days	Sat 10/8/16
12		Install Gas Line & Cycle out casing Single Shift (100-foot per Shift by ARB)	3 days	Sat 10/8/16
13		**Final Cleanup**	**4 days**	**Wed 10/12/16**
14		Final Cleanup & Demobilization	4 days	Wed 10/12/16
15		Project Finish	0 days	Sat 10/15/16

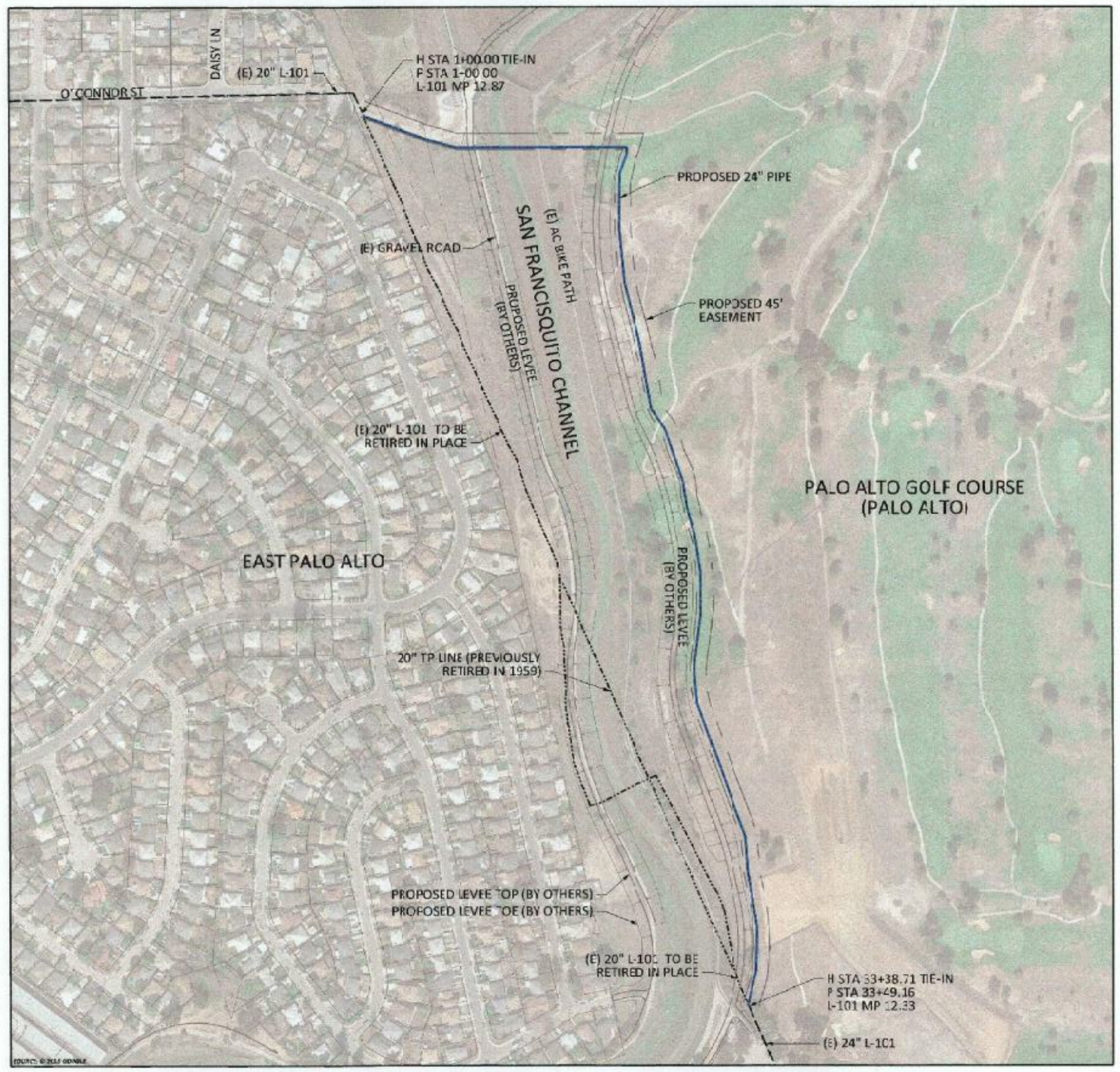


Project: 4 L-101 Palo Alto Microtu
Date: Thu 6/23/16

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline			
Split	External Tasks	Inactive Summary	Manual Summary	Progress			
Milestone	External Milestone	Manual Task	Start-only				
Summary	Inactive Task	Duration-only	Finish-only				

CP AREA # L101-PEN
WALL MAP 3280
PLAT I6, I7, J7
SANTA CLARA COUNTY
SAN MATEO COUNTY

L-101, MP 12.33 - 12.87
Relocate 3,350 Feet of 24" Pipe
San Francisquito Creek - Palo Alto, East Palo Alto



VICINITY SKETCH
NOT TO SCALE
PALO ALTO & EAST PALO ALTO, CA

SCHEDULE OF SHEETS

SAFETY PLEDGE

OSCAR H. ROSALES M18299 MECHANICAL STATE OF CALIFORNIA

811 Know what's Below. Call before you dig.

ZERO IN ON SAFETY

NO.	DATE	DESCRIPTION						APVD BY
0	11/17/15	ISSUED FOR CONSTRUCTION	31189651	DSK	CDB6	KIF7	OHR1	JDG4

REVISIONS

APPROVED BY	
PSRS	40993
SUPV	KIF7
DSGN	DSK
DWN	DSK
CHKD	CDB6
QK	
DATE	11-17-15
SCALES	AS SHOWN

PIPELINE - TITLE & INDEX
L-101 MP 12.33 - 12.87
RELOCATE 3,350 FEET OF 24" PIPE
PALO ALTO, SANTA CLARA
EAST PALO ALTO, SAN MATEO
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

BILL OF MATL	SEE SHEET 11
REF DWG LIST	SEE SHEET 2
SUPSDS	
SUPSD BY	
SHEET NO.	1 OF 12 SHEETS

31189651 0

31189651-S001-T1.dgn
17-NOV-2015 17:18PM

SUMMARY OF PROPOSED WORK:

1. INSTALL APPROX. 3,218 FEET OF 24" STEEL PIPE.
2. INSTALL APPROX. 131 FEET OF 20" STEEL PIPE.
3. TRENCH AND BACKFILL.
4. MICRO-TUNNEL AT THE SAN FRANCISQUITO CREEK CROSSING.
5. HYDROSTATICALLY TEST NEW MAIN LINE.
6. RET RE APPROX. 2,950 FEET OF 20" STEEL PIPE.
7. INSTALL (3) PIPELINE MARKERS.
8. INSTALL (2) CTS STATIONS.

SEQUENCE OF OPERATIONS:

1. INSTALL APPROX. 3,220 FT OF 24" PIPE.
2. MICROTUNNEL APPROX. 320 FT UNDER SAN FRANCISQUITO CREEK.
3. INSTALL APPROX. 131 FT OF 20" PIPE.
4. HYDROSTATICALLY TEST NEW 24" AND 20" PIPE.
5. ISOLATE USING APPROVED CLEARANCE.
6. TIE-IN NEW 24" AND 20' PIPE TO EXISTING L-101.

CONSTRUCTION NOTES:

GENERAL REQUIREMENTS:

1. UNDERGROUND SERVICE ALERT :
   CALL 811 (1-800-227-2600) A MINIMUM OF 2 BUSINESS DAYS (NOT INCLUDING INITIAL DAY OF CONTACT) IN ADVANCE FOR THE MARKING OF UNDERGROUND UTILITIES, INCLUDING ALL NON-UTILITIES BEFORE YOU DIG, GRADE, OR EXCAVATE.

2. UTILITY NOTES:
   A. DIMENSIONS SHOWN ON THESE DRAWINGS ARE BASED ON THE BEST AVAILABLE INFORMATION FROM SEVERAL SOURCES, AND SHALL BE VERIFIED IN THE FIELD BY CONSTRUCTION PERSONNEL PRIOR TO FABRICATION.
   B. THE INFORMATION SHOWN ON THESE DRAWINGS CONCERNING TYPE AND LOCATION OF UNDERGROUND UTILITIES, PROPERTY LINES, AND OTHER SUBSTRUCTURES IS NOT GUARANTEED TO BE ACCURATE OR ALL-INCLUSIVE, UNLESS OTHERWISE NOTED. CONSTRUCTION PERSONNEL ARE RESPONSIBLE FOR MAKING ALL DETERMINATIONS AS TO THE TYPE AND LOCATION OF UNDERGROUND UTILITIES AND OTHER SUBSTRUCTURES AS NECESSARY TO AVOID DAMAGE OR ENCROACHMENTS.
   C. PROSPECTING IS REQUIRED AHEAD OF WORK. ALL OFFSETS OR ROPING WILL NEED TO BE APPROVED BY THE PG&E PROJECT ENGINEER (PED), AND REDLINED DETAILS SHOWN ON PROFILE AND CONSTRUCTION DETAIL SHEETS OF EACH ADDITIONAL SUBSTRUCTURE.
   D. ALL EXCAVATIONS WITHIN EXISTING STATIONS SHALL BE HAND DUG OR EXCAVATED USING SOFT DIG METHODS (e.g. VACUUM EXCAVATIONS OR SIMILAR).

3. ELBOWS AND FIELD BENDS:
   A. ALL BENDS ARE SMOOTH FIELD BENDS, EXCEPT WHERE ELBOWS ARE SHOWN. FIELD BENDS SHALL BE MADE IN ACCORDANCE WITH A-36, SECTION 4D. FIELD BENDS MAY BE USED IN LIEU OF ELBOWS WHEN PREAPPROVED BY THE PG&E PROJECT ENGINEER (PED).
   B. IN ORDER TO AVOID EXCESSIVE STRAIN ON THE PIPELINE, THERE SHALL BE A MINIMUM SEPARATION OF 5 FEET BETWEEN A ROPED SECTION OF PIPELINE AND ANY ELBOWS OR FIELD BENDS.
   C. ALL ANGLES SHOWN IN THE PLAN AND PROFILE ARE APPROXIMATE AND SHALL BE CUT TO SUIT FIELD CONDITIONS.

4. SEPARATION FROM OTHER STRUCTURES:
   A. CROSSING UNDERGROUND FACILITIES: PG&E PIPELINE MUST BE INSTALLED WITH AT LEAST 24 INCHES OF CLEARANCE FROM ANY OTHER SUBSTRUCTURE/UTILITY NOT ASSOCIATED WITH THE PIPELINE UNLESS NOTED ON THE DRAWINGS.
   B. PARALLELING UNDERGROUND FACILITIES: THIS PIPELINE MUST BE INSTALLED WITH AT LEAST 5 FEET OF CLEARANCE FROM ANY OTHER UNDERGROUND STRUCTURE/UTILITY NOT ASSOCIATED WITH THE PIPELINE UNLESS NOTED ON THE DRAWINGS.

5. RESTORATION AND CLEAN UP:
   A. RESTORATION OF PUBLIC STREETS, SIDEWALKS, CURBS, ETC. ABOVE PIPE BEDDING SHALL BE IN ACCORDANCE WITH THE LATEST CITY, COUNTY, OR AGENCY STANDARDS.
   B. WHERE EVER THERE ARE ROW CROPS, THE TOPSOIL SHALL BE REMOVED TO A DEPTH OF 12" AND STORED ON SITE. UPON COMPLETION OF CONSTRUCTION, THE TOPSOIL SHALL BE RESTORED. TAKE CARE TO PREVENT MIXING OF TOPSOIL AND SUBSOI..

6. EXISTING GIRTH WELDS, AT TIE-IN LOCATIONS, SHALL BE IDENTIFIED AND REMOVED IF PRACTICAL.

7. WELDING REQUIREMENTS:
   A. ALL ARC WELDING IS TO BE PERFORMED IN ACCORDANCE WITH THE GAS WELDING CONTROL MANUAL TD-4160M. ALL CANS OR SPOOLS SHALL BE A MINIMUM LENGTH OF ONE PIPE DIAMETER WHENEVER POSSIBLE.
   B. INSTALL TEST STATIONS WITH THERMITE WELD CONNECTION IN ACCORDANCE WITH GAS T & D CORROSION CONTROL MANUAL O-10, O-10.1 AND O-10.2.

8. WELDING:
   WHEN INTERNAL MISALIGNMENT EXCEEDS 0.064", BACKWELD ANY GIRTH WELD WHERE THERE IS ACCESS TO THE INSIDE OF THE WELD. WHERE THERE IS NO ACCESS TO THE INSIDE OF THE WELD, MACHINE BORING OR GRINDING IS REQUIRED. BACKWELDING, GRINDING, OR BORING MUST BE DONE IN ACCORDANCE WITH THE APPROPRIATE UTILITY PROCEDURE IN THE GAS WELDING CONTROL MANUAL TD-4160M.

9. STRENGTH TEST REQUIREMENTS
   A. STRENGTH TESTING SHALL MEET PRESSURE AND DURATION REQUIREMENTS OF GAS STANDARD A-54 AND SHALL BE CONDUCTED IN ACCORDANCE WITH UTILITY PROCEDURE TD-4137S.
   B. ALL WELDS THAT HAVE NOT BEEN STRENGTH TESTED AND ALL FITTINGS SHALL BE SOAP TESTED AT 100 PSI AND AT OPERATING PRESSURE BEFORE COATING CAN OCCUR.

10. PAINTING AND COATING REQUIREMENTS:
    A. ALL EXPOSED PIPE AND FITTINGS ARE TO BE PAINTED IN ACCORDANCE WITH GAS STANDARD E-30. ALL COATING ON BURIED PIPE AND FITTINGS ARE TO BE APPLIED IN ACCORDANCE WITH GAS STANDARD E-35.
    B. FOR COATING SELECTIONS ON BURIED PIPE, SEE DIRECT BURIAL COATING SELECTIONS TABLE.

11. DOCUMENTATION OF INSPECTION OF EXISTING PIPELINE:
    WHENEVER EXISTING BURIED GAS FACILITIES ARE EXCAVATED DURING ENGINEERING OR DURING CONSTRUCTION, AN A-FORM (TD-4110P-03-F01) SHALL BE COMPLETED FOR THE GENERAL INSPECTION. THIS ALSO APPLIES TO GAS FACILITIES BEING DEACTIVATED. THE COMPLETED A-FORM SHALL BE SUBMITTED WITH THE AS-BUILT PACKAGE.

12. TIE-IN AND CLEARANCE PROCEDURE TO BE PREPARED AND PERFORMED IN ACCORDANCE WITH THE FOLLOWING WORK PROCEDURES:
    A. WP 4100-01, HOT AND COLD WORK METHODS FOR NATURAL GAS TRANSMISSION PIPELINE SHUTDOWN AND TIE-IN.
    B. WP 4100-10, GAS CLEARANCE PROCEDURES FOR FACILITIES OPERATING OVER 60 PSIG.

13. COATING REMOVAL:
    A. PERFORM THE FOLLOWING STEPS, IN ACCORDANCE WITH TD-4711P-01, BEFORE REMOVING ASPHALTIC PIPE WRAP ON PIPELINES INSTALLED PRIOR TO 1972 (BASED ON PG&E ANALYSIS, PIPE INSTALLED IN 1972 OR LATER DOES NOT HAVE PIPE WRAP THAT CONTAINS ASBESTOS):
       1. REFER TO THE "EXISTING PIPE SPECS (PRE-1972)" STAMP TO DETERMINE IF A SAMPLE HAS BEEN COLLECTED OR IF A SAMPLE IS REQUIRED:
          a. "YES" REPRESENTS HISTORICAL RESULTS ARE AVAILABLE SHOWING THAT PIPE WRAP CONTAINS ASBESTOS. NO SAMPLE IS REQUIRED.
          b. "NO" REPRESENTS HISTORICAL RESULTS ARE AVAILABLE AND THE PIPE WRAP DOES NOT CONTAIN ASBESTOS (CONTENT WAS NON DETECT). NO SAMPLE IS REQUIRED.
          c. "UNKNOWN" REPRESENTS NO HISTORICAL RESULTS ARE AVAILABLE. A SAMPLE IS REQUIRED IF THE PIPE INSTALLATION DATE IS PRIOR TO 1972.
       2. WHEN A PIPE WRAP SAMPLE IS REQUIRED TO BE ANALYZED FOR ASBESTOS:
          a. COLLECT SAMPLE PER TD-4711P-01 AND COMPLETE CHAIN OF CUSTODY FORM TD-4711P-01-F01.
          b. FILE PINK COPY OF THE CHAIN OF CUSTODY FOEM AND FINAL LABORATORY RESULTS WITH THE AS-BUILTS.
       3. WHEN REMOVING PIPE WRAP THAT CONTAINS ASBESTOS, OR FOR EMERGENCY WORK, FOLLOW TD-4711P-01 "PIPE WRAP REMOVAL, HANDLING AND DISPOSAL".

CATHODIC PROTECTION NOTES:

1. THE PERSON FILLING OUT THE A-FORM (TD-4110P-03-F01) S RESPONSIBLE FOR BOTH THE INTERNAL CORROSION AND EXTERNAL CORROSION INSPECTION OF THE PIPELINE.
2. UPON COMPLETION OF BORINGS, CONTACT THE CORROSION SUPERVISOR FOR THE LOCAL AREA/DIVISION TO PERFORM CURRENT DRAIN TESTS ON THE PIPELINE SEGMENT THAT WAS INSTALLED IN THE BORE. THE CURRENT DRAIN TEST MUST BE PERFORMED PRIOR TO WELDING PIPE ON EITHER SIDE OF THE BORE.
3. FOR THE INSTALLATION OF THE OMNIMETRIX RECTIFIER REMOTE MONITOR, CONTACT THE CORROSION SUPERVISOR FOR THE LOCAL AREA/DIVISION.
4. BONDING CABLES TO BE INSTALLED ACROSS PIPELINE CUT-OUTS AT ALL LOCATIONS THE PIPELINE IS SEVERED PRIOR TO REMOVAL. CHAIN CLAMPS, MAGNETIC CLAMPS, OR OTHER CONSTRUCTION MANAGEMENT APPROVED CLAMPS AND #6 (MIN) STRANDED CABLE SHALL BE UTILIZED. CLAMPS TO REMAIN IN PLACE UNTIL PIPELINE IS TIED IN.

RETIREMENT PROCEDURE FOR EXISTING PIPE:

1. GT&D UTILITY WORK PROCEDURE TD 9500P-16, "DEACTIVATION AND/OR RETIREMENT OF UNDERGROUND GAS FACILITIES," SHALL BE FOLLOWED.
2. THE EXISTING PIPE SECTIONS SHALL HAVE FREE LIQUIDS REMOVED AND BE 100% PURGED PER GAS DESIGN STANDARD A-38, "PROCEDURES FOR PURGING GAS FACILITIES."
3. THE PIPE SHALL BE SECTIONALIZED AT INTERVALS AS SPECIFIED IN THE RETIREMENT PLAN. THE LOCATIONS CALLED OUT ARE APPROXIMATE AND ARE SUBJECT TO FIELD VERIFICATION TO IDENTIFY THE MOST OPTIMUM LOCATION IN THAT VICINITY. ACCURATE SURVEY DATA MAY NOT BE AVAILABLE FOR THESE LOCATIONS SO USE CAUTION DURING EXCAVATION AND WHEN IDENTIFYING THE PIPELINE TO BE RETIRED. OTHER ACTIVE PIPELINES MAY BE IN THE AREA.
4. AT EACH SUCH LOCATION NOTED ABOVE, A PIECE OF PIPE AT LEAST 24" LONG SHALL BE REMOVED. INSTALL A 1" HIGH PRESSURE SAVE-A-VALVE (H-17491, M022287) TO CHECK FOR PRODUCT AND PRESSURE PRIOR TO CUTTING INTO THE PIPELINE. THE OPEN ENDS OF THE RETIRED PIPE SHALL BE SEALED BY THE MOST APPROPRIATE METHOD OUTLINED IN GT&D UTILITY WORK PROCEDURE TD-9500P-16. BACKFILL MUST BE THOROUGHLY COMPACTED IN PLACE OF THE REMOVED SECTION OF PIPE.

DESIGN CHANGE PROCEDURE

MAINTENANCE AND CONSTRUCTION PERSONNEL MUST OBTAIN APPROVAL FROM THE PROJECT ENGINEER (PED) BEFORE MAKING ANY DESIGN CHANGE TO GAS FACILITIES PER WP-4900.

JOB SPECIFIC NOTES

ALL FIELD CHANGES REQUIRE APPROVAL BY PROJECT ENGINEER (PED). SEE CONTACT INFORMATION.

CONTACT INFORMATION:

PROJECT MANAGER	----	JEFF HAHN	925-244-3253
PROJECT ENGINEER (PED)	----	JOSE QUINTERO	925 244-3208
RESPONSIBLE ENGINEER (RE)	----	OSCAR ROSALES	925-328-5968
PIPELINE ENGINEER (PLE)	----	ELPINIKE PAPPOUS	925-328-6169
ESTIMATOR / DESIGNER	----	DEAN SCHMITZ	925-244-3493
FIELD ENGINEER	----	GIAN CERVONE	707-775-8608
CONSTRUCTION MANAGER	----	CHRIS WILLAMS	209-272-2811
LAND PLANNER	----	MALLORY CLAY	925-951-3568
ENVIRONMENTAL	----	TIM ANDREWS	415-693-8212
ENVIRONMENTAL - WATER	----	STEPHEN QUALE	510-316-3644
CORROSION ENGINEER	----	JONATHON RIGOTTI	925-328-5876
TRANSMISSION PLANNER	----	STEWART LEE	925-788-0675
I&R (CLEARANCES)	----	VERN LOPES	650-766-3851

REFERENCE DRAWINGS:

OPERATING MAP	----	384522 REV 81 (SHT 2 OF 3) MILPITAS TERMINAL TO LOMITA PARK METER STATION LINES 101, 109, 132, & 147
PLAT SHEETS	----	3280 (I6, I7, J7)
AS BUILT	----	GM #144674
DRAWING	----	381100 (75-76)

REGISTERED PROFESSIONAL ENGINEER OSCAR H. ROSALES M18299 MECHANICAL STATE OF CALIFORNIA

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NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
0	12/2/15	ISSUED FOR CONSTRUCTION	31189651	DJSK	CDB6	KJF7	DHR7

REVISIONS

APPROVED BY	
PSRS 40993	
SUPV KJF7	
DSGN DJSK	
DWN DJSK	
CHKD CDB6	
OK	
DATE 11-17-15	
SCALES AS SHOWN	

JDG4
DHR7

PIPELINE - CONSTRUCTION NOTES
L-101 MP 12.33 - 12.87
RELOCATE 3,350 FEET OF 24" PIPE
PALO ALTO, SANTA CLARA
EAST PALO ALTO, SAN MATEO
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

BILL OF MATL	SEE SHEET 11
REF DWG LIST	SEE SHEET 2
SUPSD#	
SUPSD BY	
SHEET NO.	2 OF 12 SHEETS

31189651 | 0

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17-NOV-2015 12:18PM

DIRECT BURIAL COATING SELECTIONS LISTED IN ORDER OF PREFERENCE	
MAIN LINE COATING	FBE
MINOR REPAIRS	3M SCOTCHKOTE 323, PROTAL 7200, FBE
TIE-IN WELDS	3M SCOTCHKOTE 323, PROTAL 7200, FBE
GIRTH WELDS	3M SCOTCHKOTE 323, PROTAL 7200, FBE
BUTT WELDED FITTINGS	3M SCOTCHKOTE 323, PROTAL 7200, FBE
VALVE ASSEMBLIES	3M SCOTCHKOTE 323, PROTAL 7200, DEVGRIP 238
SHORT SEGMENTS OF PIPE	3M SCOTCHKOTE 323, PROTAL 7200, FBE
AIR-TO-SOIL TRANSITIONS	PROTAL 7200 / PSX 700
PRESSURE CONTROL FITTINGS	BODY: PROTAL 7200 FLANGE: WAXTAPE
TIE-INS/COATING TRANSITIONS	PROTAL 7200, WAX TAPE, POLYKEN TAPE
BORED COATING SELECTIONS LISTED IN ORDER OF PREFERENCE	
MAIN LINE COATING	ARC APPLIED OVER FBE
MINOR REPAIRS	PROTAL 7200, POWERCRETE J, 3M SCOTCHKOTE 323
TIE-IN WELDS	ARC OVER FBE, PROTAL 7200, POWERCRETE J

NOTES:

1) CONTACT THE PIPELINE ENGINEER (PLE) TO REQUEST A VARIANCE FROM THE ABOVE COATING SELECTIONS.
2) ALL COATINGS ARE TO BE APPLIED IN ACCORDANCE WITH 55&S E-30 AND E-35.

INTERNAL CORROSION (IC) DESIGN & CONSTRUCTION REVIEW		
IC THREAT (PER RMP-16)	YES X	NO
IC REVIEW COMPLETED BY (CORROSION ENGINEER OR DESIGNATE)	LAN ID	DATE
CORROSION ENGINEERING HAS REVIEWED THIS DESIGN AND INCORPORATED ANY NECESSARY IC DESIGN AND CONSTRUCTION CONSIDERATIONS. DOCUMENTATION OF THE REVIEW AND ACTIONS TAKEN ARE IN THE JOB PACKAGE AND INCORPORATED IN THIS DESIGN.	JBRL	07-13-15
EDRS ROUTING NUMBER:	2015-59975	

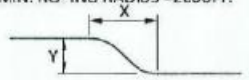
INSTALLATION TESTED OR INSPECTED AND NOTED ON DRAWING.
ALL CORROSION LEVELS SATISFACTORY PER PG&E GAS UTILITY STANDARD TD-4181S.

QUALIFIED EMPLOYEE DATE

CORROSION MECHANIC'S SIGNATURE IS REQUIRED WHEN A CPA BOUNDARY IS WITHIN THE SCOPE OF THE PROJECT.

ROPING TABLE

MINIMUM DISTANCE REQUIRED TO ROPE AN OFFSET OF 24" O.D.x 0.375 WT. API-5L, GR. X-60, SAWL PIPE.
MIN. ROPING RADIUS =2000FT.



Y	X	Y	X
3.0	117	5.5	159
1.0	83	6.0	166
1.5	83	6.5	173
2.0	96	7.0	179
2.5	107	7.5	186
3.0	117	8.0	192
3.5	127	8.5	198
4.0	136	9.0	203
4.5	144	9.5	209
5.0	152	10.0	214

LEGEND:

- GT — GAS TRANSMISSION LINE
- GD — GAS DISTRIBUTION LINE
- GS — GAS SERVICE LINE
- GT (RETIRED) — GAS TRANSMISSION LINE (RETIRED)
- GD (RETIRED) — GAS DISTRIBUTION LINE (RETIRED)
- GS (RETIRED) — GAS SERVICE LINE (RETIRED)
- ET — ELECTRIC TRANSMISSION LINE
- ED — ELECTRIC DISTRIBUTION LINE
- ES — ELECTRIC SERVICE LINE
- T — TELEPHONE LINE
- FO — FIBER OPTIC LINE
- TV — CABLE TV LINE
- SD — STORM DRAIN LINE
- SS — SEWER LINE
- W — WATER LINE
- EP — EDGE OF ROAD
- FC — FACE OF CURB
- UNPAVED ROAD
- RAILROAD
- TEMPORARY EASEMENT
- PROPERTY BOUNDARY
- FENCE
- WALL
- BARRIER
- TEMPORARY BARRIER (TYPE K)
- GUARD RAIL
- DASHED PAVEMENT MARKINGS
- TOE OF SLOPE
- TOP OF SLOPE
- GAS LINE MARKER (ALL)
- GAS LINE MARKER (PADDLE DUAL)
- GAS LINE MARKER (PADDLE SINGLE)
- GAS LINE MARKER (POST)
- GAS LINE INDICATOR (DISC)
- INSULATION JOINT
- PRESSURE CONTROL FITTING
- GAS BOX
- HPR — GAS HIGH PRESSURE REGULATOR
- M — GAS METER
- DR — GAS DISTRIBUTION REGULATOR
- G — PG&E GAS MANHOLE
- G — GAS VAULT
- GAS VENT
- E — PG&E ELECTRIC MANHOLE
- E — ELECTRIC VAULT
- UTILITY POLE (ELECTRIC)
- UTILITY POLE (OTHER)
- JOINT POLE
- EXISTING ELECTRIC TOWER
- W — WATER METER
- WATER VALVE
- SD — STORM DRAIN
- SEWER MANHOLE
- FOREIGN MANHOLE
- TV — CABLE TV BOX
- T — TELECOMM BOX
- T — TELECOMM MANHOLE
- T — TELECOMM VAULT
- STREET LIGHT BOX
- TREE
- A — ANODE
- A — DEEPWELL ANODE
- CATS — COMPUTER AUTOMATED TEST STATION
- CTS — COUPON TEST STATION
- ETS — ELECTROLYSIS TEST STATION
- R — POLE-MOUNTED RECTIFIER
- POTHOLE
- CITY/COUNTY MONUMENT
- MONUMENT, SEE DESCRIPTION
- SURVEY CONTROL POINT
- ℄ — CENTERLINE
- ACCESS ROAD
- LAYDOWN / STAGING / CONSTRUCTION IMPACT AREA
- EXCAVATION / BELL HOLE
- SAFETY ZONE LIMITS
- ENVIRONMENTALLY SENSITIVE AREAS

DETAIL LEGEND:

- PROPOSED GAS TRANSMISSION LINE
- EXISTING GAS TRANSMISSION LINE
- GAS TRANSMISSION LINE (TO BE DEACTIVATED)
- GAS TRANSMISSION LINE (TO BE RETIRED)
- GAS TRANSMISSION LINE (TO BE REMOVED)
- PIPE END CUT (SIDE)
- PIPE END CUT
- GAS VALVE
- FLOW — FLOW ARROW
- TIE-IN WELD
- MATERIAL OF RECORD ASSET

Acronym	Definition	Acronym	Definiton	Acronym	Definition	Acronym	Definition
(E)	Existing	DP	Design Pressure	LN	Linear Weldable	SD	Storm Drain
(P)	Proposed	DPV	Damage Prevention Volume	LNW	Linear Non-Weldable	SHT	Sheet
API	American Petroleum Institute	DR	Distribution Regulator	LONG	Longitude	SL	Sewer Lateral
APN	Assessor's Parcel Number	DREG	District Regulator	M	Monitor	SMLS	Seamless
ARC	Abrasion Resistant Coating	DSAW	Double Submerged Arc-Welded	MAOP	Maximum Allowable Operating Pressure	SMYS	Specified Minimum Yield Strength
ASME	American Society of Mechanical Engineers	DWA	Deep Well Anode	MAX	Maximum	SPEC	Specification
ASTM	American Society for Testing Materials	ELE	Electric	MH	Manhole	SS	Sanitary Sewer
ATM	Atmosphere	ELEV	Elevation	MIN	Minimum	SSAW	Single Submerged Arc-Welded
B	Bare Steel	EM	Electronic Marker	MLV	Main Line Valve	STA	Station
BBCL	Bell Bell Chil Ring	EMS	Engineering Material Specification	MOP	Maximum Operating Pressure	STD	Standard
BC	Back of Curb	EP	Edge of Road	MP	Mile Point	STL	Steel
BD	Blowdown	ERW	Electric Resistance Welded	MW	Working Monitor	STPR	Strength Test Pressure Report
BLDG	Building	ETS	Electrolysis Test Station	NDE	Non-Destructive Examination	T	Tied (Connected to System)
BOM	Bill of Materials	F	Filter	NOP	Normal Operating Pressure	TD	Technical Document
BTU	British Thermal Units	FBE	Fusion Bonded Epoxy	NPC	Non-Protected/Native Coupon	TT	Top Tap
BW	Back of Walk	FC	Face of Curb	NTS	Not to Scale	TCE	Temporary Construction Easement
BYP	Bypass	FDP	Future Design Pressure	OC	On Center	TCP	Traffic Control Plan
CATS	Computer Automated Test Station	FL	Fence Line	OD	Outside Pipe Diameter	TDW	T. D. Williamson
CCV	Corrosion Control Volume	FLG	Flange	OH	Overhead	TSP	Transmission System Planning
CI	Cast Iron	G	Natural Gas	P	Pipeline	TYP	Typical
CL	Centerline	GM	Natural Gas Main	P/L	Property Line	UG	Underground
CNG	Compressed Natural Gas	GR	Grade	PC	Protected/Polarized Coupon	UON	Unless Otherwise Noted
CONTR	Contractor	GS	Natural Gas Service	PCF	Pressure Control Fitting	USA	Underground Service Alert
CP	Cathodic Protection	GS&S	Gas Standards and Specfications	PL	Plastic	UT	Ultra-Sonic Test
CROP	Conditional Reduction of Pressure	GW	Natural Gas Well	PLC	Programmable Logic Controllers	V	Valve
CTR	Center	H	Horizontal	PSI	Pounds per Square Inch	VIF	Verify in Field
CTS	Coupon Test Station	HDD	Horizontal Directional Drill	RAD	Radius	VOL	Volume
CU	Copper	HFW	High Frequency Weld	RE	Reference	W	Water
DE	Dead End	HPR	High Pressure Regulator	REG	Regulator	WT	Wall Thickness
DCUST	Distribution Customer	ILI	In-Line Inspection	ROW	Right of Way	W/	With
DEG	Degree	JT	Joint Trench	S	Screwed	W/O	Without
DET	Detail	L	Line Number	SAWH	Submerged Arc-Welded Helical	WOW	Without Locating Wire
DF	Design Factor	L/R	Left/Right	SAWL	Submerged Arc-Welded Longitudinal	WP	Work Procedure
DFM	Distribution Feeder Main	LAT	Latitude	SCADA	Supervisory Control and Data Acquisition	WS	Water Service
DIST	Distribution	LNG	Liquid Natural Gas				

REGISTERED PROFESSIONAL ENGINEER OSCAR R. ROCHES M18299 MECHANICAL STATE OF CALIFORNIA

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0	12/16/15	ISSUED FOR CONSTRUCTION	3189651	D9SK	CD16	CEF7	DMR1 JDG4

REVISIONS

APPROVED BY	
PSRS 40593	
SUPV KEF7	
DSGN D9SK	
DWN D9SK	
CHKD CD16	
OK	
DATE 11-17-15	JDG4
SCALES AS SHOWN	DMR1

PIPELINE - LEGEND & STAMPS
L-101 MP 12.33 - 12.87
RELOCATE 3,350 FEET OF 24" PIPE
PALO ALTO, SANTA CLARA
EAST PALO ALTO, SAN MATEO
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

BILL OF MATL	SEE SHEET 11
REF DWG LIST	SEE SHEET 2
SUPSDS	
SUPSD BY	
SHEET NO.	3 OF 12 SHEETS

31189651 | 0

3189651-S003-LG.dgn 12-NOV-2015 17:17PM

RIGHT OF WAY

SURVEY PLAN SCALE: 1"=40'

(E) 20" L-101

O' CONNOR ST

PROPOSED SNIFF HOLE

(E) ELECTRIC TRANSMISSION TOWERS

(E) FLOOD WALL

PROPOSED LEVEE TOP (BY OTHERS)
PROPOSED LEVEE TOE (BY OTHERS)

0+00 1+00 2+00 3+00 4+00 5+00 6+00 7+00 8+00 9+00 10+00

PROPOSED 20" L-101

PROPOSED 45' EASEMENT

PROPOSED 24" L-101

H STA 1+00.00 TIE-IN
P STA 1+00.00 MP 12.87

DET 1/8

5'-0" TYP

25'X 15' EXIT BORE PIT

CTS

45'X 15' ENTRY BORE PIT

H STA 1+06 45 DEG LT
P STA 1+06

H STA 2+86.30 6 DEG LT
P STA 2+87.95

H STA 3+82.37 16 DEG LT
P STA 3+88.45

H STA 8+57.63 3R 90DEG RT
P STA 8+73.61

H STA 880.63 20 DEG RT
P STA 890.61

13'-6"

13'-1"

H STA 9+40.15 16 DEG LT
P STA 9+50.14

EAST PALO ALTO

SAN FRANCISQUITO CHANNEL

PALO ALTO GOLF COURSE

(E) 22" L-101 TO BE RETIRED

(E) AC BIKE PATH

MATCHLINE H 10+10.00

SURVEY PROFILE HORIZONTAL SCALE: 1"=40'
VERTICAL SCALE: 1"=10'

30 20 10 0 -10 -20 -30

(E) GRADE AT GAS LINE CL

DESIGN SURFACE (BY OTHERS) AT GAS LINE CL

ELEV 17.87 ELEV 17.55 ELEV 7.70 ELEV 6.20 ELEV 6.00 ELEV 6.00 ELEV 7.35 ELEV 7.22 ELEV 6.51 ELEV 6.82 ELEV 19.36 ELEV 19.03 ELEV 8.32

GMP6 ELEV 7.08

GMP7 ELEV 5.71

4'-4" 27'-0" 25'-0" 10'-0" 20'-0" 21'-0" 4'-5"

PROPOSED 24" GAS LINE (L-101)

PROPOSED BORE PIT

25'-0" 45'-0"

3 DET 10

MINIMUM COVER: 48"

1+06.00 U/G GAS LINE
1+48.12 OVH ELECTRIC TRANSMISSION LINE
3+46.60 U/G ELEC TRANSMISSION LINE

4+10.11 LEVEE TOE 12.04
4+15.82 LEVEE PROPOSED 17.55 (BY OTHERS)
4+32.17 LEVEE PROPOSED 17.87 (BY OTHERS)
4+32.96 EDGE OF GRAVEL ROAD 13.38
4+41.03 EDGE OF GRAVEL ROAD 13.38
4+57.91 LEVEE TOE 11.25
4+87.44 LEVEE TOE 7.00
4+98.54 C-CHANNEL RIGHT 5.97
5+12.45 H-CANAL 3.96
5+30.67 H-CANAL 0.64
5+43.32 C-CHANNEL LEFT 5.94
5+47.34 LEVEE TOE 7.00
6+53.77 FENCE 4.43
7+57.84 LEVEE TOE 3.71
7+81.17 LEVEE TOP 5.00
7+93.52 LEVEE TOP 5.00
8+07.59 LEVEE PROPOSED 19.03 (BY OTHERS)
8+07.59 LEVEE TOP 5.12
8+24.99 LEVEE TOE 4.9
8+59.82 FENCE PROPOSED 5.3 (BY OTHERS)
8+55.37 LEVEE PROPOSED (BY OTHERS)

PIPELINE STATIONING

H 1+00 TIE-IN 20"
P 1+00

H 1+06.00 45° LT, SAG
P 1+06.00 ROLL 45°

H 1+10.00 45° OB 20"
P 1+11.65

H 1+30 20X24 RDCR
P 1+31.65

H 2+86.30 6° LT
P 2+87.95

H 3 71.68 45° OB
P 373.33

H 3+82.37 16° LT 45° SAG
P 3+88.45 ROLL

H 6+78.40 45° SAG
P 6+84.48

H 6+87.59 45° OB
P 6+97.48

H 8+27.59 4° SAG
P 8+37.48

H 8+63.63 90° 3R RT
P 8+73.61 ROLL 4°

H 9+40.15 16° LT
P 9+50.14

H 9+64.08 5° OB
P 9+74.07

MATCHLINE H 10+10.00

BOM# 3 8 3 3 4 1 7 1 7 1 7 1 7 1 1 7 1 7 5 7 1 7 1 1

DESIGN CRITERIA

BOM#	CLASS LOCATION	DESIGN FACTOR	FDP (PSIG)	FDP (% SMYS)	MAOP (PSIG)	MAOP (% SMYS)	MIN TEST PRESSURE (PSIG)	MIN TEST PRESSURE (% SMYS)	MAX TEST PRESSURE (PSIG)	MAX TEST PRESSURE (% SMYS)	PSIG @ 90% SMYS	TEST MEDIUM	PIPE SPEC.	O.D. (IN.)	W.T. (IN.)	WELD INSPECTION* NDT	100%	*%
1	3	0.50	720	28.80	720	28.80	1080	43.20	1280	51.20	2250	WATER	API 5L X-60 SAWL	24.0	0.500		X	
2	3	0.50	720	38.40	720	38.40	1080	57.60	1280	68.27	1688	WATER	API 5L X-60 SAWL	24.0	0.375		X	
3	3	0.50	720	29.53	720	29.53	1080	44.30	1280	52.51	2154	WATER	API 5L X-65 HFW	20.0	0.375		X	

*VISUALLY INSPECT ALL WELDS. (THIS REQUIREMENT APPLIES EVEN IF NON-DESTRUCTIVE TESTING IS REQUIRED)

TD-4160P-60

REVISIONS

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
1	10/30/15	ISSUED FOR CONSTRUCTION	31189651	D9SK	CDB6	KI-7	OHRI JDS4

APPROVED BY: PSRS 40983 | SUPV KI7 | DSGN D9SA | DWN D9SK | CHKD CDB6 | QK | DATE 11-17-15 | SCALES AS SHOWN — JDS4 OHRI

PIPELINE - PLAN & PROFILE
L-101 MP 12.33 - 12.87
RELOCATE 3,350 FEET OF 24" PIPE
PALO ALTO, SANTA CLARA
EAST PALO ALTO, SAN MATEO
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

BILL OF MATL SEE SHEET 13
REF DWG LIST SEE SHEET 2
SUPSDS
SUPSD BY
SHEET NO. 4 OF 12 SHEETS

31189651 0

NOTE:
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SAFETY PLEDGE
I ALWAYS PUT SAFETY FIRST.
I LOOK FOR AND ACT TO RESOLVE UNSAFE SITUATIONS.
I HELP AND ENCOURAGE OTHERS TO ACT SAFELY.

GAS TRANSMISSION ESTIMATING & DESIGN

REGISTERED PROFESSIONAL ENGINEER OSCAR H. ROSALES M18295 MECHANICAL STATE OF CALIFORNIA

31189651-3004-PLP.dgn 18-NOV-2015 10:50AM

RIGHT OF WAY

PALO ALTO MUNICIPAL GOLF COURSE
CENSUS TRACT 4540.01(1)(2)
CITY OF PALO ALTO REAL ESTATE DIVISION
SANTA CLARA COUNTY
APN 003-06-001

NOTE:
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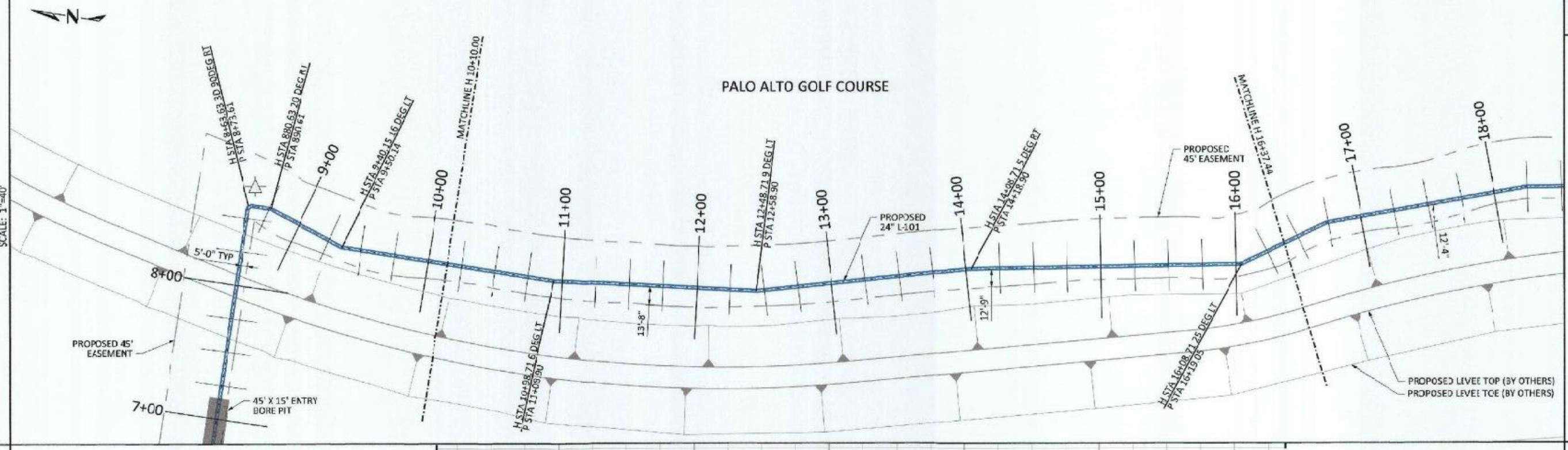
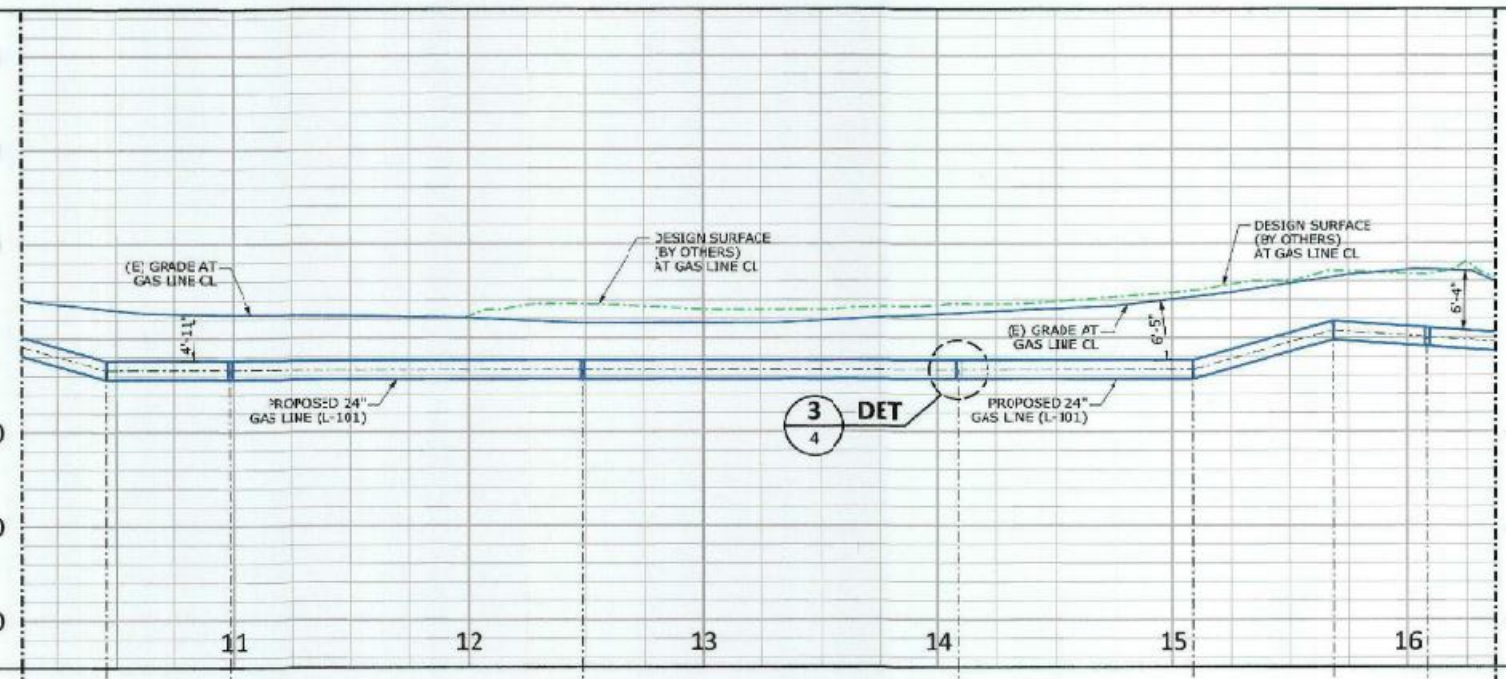
SURVEY PLAN — SCALE: 1"=40'



SURVEY PROFILE — HORIZONTAL SCALE: 1"=40' / VERTICAL SCALE: 1"=10'



MINIMUM COVER: 48"

PIPELINE STATIONING

MATCHLINE H 10+10.00
H 10+45.91 4° SAG
P 10+56.10
H 10+90.71 6° LT
P 11+08.90
H 12+48.71 9° LT
P 12+58.90
H 14+08.71 5° RT
P 14+18.90
H 15+08.96 4° SAG
P 15+19.15
H 15+68.53 5° OB
P 15+78.86
H 16+08.71 25° LT
P 16+19.05
MATCHLINE H 16+37.44

BOM#: 1 7 : 7 1 7 1 2 7 2 2 7 2 7 2

DESIGN CRITERIA

BOM#	CLASS LOCATION	DESIGN FACTOR	FDP (PSIG)	FDP (% SMYS)	MAOP (PSIG)	MAOP (% SMYS)	MIN TEST PRESSURE (PSIG)	MIN TEST PRESSURE (% SMYS)	MAX TEST PRESSURE (PSIG)	MAX TEST PRESSURE (% SMYS)	PSIG @ 90% SMYS	TEST MEDIUM	PIPE SPEC.	O.D. (IN.)	W.T. (IN.)	WELD INSPECTION* NDT	100%	%
1	3	0.50	720	28.80	720	28.80	1080	43.20	1280	51.20	2250	WATER	API 5L X-60 SAWL	24.0	0.500		X	
2	3	0.50	720	38.40	720	38.40	1080	57.60	1280	68.27	1688	WATER	API 5L X-60 SAWL	24.0	0.375		X	

*VISUALLY INSPECT ALL WELDS. (THIS REQUIREMENT APPLIES EVEN IF NON-DESTRUCTIVE TESTING S REQUIRED)

TD-4160P-60

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
0	12/2/15	ISSUED FOR CONSTRUCTION	31189651	DSK	CDB	KJF	DHR SDG

REVISIONS

APPROVED BY	
PSRS	40893
SUPV	KJF
DSGN	DSK
DWN	DSK
CHKD	CDB
OK	
DATE	11-17-15
SCALES	AS SHOWN

PIPELINE - PLAN & PROFILE
L-101 MP 12.33 - 12.87
RELOCATE 3,350 FEET OF 24" PIPE
PALO ALTO, SANTA CLARA
EAST PALO ALTO, SAN MATEO
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

BILL OF MATL SEE SHEET 11
REF DWG LIST SEE SHEET 2
SUPSDS
SUPSD BY
SHEET NO. 5 OF 12 SHEETS

31189651 | 0

SAFETY PLEDGE
I ALWAYS PUT SAFETY FIRST
I LOOK OUT AND ACT TO PREVENT UNSAFE SITUATIONS
I HELP AND ENCOURAGE OTHERS TO ACT SAFELY

GAS TRANSMISSION ESTIMATING & DESIGN

REGISTERED PROFESSIONAL ENGINEER
OSCAR H. ROSALES
M18299
MECHANICAL
STATE OF CALIFORNIA

31189651-SIG1-PLP.dgn
18-NOV-2015 10:49AM

RIGHT OF WAY

TRACT NUMBER
OWNERSHIP/AGENCY

PROPERTY SECTION NO.
PERMIT EXHIBIT NO.

PALO ALTO MUNICIPAL GOLF COURSE
GRANT: TRACT RECORDED 1979
CITY OF PALO ALTO REAL ESTATE DIVISION
SANTA CLARA COUNTY
APN 120-06-101

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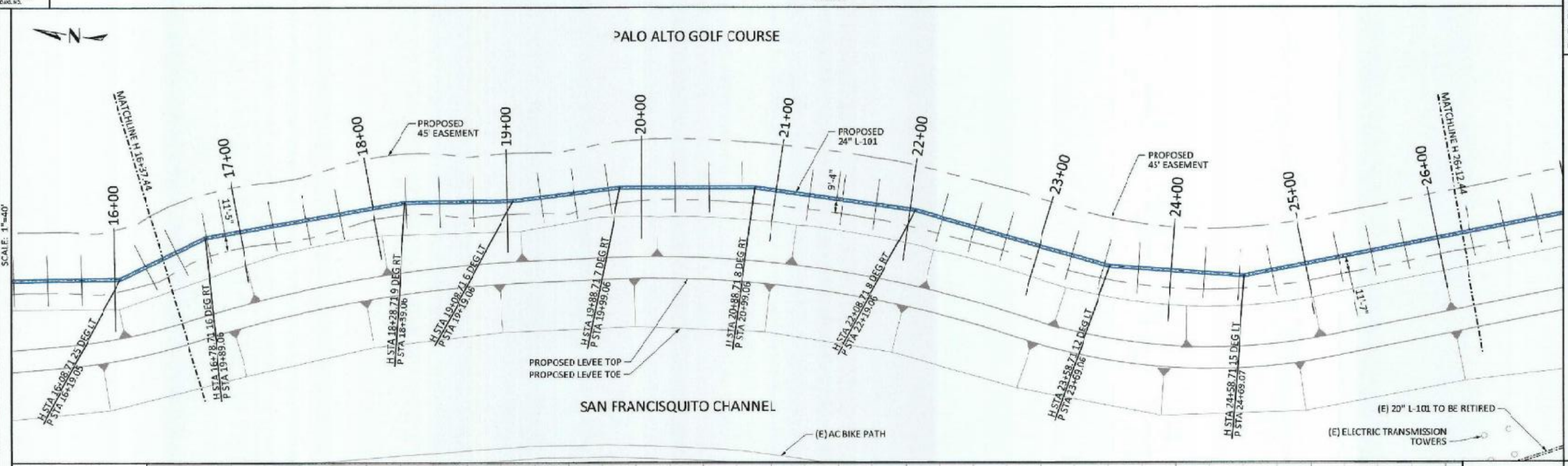
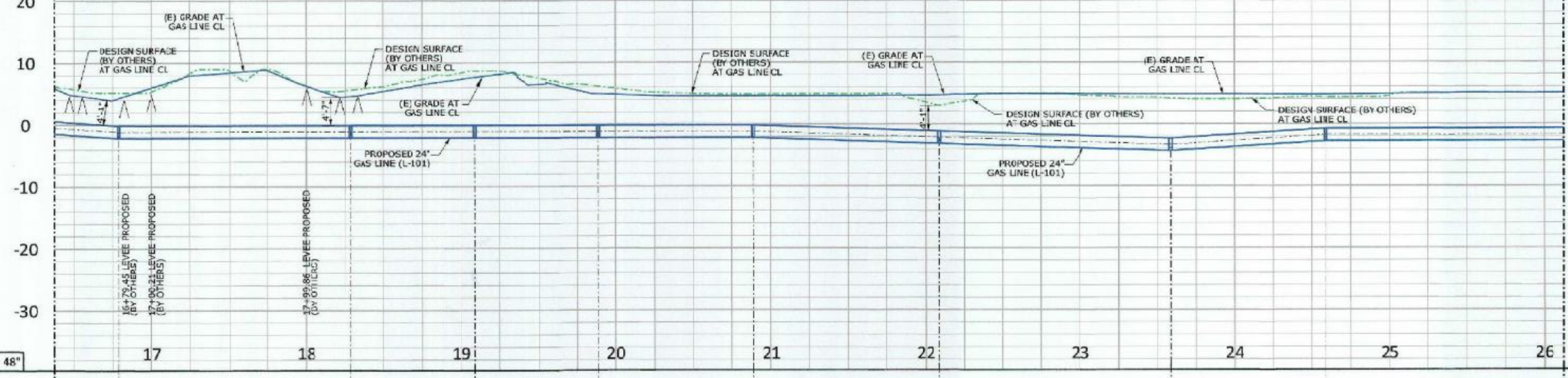
SURVEY PLAN — SCALE: 1"=40'



SURVEY PROFILE — VERTICAL SCALE: 1"=10' — HORIZONTAL SCALE: 1"=40'



MINIMUM COVER: 48"

PIPELINE STATIONING

BOM#	
	MATCHLINE H 16+37.44
2	
7	H 16+78.71 16° RT SAG P 16+89.06 ROLL 1°
2	
7	H 18+28.71 9° RT P 18+39.06
2	
7	H 19+08.71 6° LT P 19+19.06
2	
7	H 19+88.71 7° RT P 19+99.06
2	
7	H 20+88.71 8° RT UB P 20+99.06 ROLL 0.5°
2	
7	H 22+08.71 8° RT P 22+19.06
2	
7	H 23+58.71 12° LT SAG P 23+69.06 ROLL 1°
2	
7	H 24+58.71 15° LT SAG P 24+69.07 ROLL 1°
2	
	MATCHLINE H 26+12.44

DESIGN CRITERIA

BOM#	CLASS LOCATION	DESIGN FACTOR	FDP (PSIG)	FDP (% SMYS)	MAOP (PSIG)	MAOP (% SMYS)	MIN TEST PRESSURE (PSIG)	MIN TEST PRESSURE (% SMYS)	MAX TEST PRESSURE (PSIG)	MAX TEST PRESSURE (% SMYS)	PSIG @ 90% SMYS	TEST MEDIUM	PIPE SPEC.	O.D. (IN.)	W.T. (IN.)
2	3	0.50	720	38.40	720	38.40	1080	57.60	1280	68.27	1688	WATER	API 5L X-50 SAWL	24.0	0.375

WELD INSPECTION*: NDT | 100% | "2"%
X

*VISUALLY INSPECT ALL WELDS. (THIS REQUIREMENT APPLIES EVEN IF NON-DESTRUCTIVE TESTING IS REQUIRED)

TD-4160P-60

NO.	DATE	DESCRIPTION	GM/S/PC	DWN	CHKD	SUPV	APVD BY
0	12/2/15	ISSUED FOR CONSTRUCTION	31189651	DBSK	CDB6	KJF7	DBSK

REVISIONS

APPROVED BY	
PSRS	40093
SUPV	KJF7
DSGN	DBSK
DWN	DBSK
CHKD	CDB6
OK	
DATE	11-17-15
SCALES	AS SHOWN

PIPELINE - PLAN & PROFILE
L-101 MP 12.33 - 12.87
RELOCATE 3,350 FEET OF 24" PIPE
PALO ALTO, SANTA CLARA
EAST PALO ALTO, SAN MATEO
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

BILL OF MATL	SEE SHEET 11
REF DWG LIST	SEE SHEET 2
SUPSDS	
SUPSD BY	
SHEET NO.	6 OF 12 SHEETS

31189651 | 0

SAFETY PLEDGE

GAS TRANSMISSION EST MATING & DESIGN

REGISTERED PROFESSIONAL ENGINEER
OSCAR H ROSALES
M13299
MECHANICAL
STATE OF CALIFORNIA

3189651-B006-PLP.dgn
18-NOV-2015 10:59AM

RIGHT OF WAY

TRACT NUMBER
OWNERSHIP/AGENCY

PROPERTY SKETCH NO.
PERMIT DWG. NO.

PALO ALTO MUNICIPAL GOLF COURSE
CITY OF PALO ALTO REAL ESTATE DIVISION
SANTA CLARA COUNTY
(APN 008-06-08)

NOTE:
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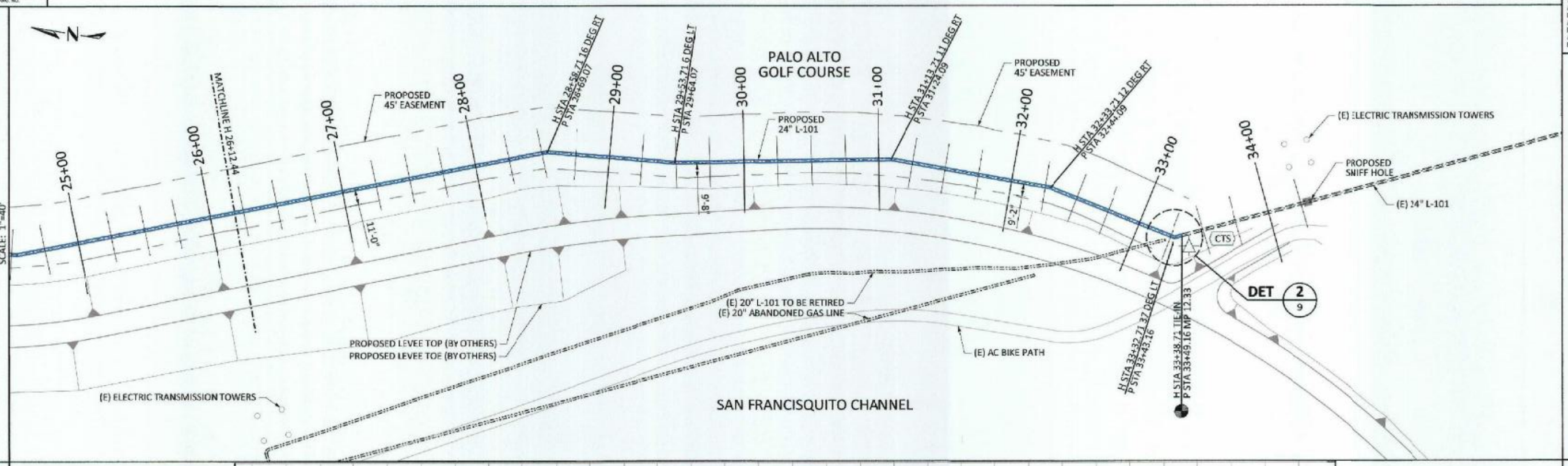
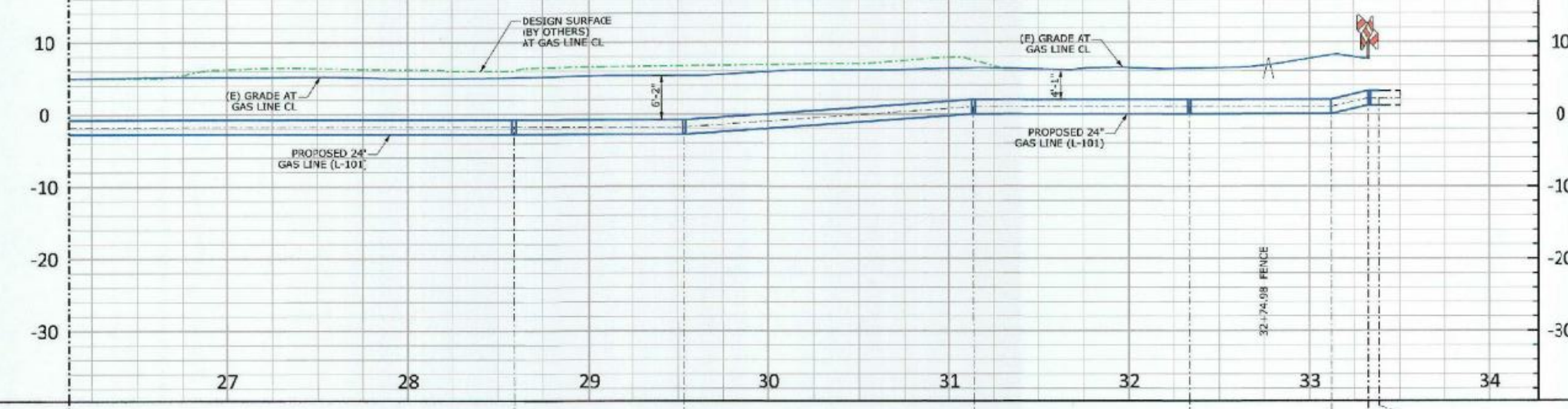
SURVEY PLAN
SCALE: 1"=40'



SURVEY PROFILE
HORIZONTAL SCALE: 1"=40'
VERTICAL SCALE: 1"=10'



MINIMUM COVER: 48"

PIPELINE STATIONING

MATCHLINE H 26+12.44
H 28+58.71 16° RT
P 28+69.07
H 29+53.71 6° LT SAG
P 29+64.07 ROLL 1°
H 31+13.71 11° RT OB
P 31+24.09 ROLL 1°
H 32+33.71 12° RT
P 32+44.09
H 33+12.70 3.4° SAG
P 33+23.08
H 33+32.71 37° LT
P 33+43.16 ROLL 3.4°
H 33+38.71 TIE-IN
P 33+49.16

3OM#

DESIGN CRITERIA

BOM#	CLASS LOCATION	DESIGN FACTOR	SDP (PSIG)	SDP (% SMYS)	MAOP (PSIG)	MAOP (% SMYS)	MIN TEST PRESSURE (PSIG)	MIN TEST PRESSURE (% SMYS)	MAX TEST PRESSURE (PSIG)	MAX TEST PRESSURE (% SMYS)	PSIG @ 90% SMYS	TEST MEDIUM	PIPE SPEC.	O.D. (IN.)	W.T. (IN.)	WELD INSPECTION* NOT	WELD INSPECTION* 100%	WELD INSPECTION* "X"%
2	3	0.50	720	38.40	720	38.40	1080	57.60	1280	68.27	1688	WATER	API 5L X-60 SAWL	24.0	0.375		X	

*USUALLY INSPECT ALL WELDS. (THIS REQUIREMENT APPLIES EVEN IF NON-DESTRUCTIVE TESTING IS REQUIRED)

TD-4160P-60

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APV'D BY
0	11/24/15	ISSUED FOR CONSTRUCTION	31189651	DJSK	CDB6	KJF7	DHR1

REVISIONS

APPROVED BY
PSRS 40693
SUPV KJF7
DSGN DJSK
DWN DJSK
CHKD CDB6
DR
DATE 11-17-15
SCALES AS SHOWN

PIPELINE - PLAN & PROFILE
L-101 MP 12.33 - 12.87
RELOCATE 3,350 FEET OF 24" PIPE
PALO ALTO, SANTA CLARA
EAST PALO ALTO, SAN MATEO
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

BILL OF MATL SEE SHEET 1
REF DWG LIST SEE SHEET 2
SUPSOS
SUPSO BY
SHEET NO. 7 OF 12 SHEETS

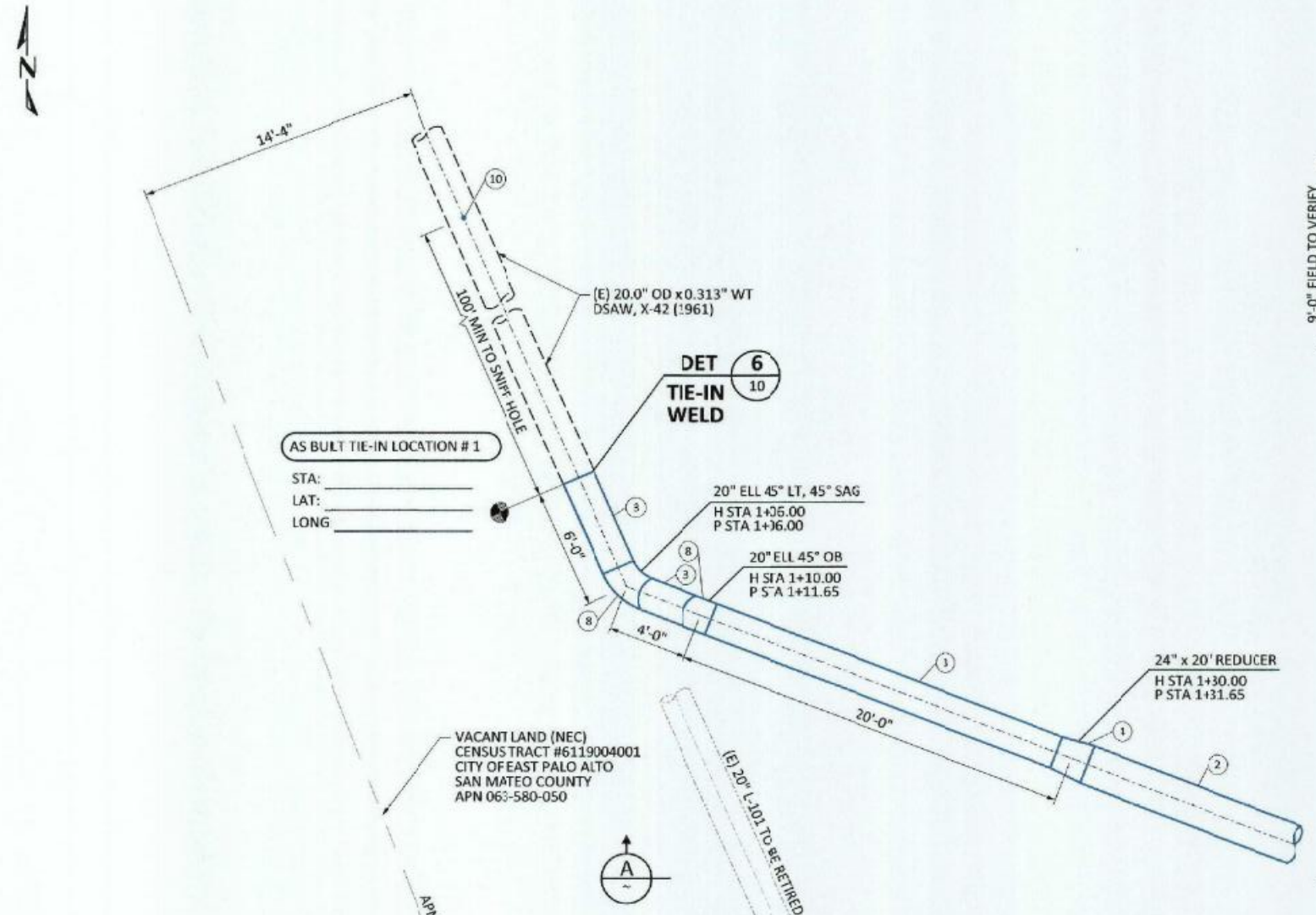
31189651 | 0

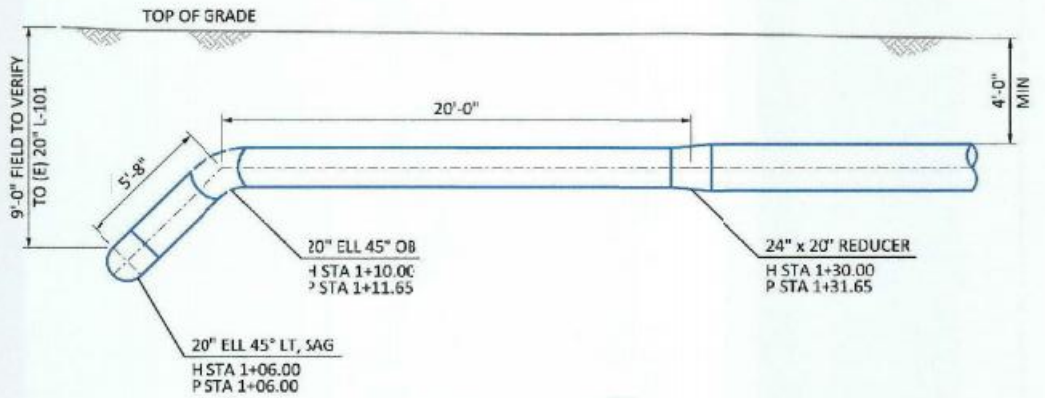
SAFETY PLEDGE
I ALWAYS PUT SAFETY FIRST.
I LOOK FOR AND ACT TO RESOLVE UNSAFE SITUATIONS.
I HELP AND ENCOURAGE OTHERS TO ACT SAFELY.

GAS TRANSMISSION ESTIMATING & DESIGN

REGISTERED PROFESSIONAL ENGINEER
OSCAR N. ROSALES
M18299
MECHANICAL
STATE OF CALIFORNIA

31189651-3007-PLP.dgn
18-NOV-2015 10:50AM





ELEVATION A
SCALE: 1/4" = 1'-0"

DETAIL 1
SCALE: 1/4" = 1'

EXIST PIPE SPECS	
HEADER SIZE	20.0" WALL THICKNESS: 0.313"
PIPE SPECS: DSAW, X-42	
PRESENT MAOP:	365 PSIG
% SMYS @ MAOP:	27.70%
INSTALL JN: 149403	YEAR: 1961

MAXIMUM ALLOWABLE PRESSURE DURING WELDING (G.S.&S. D-22)

EVALUATE THE FOLLOWING OPERATING PRESSURE LIMITATIONS TO DETERMINE THE MAXIMUM OPERATING PRESSURE PERMITTED DURING WELDING

A) (365 PSIG) WHEN WELDING ON BODY OF THE PIPE. UNLESS,

B) (262 PSIG) WHEN WELDING WITHIN 3" OF THE LONGITUDINAL SEAM (EXCEPT DSAW PIPE), THE CIRCUMFERENTIAL, AND ANY BRANCH WELD, OR WITHIN 3" OF ANY DEFECT (GOUGES, CORROSION, LAMINATIONS, ETC.) IN THE PIPE WHICH EXCEEDS 1/3 OF THE NOMINAL WALL THICKNESS IN DEPTH AND/OR 1/4 OF THE NOMINAL PIPE DIAMETER IN LENGTH.

JOB #	30823996
BOM ITEM #	2
DESIGN CRITERIA	
CLASS LOCATION	3
DESIGN FACTOR	0.50
FDP	720 PSIG 38.40 % SMYS
MAOP	720 PSIG 38.40 % SMYS
STRENGTH TEST PRESSURE	
MIN.	1080 PSIG 57.60 % SMYS
MAX.	1280 PSIG 68.27 % SMYS
	1688 PSIG=90% SMYS
TEST MEDIUM	WATER
PIPE SPEC.	API 5L X-60 SAWL
O.D.	24.0" W.T. 0.375"

WELD INSPECTION (WELDING MANUAL TD-4160M) *

[X] NON-DESTRUCTIVE TESTING:
MIN % OF THE PROJECT DAILY WORK
[X] 100% VISUALLY INSPECT ALL WELDS. (THIS REQUIREMENT APPLIES EVEN IF NON-DESTRUCTIVE TESTING IS REQUIRED)
[ ] ___% ___

JOB #	30823996
BOM ITEM #	3
DESIGN CRITERIA	
CLASS LOCATION	3
DESIGN FACTOR	0.50
FDP	720 PSIG 29.53 % SMYS
MAOP	720 PSIG 29.53 % SMYS
STRENGTH TEST PRESSURE	
MIN.	1080 PSIG 44.30 % SMYS
MAX.	1280 PSIG 52.51 % SMYS
	2025 PSIG=90% SMYS
TEST MEDIUM	WATER
PIPE SPEC.	API 5L X-65 HFW
O.D.	20.0" W.T. 0.375"

WELD INSPECTION (WELDING MANUAL TD-4160M) *

[X] NON-DESTRUCTIVE TESTING:
MIN % OF THE PROJECT DAILY WORK
[X] 100% VISUALLY INSPECT ALL WELDS. (THIS REQUIREMENT APPLIES EVEN IF NON-DESTRUCTIVE TESTING IS REQUIRED)
[ ] ___% ___

WELDING INSPECTED PER PG&E WELDING MANUAL TD-4160M

VISUAL _____ ☐
RADIOGRAPHIC _____ ☐
MAGNETIC PARTICLE _____ ☐
INSPECTOR _____
DATE _____

811 Know what's below. Call before you dig.

ZERO IN ON SAFETY

NO.	DATE	DESCRIPTION	31189651	DSK	CDB	KJF	APVD BY
0	12/16/15	ISSUED FOR CONSTRUCTION					

REVISIONS

APPROVED BY	
PSRS	40993
SUPV	KJF7
DSGN	DSK
DWN	DSK
CHKD	CDB6
OK	
DATE	11-17-15
SCALES	AS SHOWN

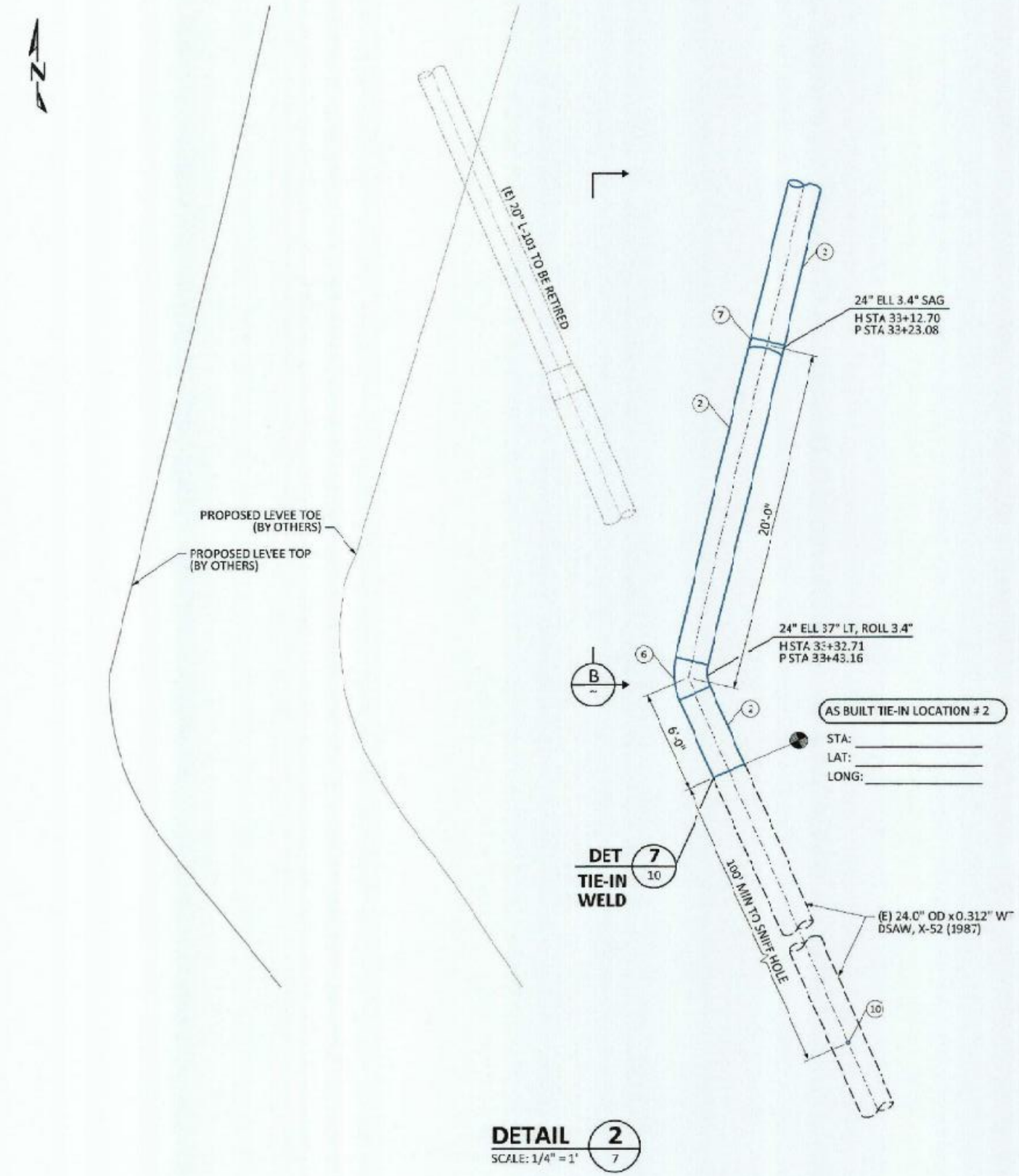
PIPELINE - DETAILS
L-101 MP 12.33 - 12.87
RELOCATE 3,350 FEET OF 24" PIPE
PALO ALTO, SANTA CLARA
EAST PALO ALTO, SAN MATEO
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER OSCAR H. ROSALES M18299 MECHANICAL STATE OF CALIFORNIA

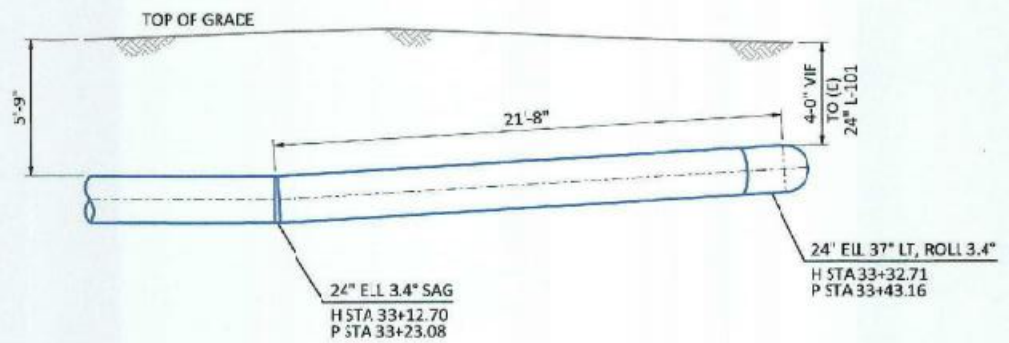
BIL OF MATL	SEE SHEET 11
REF DWG LIST	SEE SHEET 2
SUPSDS	
SUPSD BY	
SHEET NO.	8 OF 12 SHEETS

31189651 | 0

31189651-8000-BET.dgn 17-NOV-2015 17:18PM



DETAIL 2 / 7
SCALE: 1/4" = 1'



ELEVATION B / ~
SCALE: 1/4" = 1'-0"

EXIST PIPE SPECS	
HEADER SIZE:	24.0" WALL THICKNESS: .312"
PIPE SPECS: DSAW, X-52	
PRESENT MAOP: 365 PSIG	
% SMYS @ MAOP: 26.99%	
INSTALL JN: 1446'14	YEAR: 1987

MAXIMUM ALLOWABLE PRESSURE DURING WELDING (G.S.&S. D-22)

EVALUATE THE FOLLOWING OPERATING PRESSURE LIMITATIONS TO DETERMINE THE MAXIMUM OPERATING PRESSURE PERMITTED DURING WELDING

A) (365 PSIG) WHEN WELDING ON BODY OF THE PIPE. UNLESS,

B) (270 PSIG) WHEN WELDING WITHIN 3" OF THE LONGITUDINAL SEAM (EXCEPT DSAW PIPE), THE CIRCUMFERENTIAL, AND ANY BRANCH WELD, OR WITHIN 3" OF ANY DEFECT (GOUGES, CORROSION, LAMINATIONS, ETC.) IN THE PIPE WHICH EXCEEDS 1/3 OF THE NOMINAL WALL THICKNESS IN DEPTH AND/OR 1/4 OF THE NOMINAL PIPE DIAMETER IN LENGTH.

JOB # 30823995
BOM ITEM # 2

DESIGN CRITERIA

CLASS LOCATION	3		
DESIGN FACTOR	0.50		
FOP	720 PSIG	38.40	%SMYS
MAOP	720 PSIG	38.40	%SMYS
STRENGTH TEST PRESSURE			
MIN.	1080 PSIG	57.60	%SMYS
MAX.	1280 PSIG	68.27	%SMYS
	1688 PSIG	90%	SMYS
TEST MEDIUM	WATER		
PIPE SPEC	API 5L X-60 SAWL		
O.D.	24.0"	W.T.	0.375"

WELD INSPECTION (WELDING MANUAL TD-4160M) *
[X] NON-DESTRUCTIVE TESTING:
NIN % OF THE PROJECT DAILY WORK
[X] 100% * VISUALLY INSPECT ALL WELDS. (THIS REQUIREMENT APPLIES EVEN IF NON-DESTRUCTIVE TESTING IS REQUIRED)
[ ] ___% *

WELDING INSPECTED PER PG&E WELDING MANUAL TD-4160M
VISUAL [ ]
RADIOGRAPHIC [ ]
MAGNETIC PARTICLE [ ]
INSPECTOR _____
DATE _____

OSCAR H. ROSALES — REGISTERED PROFESSIONAL ENGINEER — M18299 — MECHANICAL — STATE OF CALIFORNIA

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811 Know what's below. Call before you dig.

ZERO IN ON SAFETY

NO.	DATE	DESCRIPTION	GN/SPEC	DWN	CHK'D	SUPV	APV'D BY
0	11/12/15	ISSUED FOR CONSTRUCTION	31189651	E9SK	CDB6	K1F7	OHR1

REVISIONS

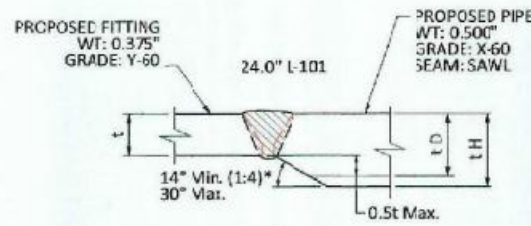
APPROVED BY: PSRS 40093; SUPV K1F7; DSGN D9SK; DWN D9SK; CHK'D CDB6; OK; DATE 11-17-15; SCALES AS SHOWN

PIPELINE - DETAILS
L-101 MP 12.33 - 12.87
RELOCATE 3,350 FEET OF 24" PIPE
PALO ALTO, SANTA CLARA
EAST PALO ALTO, SAN MATEO
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

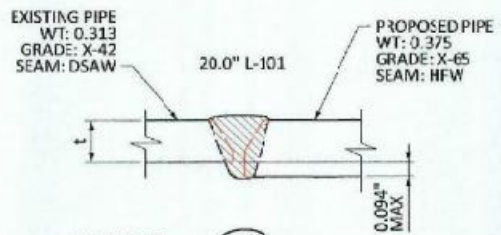
BILL OF MATL SEE SHEET 11
REF DWG LIST SEE SHEET 2
SUPSDS
SUPSD BY
SHEET NO. 9 OF 12 SHEETS

31189651 0

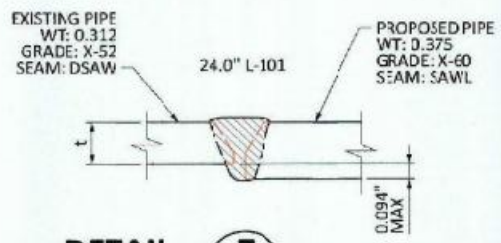
2188651-S309-DET.dgn
16-NOV-2015 07:58AM



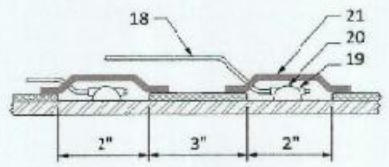
DETAIL 3 — WELD (TD-4150P-20) FIGURE 3
SCALE: NO SCALE — 4



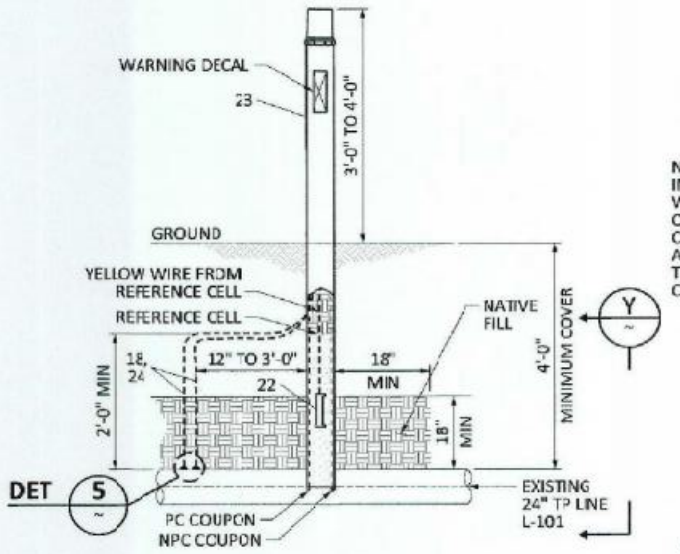
DETAIL 6 — WELD (TD-4160P-20) FIGURE 1
SCALE: NO SCALE — 8



DETAIL 7 — WELD (TD-4160P-20) FIGURE 1
SCALE: NO SCALE — 9



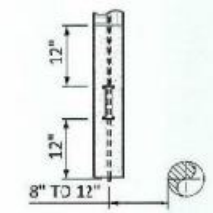
DETAIL 5 — ATTACHING THE WIRES TO THE GAS MAIN (CCV 0-10) FIGURE 1
SCALE: NTS



NOTE: INSTALL COUPONS PARALLEL TO PIPE A DISTANCE OF 8" TO 12". COUPONS MUST BE INSTALLED IN NATIVE SOIL WITHIN 18" OF ELECTRODE. TAMP NATIVE AND ADD IMPORT TO ACHIEVE A MINIMUM 95% COMPACTION.

DETAIL 4 — COUPON TEST STATION ABOVE GROUND CCV 0-10.2
SCALE: NTS

NOTE:
INSTALL REFERENCE ELECTRODE WITHIN 12" FROM THE BOTTOM OF THE TUBE. FILL TUBING WITH CASING MUD TO AT LEAST 12" ABOVE REFERENCE ELECTRODE. THE REMAINDER OF THE TUBE CAN BE FILLED WITH NATIVE SOIL.



SECTION Y
SCALE: NTS

CATHODIC PROTECTION LOCATION TABLE					
LOCATION	CP TYPE	OTHER INFO	LINE/DFM	SHEET	*S/N (RECORD IN FIELD)*
H 3+80.00	CTS		L-101	4	
H 33+40.00	CTS		L-101	7	

ATTENTION FOREMAN
24 HOURS PRIOR TO STARTING JOB CONSULT AREA CORROSION MECHANIC AT 8-441-5576 FOR LOCATING WIRE INSTALLATION AND CATHODIC PROTECTION REQUIREMENTS

OSCAR H. ROSALES — REGISTERED PROFESSIONAL ENGINEER — M18295 — MECHANICAL — STATE OF CALIFORNIA

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REVISIONS										
NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHK'D	SUPV	APV'D BY			
0	12/2/15	ISSUED FOR CONSTRUCTION	31189651	DJSK	CDB6	KLF7	DMR1	JDG4		

APPROVED BY	
PSRS	40993
SUPV	KLF7
DSGN	DJSK
DWN	DJSK
CHK'D	CDB6
QK	
DATE	11-17-15
SCALE	AS SHOWN

PIPELINE - DETAILS
L-1C1 MP 12.33 - 12.87
RELOCATE 3,350 FEET OF 24" PIPE
PALO ALTO, SANTA CLARA
EAST PALO ALTO, SAN MATEO
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

BILL OF MATL	SEE SHEET 11
RIF DWG LIST	SEE SHEET 2
SUPSDS	
SUPSD BY	
SHEET NO.	10 OF 12 SHEETS

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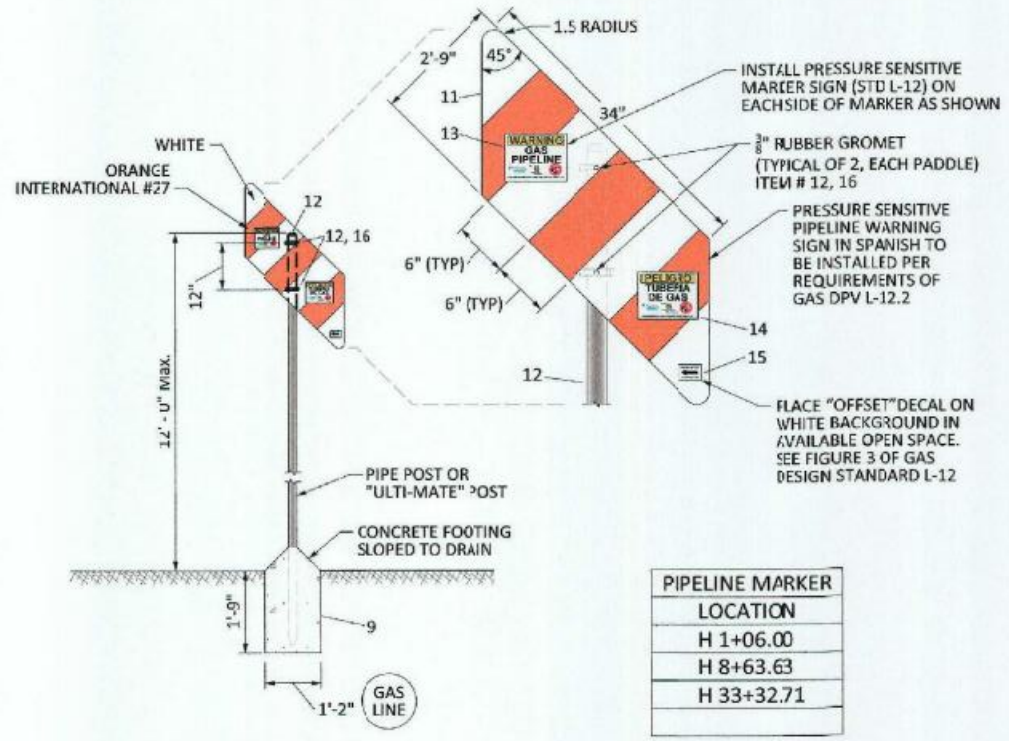
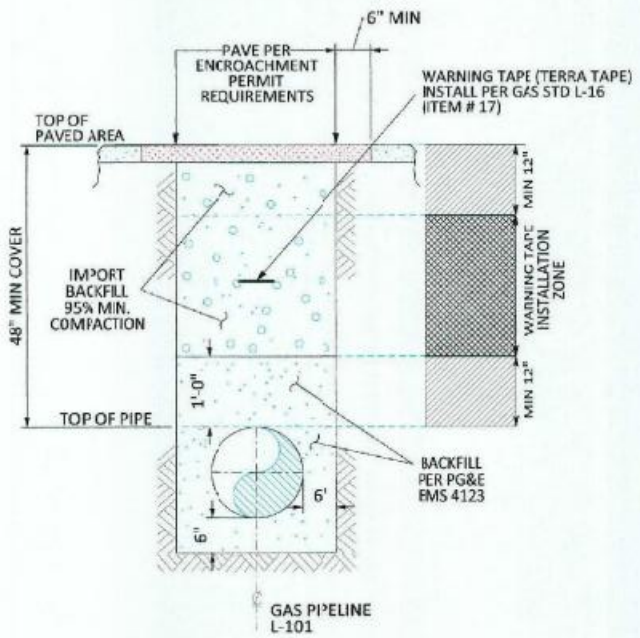
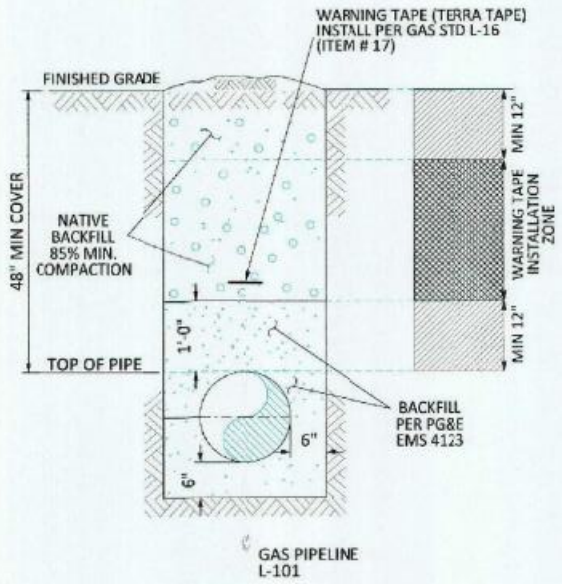


PIPELINE MARKER
LOCATION
H 1+06.00
H 8+63.63
H 33+32.71

TYPICAL PIPELINE PADDLE MARKER
SCALE: NO SCALE INSTALL PER DPV L-11.1



TYPICAL "T" TRENCH PAVED AREA
SCALE: NO SCALE IMPORT BACKFILL



TYPICAL TRENCH NON-PAVED AREA
SCALE: NO SCALE NATIVE BACKFILL

FG&E CODE	ITEM NO.	QNTY.	ORDER NO. 30823996 DESCRIPTION	CATALOG OR REFERENCE	OTHER DATA
MC10863	1	320'	PIPE, 24", STEEL, 24.0" OD x 0.500" WT, API 5L X-60 SAWL (DSAW), FBE+ARC	GAS STD A-15	--
MC10790	2	3,220'	PIPE, 24", STEEL, 24.0" OD x 0.375" WT, API 5L X-60 SAWL (DSAW), FBE	GAS STD A-15	--
MC11083	3	131'	PIPE, 20", STEEL, 20.0" OD x 0.375" WT, API 5L X-65 HFW, FBE	GAS STD A-15	--
MC22168	4	1	REDUCER , 24" X 20", STEEL 24.0" OD x 0.375" WT X 20.0" OD x 0.375" WT, API 5L, Y-60	GAS STD B-20.2	--
MC22261	5	1	ELBOW, 24", STEEL, 90 DEG, 24.0" OD x 0.500" WT, Y-60, 3R	GAS STD B-20.2	--
MC22430	6	1	ELBOW, 24", STEEL, 90 DEG, 24.0" OD x 0.375" WT, Y-60, LR	GAS STD B-20.2	--
MC22999	7	30	ELBOW, 24", STEEL, 45 DEG, 24.0" OD x 0.375" WT, Y-60, LR	GAS STD B-20.2	--
MC20349	8	2	ELBOW, 20", STEEL, 45 DEG, 20.0" OD x 0.375" WT, Y-60, LR	GAS STD B-20.2	--
--	9	AS REQ'D	CONCRETE	--	--
MC22289	10	4	NIPPLE, SAV-A-VALVE, 2", STEEL, TYPE H-17491, 1,200 PSI GWP 1,440 PSI MAX (COMPLETE WITH STEEL CAP)	GAS STD C-14	--
M379959	11	6	COATED ALUMINUM PADDLE MARKER (FIGURE 1)	DPV L-11.1	--
MC18566	12	3	PIPE, MARKER, 2" X 12' GALVANIZED STEEL, SCHEDULE 40, ASTM 120, CLAMP-ON U-BOLT ASSEMBLY, INCLUDING: • (2) GALVANIZED 1/4" U-BOLT FOR 2.375" OD PIPE WITH NUTS • (2) 1/8" U-BRACKET • (2) RUBBER WASHER PRESS-ON 20 GAUGE PIPE CAP TO FIT 2" STANDARD PIPE	DPV L-11.1	--
M379962	13	6	PIPELINE WARNING SIGN DECAL, FIGURE 1	DPV L-12	--
M379961	14	6	SPANISH-LANGUAGE WARNING SIGN DECAL, FIGURE 2	DPV L-12	--
M379960	15	6	OFFSET ARROW DECAL, FIGURE 3	DPV L-12	--
MC18704	16	6	CLAMP-ON U-BRACKET ASSEMBLY, INCLUDING GALVANIZED 1/4" U-BOLT FOR 2.375" OD PIPE WITH NUTS, 1/8" U-BRACKET, AND 5/16" X 1" BOLT WITH FIBER WASHER	DPV L-11.1	--
M379947	17	1 ROLL	GAS PIPELINE UNDERGROUND WARNING TAPE (TERRA TAPE)	DPV L-16	--
M294991	18	AS REQ'D	WIRE, #10 HMWPE WITH 47 MIL THICKNESS 600 VOLTS, SOLID COPPER, BLACK INSULATION	TD 4181, O-10	--
M303755	19	2	SLEEVE, COPPER, THERMOWELD A200 OR EQUIVALENT	TD 4181, O-10	--
M359260	20	2	CARTRIDGE, CADWELD CA-15, OR THERMOWELD 15P, 15-GRAM, 20 PER BOX	TD 4181, O-10	--
M562324	21	2	HANDY CAP, ROYSTON, 4" x 4" PATCH	GAS STD E-27	--
M241269	22	2	ELECTRODE REFERENCE GMC STAPERM CUCUS04, GMC ELECTRICAL # CU-2-FW, W/ POINTED CERAMIC TIP AND 15' OF #14 RHH-RHW YELLOW WIRE. (EACH UNIT SHOULD BE PACKED WITH SPECIAL NON-ORGANIC CASING MUD)	CCV O-10.2	--
M560691	23	2	COUPON TEST STATION	CCV O-10.2	--
M294107	24	AS REQ'D	WIRE, #10 HMWPE WITH 47 MIL THICKNESS 600 VOLTS, SOLID COPPER, WHITE INSULATION	TD 4181, O-10	--

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NO.	DATE	DESCRIPTION					APVD BY
0	12/2/15	ISSUED FOR CONSTRUCTION	31189651	D95K	CDB6	K1F7	OHR1

REVISIONS

APPROVED BY		
	PSAS	40993
	SUPV	K1F7
	DSGN	D95K
	DWN	D95K
	CHKD	CDB6
	OK	
	DATE	11-17-15
	SCALES	AS SHOWN

PIPELINE - BILL OF MATERIALS
L-101 MP 12.33 - 12.87
RELOCATE 3,350 FEET OF 24" PIPE
PALO ALTO, SANTA CLARA
EAST PALO ALTO, SAN MATEO
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER OSCAR H. ROSALES M18299 MECHANICAL STATE OF CALIFORNIA

BILL OF MATL	SEE SHEET 11
REF DWG LIST	SEE SHEET 2
SUPSDS	
SUPSD BY	
SHEET NO. 11 OF 12 SHEETS	
31189651	0

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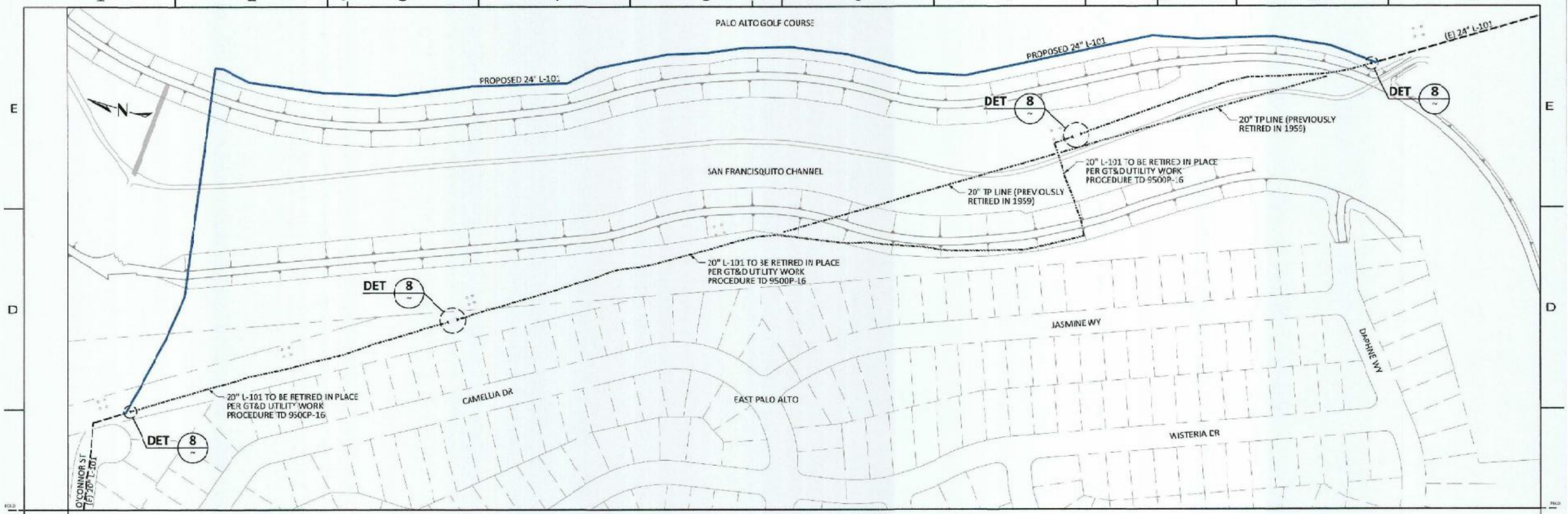
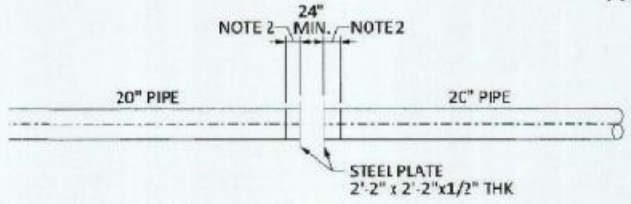


PLAN
SCALE: 1" = 100'

DEACTIVATION PROCEDURE FOR EXISTING PIPE:

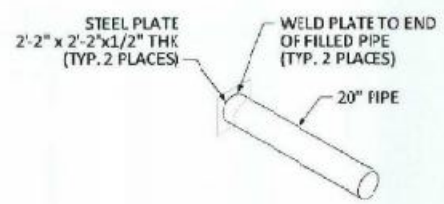
1. GT&D UTILITY WORK PROCEDURE TD 9500P-16 SHALL BE FOLLOWED.
2. THE EXISTING PIPE SECTIONS SHALL HAVE FREE LIQUIDS REMOVED AND BE 100% PURGED AS PER STANDARD A-38.
3. AT THE INTERVALS OF APPROXIMATELY 1000' OR A MAXIMUM OF 4000' THE MAIN SHALL BE SECTIONALIZED. THE LOCATIONS CALLED OUT ARE APPROXIMATE AND ARE SUBJECT TO FIELD VERIFICATION TO IDENTIFY THE MOST OPTIMUM LOCATION. ACCURATE SURVEY DATA MAY NOT BE AVAILABLE FOR THESE LOCATIONS SO USE CAUTION DURING EXCAVATION AND WHEN IDENTIFYING THE PIPELINE TO BE RETIRED.
4. AT EACH SUCH LOCATION NOTED ABOVE, A PIECE OF PIPE AT LEAST 24" LONG SHALL BE REMOVED. INSTALL A SAVE-A-VALVE TO CHECK FOR PRODUCT AND PRESSURE PRIOR TO CUTTING INTO THE PIPELINE. THE OPEN ENDS OF THE RETIRED MAIN SHALL BE SEALED BY THE MOST APPROPRIATE METHOD OUTLINED IN GT&D UTILITY WORK PROCEDURE TD 9500P-16. BACKFILL MUST BE THOROUGHLY COMPACTED IN PLACE OF THE REMOVED SECTION OF PIPE.
5. VALVES MAY BE REMOVED AND SALVAGED IF THE COST OF REMOVAL IS JUSTIFIED.

TYPICAL DEACTIVATION DETAIL



8 PLAN VIEW
SCALE: NOT TO SCALE

NOTES:
1. REMOVE A MINIMUM OF 24" OF PIPE.
2. PER PG&E WORK PROCEDURE TD 9500P-16.



ISOMETRIC VIEW
SCALE: NOT TO SCALE

REGISTERED PROFESSIONAL ENGINEER OSCAR R. ROSALES M18299 MECHANICAL STATE OF CALIFORNIA

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NO	DATE	DESCRIPTION	31189651	DISK	CDB6	KJF7	APVD BY
0	11/24/15	ISSUED FOR CONSTRUCTION		GM/SPEC	DWN	CHKD	SUPV

REVISIONS

APPROVED BY	
PGRS 40993	
SUPV KJF7	
DSGN D95R	
DWN D95R	
CHKD CDB6	
OK	
DATE 11-17-15	
SCALE: AS SHOWN	

PIPELINE - DEACTIVATION SHEET
L-101 MP 12.33 - 12.87
RELOCATE 3,350 FEET OF 24" PIPE
PALO ALTO, SANTA CLARA
EAST PALO ALTO, SAN MATEO
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

BIL OF MAT:	SEE SHEET 11
REL DWG LIST	SEE SHEET 2
SUPSDS	
SUPSD BY	
SHEET NO.	12 OF 12 SHEETS

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