

**SECTION 608
HORIZONTAL DIRECTIONAL DRILLING**

608.1 DESCRIPTION:

This specification covers requirements for installation of underground infrastructure using the trenchless technology method known as Horizontal Directional Drilling (HDD). All installations shall be in accordance with the approved HDD Consortium’s “Horizontal Directional Drilling Good Practices Guideline, third edition” and updates thereof.

The HDD method involves first drilling a pilot bore in the location(s) as indicated on the plans, next enlarging the drilled pilot bore to facilitate the installation of the required pipe line or bundle, herein referred to as the “product pipe”. The pilot bore is enlarged approximately 1.5 times the size of the product pipe and is pulled into the enlarged borehole.

Installations are classified as small, medium or large which serves as a general indication of the level of equipment required for the installation. The size of bore is measured in inch-feet and is calculated by multiplying the nominal product pipe diameter in inches multiplied by the minimum allowable length of crossing in feet as indicated on the plans or as can reasonably be inferred from the locations of such bends, fittings, service connections, valves and any other equipment requiring excavation and/or connection to the pipe line at a specified location. The bore shot size refers to each individual bore shot, not the total footage of the permitted design.

Bore size calculation: 200 foot installation of a 4 inch diameter pipe has a bore size of 800 in-ft.
(200ft × 4in = 800 in-ft)

Table 608-1	
Classification of Bore Sizes	
Classification	Bore Size
Small	Up to 6,000 in-ft
Medium	6,001 in-ft to 15,000 in-ft
Large	Above 15,000 in-ft

608.2 HDD TERMS AND DEFINITIONS:

- a. Pilot Hole: The initial controlled drilled horizontal shaft used to guide the enlargement to design size and eventual installation of the pipe.
- b. Reaming: The back reaming hole opener is attached to the drill pipe and rotated and pulled back through the pilot hole to enlarge the bore in one or more passes to the size for pipe installation.
- c. Pullback: The pipe installation pulled back by a swivel/pulling head connected behind the reamer, which pulls the prepared pipe into place.
- d. Drilling Fluids: Fluids consisting of water, bentonite, and any approved additives such as environmentally safe polymers, lubricants, and viscosifiers.
- e. Bore-tracking Equipment: Methods and systems generally defined as a walkover or non-walkover. To be specified by the Contractor and used to measure the actual accuracy of the bore to the specific line and grade. The bore path is monitored during the pilot bore by taking periodic readings of the inclination and azimuth of the probe located within the drive bit.
- f. Bore-tracking Pit: An excavated area for entry, exit, slurry sump pits or any other excavation used to manage, control and track the progress of the bore.
- g. Critical Structure: Any pipeline, utility, building, structure, bridge, pier, or similar construction partially or entirely located within a zone of active excavation.

608.3 MATERIALS:

All product pipe material shall be of the size type and classes shown on the plans.

Sectional pipe is pipe that requires assembly of the joints, such as a bell and spigot type pipe, shall be of a type that is specifically designed for installation by HDD.

Non-sectional pipe is pipe that requires joining together by a fusion or welding process. It is assembled prior to pulling the product pipe into the bore hole.

Non-sectional pipe that requires fusion of the joints, such as HDPE or Fusible-PVC, shall be fused by a skilled operator. The facility owner is responsible for maintaining a training program to ensure qualifications are maintained for joining procedures. Pipe manufacturer or accredited training agency certifications are also acceptable. Untrained personnel shall not be permitted to perform fusion of any pipe on the project. The contractor shall utilize a data-logger or manually record the following information for each fused joint in the product pipe line, unless the product pipe is pulled through a sleeve.

- Date and Time of joint
- Temperature
- Fusion pressure applied to joint
- Joining/Fusion time
- Cooling time

Non-sectional pipe used for dry utilities and/or as a sleeve will not require items listed above.

#14 or larger AWG solid tracer wire may be used if the product pipe is pulled through a sleeve and the tracer wire is pulled with the product pipe. Comply with ARS 40-360.22, para M.

608.4 RECORD DOCUMENTS AND SUBMITTAL REQUIREMENTS:

The Record Documents requiring submission to the Project Engineer for the facility owner are based on the bore size classification and are as shown in Table 608-2. The Contractor shall provide the indicated documents based on the bore size. The required items contained in items 1 through 9 shall be submitted to the Project Engineer for the facility owner prior to the authorization to commence field construction. Copies of all documents shall also be maintained at the construction site and be available for inspection.

Table 608-2			
Submittal Requirements			
Required Record Document	Bore Size Classification		
	Small	Medium	Large
1. Agency Approved Plans	•	•	•
2. Personnel Qualifications	•	•	•
3. Surface Survey		•	•
4. Bore Plan/Profile		•	•
5. Drilling Fluid Management Plan		•	•
6. Equipment & Site Setup			•
7. Drilling Fluid Pressure Calculations			•
8. Pipe Stress and Pullback Calculations			•
9. As-Built/Drillers Log	•	•	•

608.4.1 Agency Approved Plans: The facility owner shall submit plans for approval to the Agency in whose ROW the facility owner is proposing to install the new utility. Any changes from the approved plans will require a re-submittal of plans and re-approval. Identify all property lines, ROW, and easements. No work is to take place outside of the construction limits as show on the Agency Approved Plans.

608.4.2 Personnel Qualifications: The Contractor shall provide a competent and experienced individual who shall be present at all times while HDD operations are being performed. The individual shall be a responsible representative who is thoroughly familiar with the equipment and type of work and shall be in direct charge and control of the operation at all times. The individual shall possess experience with projects of a similar kind and nature, and have undergone appropriate training evidenced by a certificate of attendance from a training program,. Documentation of experience and training shall be .provided upon request.

608.4.3 Surface Survey: A surface survey is only required when specified by contract documents. Prior to starting the drilling operation the contractor shall submit to the Engineer a surface survey of elevations along the planned bore alignment, the maximum interval between elevations shall be ten feet (10'). Upon completion of the installation of the product pipe, the Contractor shall have a second survey performed and shall have the elevations compared with the pre-bore survey elevations. The second survey and the comparative results shall be submitted to the Engineer. Any change in elevation greater than ½" shall be considered excessive and shall be repaired at the Contractor's expense. Any elevation deviation of a flow line that is greater than ¼" shall be considered excessive and shall be repaired at the Contractor's expense.

608.4.4 Bore Plan/Profile: A scaled drawing of the pilot bore plan and profile shall be submitted by the Contractor. Show finished grade, the proposed pilot bore size and path, all existing utilities with minimum vertical and horizontal clearances.

608.4.5 Drilling Fluid Management Plan: Indicate the type and amount of the drilling fluid planned to be used on the project. Include MSDS sheets for the identified drilling fluid components and additives. The drilling fluid plan is developed based upon the anticipated soil conditions and a sufficient supply of fluid is to be available to enable successful completion of the bore. Indicate the intended method of disposal of spent drilling fluids and include approvals from off-site disposal sources. The Drilling Fluid Management Plan shall identify contingency measures to be employed in case of inadvertent returns. The contingency plan may include containment with sediment control devices, removal with vacuum equipment or other such contingency measures. In all cases, the plan shall indicate that should primary control measures fail and inadvertent returns cannot be controlled, work will be suspended until such a time as the plan can be revised and effective control measures can be implemented.

608.4.6 Equipment & Site Setup: Specifications on directional drilling equipment shall be utilized to ensure that the equipment will be adequate to complete the project. Equipment list is to include but not be limited to: drilling rig, mud system, mud motors (if applicable), down-hole tools, guidance system, and rig safety systems. Include calibration records for guidance equipment. Identify the site setup dimensions and where the equipment shall be located. Equipment shown on the site layout is to include but not be limited to: drilling rig, mud system, drill rod stock pile and mud return pit. Identify the pipe staging and assembly areas.

608.4.7 Drilling Fluid Pressure Calculations: Provide documentation sealed by the permitting agency's Arizona registered professional engineer for the calculations of minimum required and maximum allowable drilling fluid pressures anticipated throughout the bore to maintain drilling fluid circulation and minimize the occurrence of inadvertent returns. Indicate how such pressures shall be monitored and recorded throughout the progression of the bore. Provide manufacturers specifications for any down hole fluid pressure monitoring systems and properly calibrate such systems prior to commencing the installation.

608.4.8 Pipe Stress and Pullback Calculations: Submit documentation indicating the product pipe manufacturer's specified maximum allowable bending radius and maximum allowable pulling force for the pipe being installed. Provide calculations sealed by the permitting agency's Arizona registered professional engineer that show the anticipated bending radii for each segment of the pipe and the total anticipated pulling force required to complete the installation do not exceed the maximum allowable pulling forces for the pipe. The Drill Rig to be employed shall be capable of exerting a pullback force of at least 2 times that of the total anticipated pulling force required to complete the installation of the pipe specified. Furnish documentation indicating how the pulling forces introduced to the pipe

will be monitored and indicate the methods that will be employed to record such data and ensure that the force exerted on the pipe does not exceed the pipes maximum allowable pulling force.

608.4.9 As-Built/Drillers Log: Identify the installed location of the bore on a scaled drawing referencing any benchmark information provided on the original construction drawings. Also indicate the location of all existing utilities as provided on the original construction drawings and verified in the field as well as any undisclosed utilities as discovered in the field throughout the prosecution of this work. Also submit copies of any drilling fluid logs, pipe fusion logs and any other such information as it pertains to the work undertaken pursuant to this specification.

- Rod/joint number
- Time of recording
- Depth of locate reading
- Pitch, roll and clock-face.

608.5 CONSTRUCTION:

608.5.1 Horizontal Directional Drilling Equipment The HDD equipment is to have an electronic "walkover" tracking system or a Magnetic Guidance System (MGS) to accurately guide boring operations; a system to monitor maximum pullback pressure during pull-back operations; a system to detect electrical current from the drill string shall be in place with an audible alarm that automatically sounds when an electrical current is detected; a vacuum unit of sufficient capacity to handle the drilling fluid volume, and trained and competent personnel to operate the systems. All equipment shall be in good, safe condition with sufficient supplies, materials and spare parts on hand to maintain the system in good working order for the duration of the project.

608.5.2 Guidance System: An electronic "walkover" tracking system or a Magnetic Guidance System (MGS) probe or proven (non-experimental) gyroscopic probe and interface for continuous and accurate determination of the location of the drill head shall be used during the drilling operation. The locating system shall be capable of determining the in ground position of the drill head and shall be accurate to $\pm 2\%$ of the distance from the transmitter to the receiver. It shall enable the driller to guide the drill head by providing information on the pitch; roll and clock face orientation of the drill head. The locating system shall be capable of determining the depth of the drill head from the transmitter to the surface at any location along the path of the bore. The locating system shall be calibrated per the manufacturer's specifications prior to commencing the bore.

608.5.3 Drilling Fluid (Mud) System: A self-contained, closed, drilling fluid mixing system of sufficient size to mix and deliver drilling fluid composed of bentonite clay, uncontaminated water, and appropriate additives. The mixing system shall be able to molecularly shear individual bentonite particles from the dry powder to avoid clumping and ensure thorough mixing. The drilling fluid reservoir tank shall be of sufficient capacity to supply an amount of drilling fluid that is equal to the maximum rated output of the drilling fluid pump over at least fifteen minute duration. Ensure the drilling fluid is mixed per drilling fluid manufacturer's recommendations and continually agitate the drilling fluid during drilling operations.

Drilling fluid shall be uncontaminated water mixed with bentonite clay, polymer or appropriate drilling fluid additive. The Contractor shall be responsible to monitor drilling fluid properties and return fluid properties and shall modify the drilling fluid mix as appropriate for the soil conditions encountered. Contractor shall continually monitor and record any necessary drilling fluid properties such as viscosity as determined by a marsh funnel. The drill fluid pumping system shall be capable of delivering drilling fluid at a sufficient output rate and at minimum pressures as necessary to enable successful completion of the bore. Furnish pumping equipment and/or vacuum truck(s) of sufficient size to convey drilling fluid from containment areas, to storage and recycling facilities or disposal.

608.5.4 Directional Drilling Operation: Prior to drilling the pilot hole, "Walk" the bore path with the locating system as per the manufacturer's specifications attempting to identify any areas of potential interference and record the results of such inspections. Verify that all known utilities have been located and there is no conflict with the proposed work. Ensure all utilities that run parallel within 2' of the proposed work are exposed at intervals sufficient to determine there will be no conflict with the proposed work.

Profile the ground along the bore path every 10' and tie to an existing local temporary benchmark that will not be impacted by proposed construction. After the pull back is complete confirm the ground has not heaved, any heaving greater than 1" or settlement less than 1" will require the contractor to submit a plan to repair all damaged areas.

Determine the depth of the drill head every 10 ft or every rod length, whichever distance is greater. Record location information for the entirety of the bore, either manually in a driller's log or automatically via the locating system. Make all recorded readings and plan and profile information available at all times. Do not allow the deflection radius of the drill pipe exceed the deflection limits of the product pipe at any time throughout the crossing. Use white paint and mark the depth of the pilot bore on the ground at an interval not exceeding ten feet (10').

Stabilize the open bore hole by means of bentonite drilling slurry pumped through the drill rod and through openings in the drill head or reamer. The drilling slurry shall be in a homogenous/flowable state serving as an agent to carry the loose cuttings to the surface through the annulus of the borehole. Calculate the volume of drilling fluid required for each reamer pass based upon hole size and soil conditions. The driller shall not be permitted to "outrun his mud" which is the condition occurring when the drilling penetration or retrieval rate is generating cuttings at a rate faster than the drill fluid pumping system can suspend and convey the cuttings out of the bore hole.

Contain all drilling fluids in pits or holding tanks for recycling or disposal. Monitor drill fluid circulation throughout the duration of the bore activity and immediately take corrective actions to restore fluid circulation should circulation be lost.

Upon completion of the pilot bore, ream the bore hole up to a large enough diameter to accommodate the pullback of the product pipe. The final reamed hole opening shall be 1.5 times the outside diameter of the product pipe for pipe lines 24" or less, or no larger than 12" plus the outside diameter of the product pipe for pipe lines greater than 24".

Maintain a one foot (1') minimum separation between the outside of the pilot bore hole and the outside of the utility when no reaming is required to install the product pipe.

When the pilot bore hole is to be reamed maintain a minimum separation between the outside of the pilot bore hole and the outside of existing utility equal to one foot greater than the largest required reamer diameter.

608.5.5 Handling Product Pipe: Care shall be taken during transportation of the product pipe to prevent it from being cut, kinked or damaged. Use ropes, fabrics or rubber protected slings and straps when handling pipes. Do not use chains, cables or hooks inserted into the pipe ends. Use slings spread apart for lifting each length of pipe. Do not drop pipe or fittings onto rocky or unprepared ground.

Store pipe on level ground that is free of sharp objects that could damage the pipe. Limit the stacking of pipes to a height that will not cause excessive deformation of the bottom layers of pipe under anticipated temperature conditions. Where necessary due to ground conditions store the pipe on wooden sleepers, spaced suitably and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.

Handle assembled pipe in a manner that avoids damage to the pipe. The pipe is not to be dragged over sharp objects. Position slings to prevent stress on pipe joints. Product pipe that has cuts, gouges, or excessive deformation shall be removed and replaced.

608.6 MEASUREMENT:

Measurement of product pipe installed by HDD shall be by the lineal foot of pipe installed. Measurement shall be along the centerline of the product pipe, through all valves, fittings and manholes, from centerline to centerline of valves, fittings or structures or to the end of pipe.

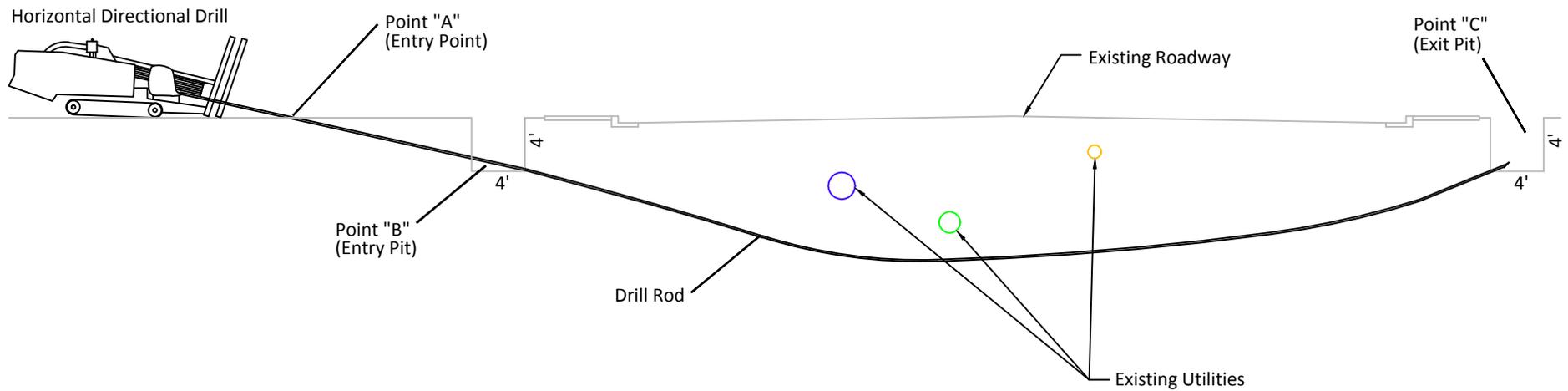
608.7 PAYMENT:

Payment will be made at the contract unit price for each type and size of product pipe. Payment shall be compensation for furnishing all labor, material, tools, and equipment required for the horizontal directional drilled

installation of product pipe, complete in place, including all related excavation, shoring and bracing, backfill, and compaction. When specified payment shall also include, testing, disinfecting, and connections to existing lines or works.

- End of Section -





Notes:

- 1.) For every 1' of cover, entry point (Point "A") needs to be setback 10' from entry point (Point "B").
- 2.) Minimum setback is 40' from Point "A" to Point "B".
- 3.) Drill rod can handle 6" of steering every 10'.
- 4.) The size of the drill hole must have a minimum of 2' clearance from existing utilities.

DETAIL NO.



STANDARD DETAIL
ENGLISH

HDD typical layout

REVISED

DETAIL NO.