

## SECTION 24 DIRECTIONAL DRILLING

**24-1 SUBMITTALS** - Prior to beginning work, Contractor shall submit to the Engineer a general work plan outlining the procedure and schedule to be used to execute the work. The submittal shall include:

1. Diagram of boring pits, bore path, entry and exit points, drawn to scale with pertinent dimensions to convey relationship with and impacts to adjacent facilities and improvements.
2. Specifications for directional boring equipment to be used to ensure that the equipment will be adequate to complete the work.
3. Documentation of relevant training and experience of personnels to used on the Project.

**24-2 EQUIPMENT** - The directional boring equipment shall consist of a directional boring rig of sufficient capacity to perform the bore and pullback the pipe, a boring fluid mixing and delivery system of sufficient capacity to successfully complete the crossing, a guidance system to accurately guide boring operations, and trained and competent personnel to operate the system. All equipment shall be in good, safe operating condition with sufficient supplies, materials, and spare parts on hand to maintain the system in good working order for the project duration.

1. **Boring Rig** - The directional boring machine shall consist of a hydraulically powered system to rotate, push, and pull a hollow drill pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill (bore) head. The machine shall be anchored to the ground to withstand the pulling, pushing, and rotating pressure required to complete the crossing. The hydraulic power system shall be self-contained with sufficient pressure and volume to power boring operations. Hydraulic system shall be free of leaks. Rig shall have a system to monitor and record maximum pull-back pressure during pull-back operations. The rig shall be grounded during boring and pull-back operations. Sufficient spare parts shall be kept on hand for any breakdowns which can be reasonably anticipated.
2. **Bore Head** - The bore head shall be steerable by changing its rotation and shall provide the necessary cutting surfaces and boring fluid jets.
3. **Mud Motors** - If required, mud motors of adequate power to turn the required boring heads shall be provided.
4. **Drill Pipe** - Drill pipe shall be constructed of high quality 4130 seamless tubing, grade D or better, with threaded box and pins. Tool joints shall be hardened to 32-36 RC.

**24-2.1 Guidance System** - Guidance system shall conform to industry standard or best practice, and shall be set up and operated by personnel experienced with this system. When using a system relying on magnetic effects, the operator shall be aware of any magnetic anomalies and shall consider such influences in the guidance system operation.

### **24-2.2 Boring Fluid (MUD) System**

1. **Mixing System** - A self-contained, closed boring fluid mixing system shall be of sufficient size to mix and deliver boring fluid composed of bentonite clay, potable water and appropriate additives. Mixing system shall be able to molecularly shear individual bentonite particles from the dry powder to avoid clumping and ensure thorough mixing. Mixing system shall continually agitate the boring fluid during boring operations.
2. **Boring Fluids** - Drilling fluid shall be composed of clean water and an appropriate additive. Water shall be clean with a pH of 8.5-10. Water with a lower pH or with excessive calcium shall be treated with the appropriate amount of sodium carbonate or compound of similar character. The water and additive shall be mixed thoroughly and be absent of any clumps or clods. No hazardous additives shall be used. Boring fluid shall be maintained at a viscosity sufficient to suspend cuttings and maintain the integrity of the bore wall.
3. **Delivery System** - Mud pumping system shall be capable of delivering the boring fluid at a constant pressure. The delivery system shall have filters in-line to prevent solids from being pumped into the drill pipe. Connections between pump and drill pipe shall be relatively leak free. Used boring fluid and boring fluid spilled during boring operations shall be contained and properly disposed of. A berm, minimum of 12" high, shall be maintained around boring equipment, boring fluid mixing system, entry and exit pits and boring fluid recycling system (if used) to prevent spills into surrounding environment. Pumps and or vacuum truck(s) of sufficient size shall be in place to convey excess boring fluid from containment areas to storage facilities.

### **24-2.3 Other Equipment**

1. Pipe Rollers - Pipe rollers, if required, shall be of sufficient size to fully support pipe weight while being hydro-tested and during pull-back operations. Sufficient number of rollers shall be used to prevent excess sagging of pipe.
2. Pipe Rammers/Pullers - Hydraulic or pneumatic pipe rammers or pullers shall only be used if necessary and with the authorization of Engineer.
3. Other devices or utility placement systems for providing horizontal thrust, other than those previously defined herein, shall not be used unless approved by Engineer prior to commencement of work. Consideration for approval will be made on an individual basis for each specified location. Proposed device or system will be evaluated, prior to approval or rejection, on its potential ability to complete utility placement satisfactorily without undue stoppage and to maintain line and grade within tolerances prescribed by the particular project conditions.

**24-3 EXECUTION** - Contractor shall notify Engineer 48 hours in advance of starting work. Directional Bore shall not begin until the Engineer is present at the job site and agrees that proper preparations have been made. The Engineer's approval for beginning installation shall in no way relieve the Contractor of the ultimate responsibility for the satisfactory completion of the work.

### **24-3.1 Preparation**

1. Documentation - Prior to any alterations to the area to receive boring, Contractor shall photograph or video tape entire work area including entry and exit points. One copy of images shall be provided to the Engineer.
2. Bore Path Survey - The entire drill path shall be accurately surveyed with all entry and exit stakes placed in the appropriate locations within the areas indicated on Drawings. If Contractor is using a magnetic guidance system, drill path will be surveyed for any surface geo-magnetic variations or anomalies.
3. Environmental Protection - Contractor shall place silt fence between all boring operations and any drainage, wetland, waterway or other area designated for such protections by Contract or state, federal and local regulations. Additional environmental protection necessary to contain any hydraulic or boring fluid spills shall be put in place, including berms, liners, turbidity curtains, and other measures. Contractor shall adhere to all applicable environmental regulations. Fuel or oil may not be stored in bulk containers within 200' of any water-body or wetland.
4. Utility Locations - Contractor shall notify all companies with underground utilities in the work area via Underground Service Aler (USA). Once the utilities have been located Contractor shall physically identify the exact location of the utilities by vacuum or hand excavation, when possible, in order to determine the actual location and path of any underground utilities which might be within ten (10) feet of the bore path. Contractor shall not commence boring operations until the location of all underground utilities within the work area have been verified.
5. Safety - Contractor shall adhere to all applicable state, federal and local safety regulations.
6. Site Preparation - Work site as indicated on drawings, within right-of-way, shall be graded to provide a level working area. Contractor shall confine all work to designated work areas and no alterations beyond what is required for operations shall be made.

### **24-3.2 Boring Procedure**

1. Pipe - Pipe shall be connected together in one length prior to pull-back operation, if space permits. Pipe shall be placed on pipe rollers before pulling into bore hole, with proper roller spacing to prevent excessive sagging of pipe.
2. Pilot Hole - Pilot hole shall be drilled on bore path with no deviations greater than 5% of depth over a length of 100'. In the event that the pilot hole does deviate from bore path more than 5% of depth in 100', Contractor shall notify Engineer, and Engineer may require Contractor to pull back and re-drill from the location along bore path just prior to substantial deviation.

3. In the event that a boring fluid fracture, an inadvertent return, or a returns loss occurs during pilot hole boring operations, Contractor shall cease boring, wait at least 30 minutes, inject a quantity of boring fluid with a viscosity exceeding 120 seconds as measured by a March Funnel Test, and then wait an additional 30 minutes. If mud fracture or returns loss continues, Contractor shall cease operations and notify Engineer. Engineer and Contractor shall discuss and agree to additional mitigation options, and work shall then proceed accordingly.
4. Reaming - Upon successful completion of pilot hole, Contractor shall ream bore hole to an outside diameter that is at least 25% greater than the pipe to be installed, using the appropriate tools. Contractor shall not attempt to ream at one time more length than the boring equipment and mud system are designed to safely handle.
5. Pull-Back - After successfully reaming bore hole to the required diameter, Contractor shall pull the pipe to be installed through the bore hole. In front of the pipe shall be a swivel. Once pull-back operations have commenced, operations shall continue without interruption until pipe is completely pulled into bore hole. During pull-back operations Contractor shall not apply more than maximum safe pipe pull pressure at any time.

In the event that the pipe becomes stuck, Contractor shall cease pulling operations to allow any potential hydro-lock to subside, and then recommence pulling operations. If pipe remains stuck, Contractor shall notify Engineer. Engineer and contractor shall discuss and agree to mitigation options, and work shall then proceed accordingly.

6. Pipe Testing - Following successful pull-back of pipe, contractor shall hydro-test pipe as described per Section 19-4.13 of these Technical Provisions.
7. Site Restoration - Following boring operations, contractor shall de-mobilize equipment and restore the work site to its original condition. All excavations shall be backfilled and compacted to match surround grades.

**24-4 MEASUREMENT** - When specified to be measured and paid as a separate item of work, pipe and conduit shall be measured along the longitudinal axis between the ends as laid and shall include the actual pipe in place.

**24-5 PAYMENT** - When specified to be paid as a separate item of work, the price per linear foot for pipe and conduit in place shall be considered full compensation for all materials, equipment, labor, and incidentals to install pipe and conduit, including the control of ground and surface waters, and all other work necessary to install the pipe, complete in place; and no additional compensation shall be allowed therefor.