

SECTION VIII

(Sub-Section 475)

Horizontal Directional Drilling

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HORIZONTAL DIRECTIONAL DRILLING (HDD)
SUB-SECTION 475

1.0 GENERAL

1.1 SCOPE OF WORK

Where indicated on the drawings and specified, the Contractor shall furnish and install piping systems for water distribution and fire protection, wastewater forcemains, or reuse distribution pipelines, all as may be referred to as pressure pipe systems. The work shall not include gravity sewer systems or road crossings for pipe-on-grade using the jack and bore method. The work shall be complete, tested, and ready for operation including connections, re-connections, stub-outs and appurtenances, temporary services, and all other provisions in regard to the existing operation and modification as is required to perform the new work. All references to Industry Standards (ASTM, ANSI, AWWA, etc.) shall be to the latest revisions unless otherwise stated. Only those materials included in the County's approved materials and equipment list shall be installed, unless otherwise specified or directed. All materials shall be new unless specifically called for otherwise.

It shall be the Contractors responsibility to perform the HDD operations in strict conformance with the requirements of the agency in whose right-of-way or easement the work is being performed. For work performed on State and County R.O.W's a R.O.W Utilization Permit will be required, and shall be acquired by the Project Engineer, along with all other necessary permits

1.2 SHOP DRAWING SUBMITTALS

Any specialty item not shown on the list of "Water and Sewer Approved Materials" will require a complete shop drawing submittal. The Project Engineer may require a complete detailed shop drawing submittal for any material which, in the Engineer's opinion, may not comply with these specifications.

2.0 QUALITY ASSURANCE & EQUIPMENT

2.1 CONTRACTOR QUALIFICATIONS

All directional drilling operations shall be performed by a qualified directional drilling CONTRACTOR with at least (3) years experience involving work of a similar nature to the work required of this project.

2.2 EQUIPMENT

Submit specifications on directional drilling equipment to be used to ensure that the equipment will be adequate to complete the project. Equipment shall include but not be limited to: drilling rig, mud system, mud motors (if applicable), downhole tools, guidance system, and rig safety systems. Calibration records for guidance equipment shall be included. Specifications for any drilling fluid additives that CONTRACTOR intends to use, or might use, shall be submitted.

GENERAL:

The directional drilling equipment shall consist of a directional drilling rig of sufficient capacity to perform the bore and pull back the pipe, a drilling fluid mixing, delivery, and recovery system of sufficient capacity to successfully complete the installation, a drilling fluid recycling system to remove solids from the drilling fluid so that the fluid can be reused (if required), a magnetic guidance system or walk over system to accurately guide boring operations, a vacuum truck of sufficient capacity to handle the drilling fluid volume, and trained and competent personnel to operate the system. 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 this project.

Drilling Rig: The directional drilling machine shall consist of a hydraulically powered system to rotate and push hollow drilling 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 installation. The hydraulic power system shall be self-contained with sufficient pressure and volume to power drilling operations. Hydraulic system shall be free of leaks. Rig shall have a system to monitor and record maximum pullback pressure during pullback operations.

There shall be a system to detect electrical current from the drill string and an audible alarm which automatically sounds when an electrical current is detected.

Drill Head: The drill head shall be steerable by changing it's rotation and shall provide necessary cutting surfaces and drilling fluid jets.

Mud Motors (if required): Mud motors shall be of adequate power to turn the required drilling tools.

Drill Pipe: Shall be constructed of high quality 4130 seamless tubing, grade D or better, with threaded box and pins. Tool joints should be hardened to 32-36 RC.

2.3 GUIDANCE SYSTEM

General: An electronic walkover tracking system or a Magnetic Guidance System (MGS) probe or proven gyroscopic probe and interface shall be used to provide a continuous and accurate determination of the location of the drill head during the drilling operation. The guidance shall be capable of tracking at all depths up to fifty feet and in any soil condition, including hard rock. It shall enable the driller to guide the drill head by providing immediate information on the tool face, azimuth (horizontal direction), and inclination (vertical direction). The guidance system shall be accurate and calibrated to manufacturers specifications of the vertical depth of the borehole at sensing position at depths up to fifty feet and accurate to 2-feet horizontally on either side of the borehole.

Components: The CONTRACTOR shall supply all components and materials to install, operate, and maintain the guidance system.

The Guidance System shall be of a proven type, and shall be set up and operated by personnel trained and experienced with the system. The operator shall be aware of any geo-magnetic anomalies and shall consider such influences in the operation of the guidance system.

2.4 DRILLING FLUID (MUD) SYSTEM

Mixing System: A self-contained, closed, drilling fluid mixing system shall be of sufficient size to mix and deliver drilling 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 and to avoid clumping and ensure thorough mixing. The drilling fluid reservoir tank shall be minimum of 1,000 gallons. Mixing system shall continually agitate the drilling fluid during drilling operations.

Drilling Fluids: Drilling fluid shall be composed of clean water and bentonite clay. Water shall be from an authorized source with a pH of 8.5 – 10. Water of a lower pH or with excessive calcium shall be treated with the appropriate amount of sodium carbonate or equal. No additional material may be used in drilling fluid without prior approval from the ENGINEER. The bentonite mixture used shall have the minimum viscosities as measured by a March funnel:

Rocky Clay	-60 seconds
Hard Clay	-40 seconds
Soft Clay	-45 seconds
Sandy Clay	-90 seconds
Stable Sand	-80 seconds
Loose Sand	-110 seconds

Wet Sand -110 seconds

These viscosities may be varied to best fit the soil conditions encountered, or as determined by the operator.

Delivery System: The mud pumping system shall have a minimum capacity of 35-500 GPM and the capability of delivering the drilling fluid at a constant minimum pressure of 1200 psi.

The delivery system shall have filters in-line to prevent solids from being pumped into drill pipe. Used drilling fluid and drilling fluid spilled during operations shall be contained and conveyed to the drilling fluid recycling system or shall be removed by vacuum trucks or other methods acceptable to the ENGINEER. A berm, minimum of 12-inches high, shall be maintained around drill rigs drilling fluid mixing system, entry and exit pits, and drilling fluid recycling system to prevent spills into the surrounding environment. Pumps and or vacuum truck(s) of sufficient size shall be in place to convey drilling fluid containment areas to storage and recycling facilities for disposal.

2.5 OTHER EQUIPMENT

Pipe Rollers: Pipe rollers shall be used for pipe assembly during final product pull back.

Restrictions: Other devices or utility placement systems for providing horizontal thrust other than those previously defined in the preceding sections shall not be used unless approved by the ENGINEER prior to commencement of the work. Consideration for approval will be made on an individual basis for each specified location. The proposed device or system will be evaluated without undo stoppage and maintain line and grade within the tolerances prescribed by the particular conditions of the project.

2.6 PERSONNEL REQUIREMENTS

All personnel shall be fully trained in their respective duties as part of the directional drilling crew, and in safety. Each person must have at least two years directional drilling experience.

A competent and experienced supervisor representing the CONTRACTOR shall be present at all times during the actual drilling operations. A responsible representative who is thoroughly familiar with the equipment and type of work to be performed must be in direct charge and control of the operation at all times. In all cases, the supervisor must be continually present at the job site during the actual Directional Bore operation. The CONTRACTOR shall have a sufficient number of competent workers on the job at all times to insure the Directional Bore is made in a timely and satisfactory manner.

Personnel who are unqualified, incompetent or otherwise not suitable for the performance of this project shall be removed from the job site and replaced with a suitable person.

A professional land surveyor registered in the State of Florida may be required for Certified "as-builts" as per specifications.

3.0 MATERIALS

3.1 POLYVINYL CHLORIDE (PVC) PIPE, 4" THRU 12"

The pipe material shall be of the restrained joint type in Class 150(DR18) or Class 200 (DR14), as shown in the proposal quantities, in sizes 4" thru 12" and tested to meet or exceed performance requirements of AWWA Standard C900. Pipe O.D.'s shall be equivalent to iron pipe O.D.'s. Pipe shall include couplings, gaskets, splines and lubricant as manufactured by the pipe supplier.

Pipe may be furnished in standard 20' lengths. Couplings shall be designed for use at the rated pressures of the pipe with which they are used. All PVC pipe shall be color coded as follows:

Potable Water	-Blue
Forcemain	-Green
Re-Use	-Purple

The pipe shall be joined using a separate PVC coupling with beveled edges, built in sealing gaskets, and restraining grooves. The restraining splines shall be square and made from Nylon 101.

Exposed splines shall be cut flush from the coupling wall to reduce soil drag.

Couplings shall be beveled on leading edges to minimize soil friction.

CONTRACTOR shall adhere to the pipe manufacturer's most current calculations regarding tensile load limitations for trenchless application. This calculation shall be part of the required shop drawing submittal. (See chart below)

Size	SDR	Class	Pipe O.D	Coupling O.D.	Maximum Pull-In Force Tightest Bending	Maximum Pull-In Force Straight Pull (No Bending)
4"	18	150psi	4.800"	5.964"	6,700 lbs.	8,200 lbs.
6"	18	150psi	6.900"	8.366"	9,000 lbs.	12,800 lbs.
8"	18	150psi	9.050"	10.947"	18,000 lbs.	25,200 lbs.
10"	18	150psi	11.100"	13.361"	25,600 lbs.	35,200 lbs.
12"	18	150psi	13.200"	15.836"	26,440 lbs.	41,100 lbs.
4"	14	200psi	4.800"	5.964"	8,000 lbs.	10,300 lbs.
6"	14	200psi	6.900"	8.366"	9,300 lbs.	14,700 lbs.
8"	14	200psi	9.050"	10.947"	18,900 lbs.	28,800 lbs.
10"	14	200psi	11.100"	13.361"	25,600 lbs.	35,200 lbs.
12"	14	200psi	13.200"	15.836"	26,440 lbs.	41,100 lbs.

CONTRACTOR shall adhere to the pipe manufacturers most current calculations regarding radius of curvature for C900/RJ pipe used for trenchless application.

Pipe Diameter	Min. Radius of Curvature	Offset per 20'	Deflection per 20' Length
4"	100'	23"	11.5 Degrees
6"	150'	16"	7.6 Degrees
8"	200'	12"	5.7 Degrees
10"	250'	9"	4.6 Degrees
12"	300'	8"	.8 Degrees

3.1.1 POLYVINYL CHLORIDE (PVC) PIPE, 14"

PVC pipe of size 14" shall be at least 160psi pressure rated, DR 18, manufactured with IPS O.D.'s and conform to AWWA standard C900. All joints shall be restrained and couplings supplied by the pipe manufacture to withstand maximum safe tensile loads for HDD applications. Safe tensile load calculations shall be part of the required shop drawing submittal. In addition, minimum radius of curvature per 20-ft. length of pipe and deflection per 20ft length of pipe shall be submitted as part of the required shop drawings. Pipe shall be color coded as follows:

Potable Water	-Blue
Forcemain	-Green
Re-Use	-Purple

3.1.2 POLYVINYL CHLORIDE (PVC) PIPE, 2" AND 3"

PVC pipe of sizes 2" and 3" shall be 250psi pressure rated, SDR 17, manufactured with IPS O.D.'s, 20ft. lengths and meet or exceed ASTM Specifications D2241 and NSF 14 and 61. Couplings and fittings shall be thrust-restrained for use at the rated pressures of the pipe with which they are used. Maximum safe tensile loads allowable are 2,900 lbs. and 5,000 lbs. respectively for 2" and 3" PVC pipe. All couplings and fittings shall be manufactured for permanent use as for direct burial. Color-coding shall be as follows:

Potable Water	-Blue
Forcemain	-Green
Re-Use	-Purple

Contractor shall adhere to the pipe manufactures most current limits regarding radius of curvature when the pipe is used for HDD.

3.2 HIGH DENSITY POLYETHYLENE (HDPE) PIPE

The pipe material shall be high density (PE3408) pressure pipe intended for use as a potable water pipe, force main, or re-use main.

Pipe and fittings shall meet or exceed AWWA C906, DR9 or DR 11, in sizes 4" thru 24" and AWWA C901, DR 7.3 or DR 9 in sizes 2" and 3". Pipe O.D.'s shall be equivalent to DIP pipe O.D.'s. All pipe shall be color coded by co-extruding longitudinal stripes into the pipe outside surface as follows:

Potable Water	-Blue
Forcemain	-Green
Re-Use Main -	Purple

Polyethylene fittings shall be made from material meeting the same pressure requirements or greater as the pipe. Fittings shall be molded by the pipe manufacturer meeting AWWA 906 requirements.

3.2.1 HDPE BUTT FUSION PROCESS

For pipe sizes 4" and larger of IPS or DIPS, hydraulic fusion machines shall be used. For pipe sizes 4" IPS and smaller, manually operated equipment may be used. The butt fusion process shall be also used for fittings, the location of which is shown on the drawings.

Hydraulic fusion machines shall be fully equipped with controls for setting pressures for facing, heating and fusing. The CONTRACTOR shall provide an experienced and fully qualified machine operator who shall demonstrate his qualifications to the PROJECT ENGINEER by conducting “dry-runs” of the fusion process using at least 2 different sizes of pipe and fittings.

3.3 RESTRAINED JOINT DUCTILE IRON PIPE

Ductile iron pipe wall thickness and pressure class shall conform to ANSI Specification ANSI A21.50 (AWWA C150) and ANSI A21.51 (AWWA C151) with working pressure class up to 350. Pipe shall also be certified by ISO 9002 by an accredited registrar. Each length shall be clearly marked with the name of the manufacturer, location of the foundry, pressure rating, thickness or pressure class, nominal pipe diameter, weight of pipe without lining and length. All pipe furnished by the manufacturer shall be cast and machined at one foundry location to assure quality control and provide satisfactory test data. All ductile iron pipe shall be externally coated and internally lined as specified in this section. All ductile iron pipe used for potable water shall be color coded blue by field painting a blue stripe, 3 inches wide, along the crown of the pipe barrel, use green for the forcemains and purple for the re-use mains. Furnish DIP as shown on the plans and proposal quantities.

3.3.1 LININGS AND COATINGS

All ductile iron pipe used for potable water, forcemains, or re-use mains shall be coated on the outside with 1 mil thickness of asphaltic compound as specified in AWWA C151. Pipe used for potable water shall be furnished with cement lining as specified in AWWA C104. Pipe used for forcemains and re-use mains shall be lined with a minimum finished dry thickness of forty (40) mils of Polyethelene in accordance with the ANSI/ASTM D1248 standards.

3.3.2 DUCTILE IRON FITTINGS

Ductile iron fittings shall conform to ANSI/AWWA C153/A21.53 for compact fittings and shall be furnished by the pipe manufacturer having equal or greater pressure ratings as the pipe furnished. All fittings shall have the same exterior and interior coatings and linings as the pipe furnished.

3.3.3 JOINT TENSILE LOAD CALCULATIONS

Wherever restrained joint ductile iron pipe is used for HDD purposes, each joint shall be restrained in conformance with the pipe manufacturers most current calculations regarding tensile load limitations for HDD applications. Such calculations shall be sufficient evidence as to maximum "pull-in" force for both the tightest bend and "straight pull" necessary to install the pipe without any separation of the joint. Calculations shall take into account pipe size, pressure rating, length of pull, joint restraint and other factors as certified by a registered professional engineer in the State of Florida.

4.0 HORIZONTAL DIRECTIONAL DRILLING OPERATIONS

The CONTRACTOR shall provide all material, equipment and facilities for directional drilling. Proper alignment and elevation of the bore hole shall be consistently maintained throughout the directional drilling operation. The method used to complete the directional drill shall conform to the requirements of all applicable permits. Copies of all permits will be supplied to the CONTRACTOR by the ENGINEER.

Piping shall be placed with a minimum of 36" of cover from existing grade to top of pipe. Maximum depth of cover shall be 60" unless specifically authorized by the Project Engineer. Bore profiles demonstrating compliance with the depth of cover requirements must be submitted for piping work claimed on each request for payment. The entire drill path shall be accurately surveyed with 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.

CONTACTOR shall place a silt fence between all drilling operations and any drainage, well-fields, wetland, waterway or other area designated for such protection necessary by documents, state, federal and local regulations. Additional environmental protection necessary to contain any hydraulic or drilling fluid spills shall be put in place, including berms, liners, turbidity curtains and other measures. The pilot hole shall be drilled on the bore path with no deviations greater than 2% of depth over a length of 100-feet.

In the event that pilot does deviate from the bore path more than 2-feet of depth in 100-feet, CONTRACTOR will notify ENGINEER and ENGINEER may require CONTRACTOR to pull-back and re-drill from the location along bore path before the deviation. In the event that a drilling fluid fracture, inadvertently returns or a returns loss occurs during pilot hole drilling operations, CONTRACTOR shall cease drilling, wait at least 30 minutes, inject a quantity of drilling fluid with a viscosity exceeding 120 seconds as measured by a March funnel and wait another 30 minutes. If mud fracture or returns loss continues, CONTRACTOR

will discuss additional options with the ENGINEER and work will then proceed accordingly.

Upon completion of the pilot hole phase of the operation, a complete set of “as-built” records shall be submitted in duplicate to the ENGINEER. These records shall include copies of the plan and profile drawing, as well as directional survey reports as recorded during the drilling operation.

Upon completion and approval of the pilot hole location the hole enlarging phase shall begin. The final hole enlargement shall not exceed by 1.5 times the O.D. of the pipe joint.

The open bore hole may be stabilized by means of bentonite drilling slurry pumped through the inside diameter of the drill rod and through openings in the reamer. The drilling slurry must be in a homogenous / flowable state serving as an agent to carry the loose cuttings to the surface through the annulus of the borehole. The bentonite slurry is to be contained at the exit or entry side of the directional bore in pits or holding tanks. The slurry may be recycled at this time for re use in the hole opening operation, or shall be hauled by the CONTRACTOR to an approved dumpsite for authorized disposal. Following completion of the bore hole the product pipe shall be pulled through the hole by means of a pulling eye attached to the lead joint of pipe. Attach a 10 gauge stranded insulated locate wire to the pulling eye and the crown of the pipe (PVC or HDPE) at each joint and at 10 ft. intervals along the pipe with plastic zipper ties.

5.0 TESTING PIPE

Cleaning and flushing are to be done by the CONTRACTOR in accordance with the requirements of the contract and these specifications.

Directional drilled pipe shall be tested by the CONTRACTOR after pullback. The average pressure shall be maintained at 150 psi for two hours with no leakage as may be indicated by a drop in pressure, or as may be allowed by the ENGINEER.

The test pump and water supply shall be arranged to allow accurate measurements of the water required to maintain the test pressure. Any material showing seepage or the slightest leakage shall be replaced as directed by the ENGINEER at no additional expense to the OWNER.

The manufacturer’s recommendations on pipe stretch allowances, bend radius and tensile strength, allowable make-up water, and duration of test pressure shall be observed but may not be approved by the ENGINEER.

Installed pipelines shall be tested end to end.

All service lines on the new main shall also be tested along with the newly installed mains.

6.0 SITE RESTORATION

Following HDD operations, CONTRACTOR will de-mobilize equipment and restore the work site to the original condition or better. All excavations will be backfilled and compacted according to the specifications or as directed by the ENGINEER.

Surface restoration shall be completed in accordance with the requirements of the contract, to a condition as good or better than existed prior to construction using like materials as the original.

7.0 RECORD KEEPING AND AS-BUILTS

CONTRACTOR shall maintain a daily project log of drilling operations and a guidance system log with a copy given to the ENGINEER at completion of the project.

The CONTRACTOR shall furnish "as-built" plan and profile drawings based on these recordings showing the actual location horizontally and vertically of the installation, and all utility facilities found during the installation. "As-Built" plans shall be submitted for piping work claimed on each pay request. "

"As-built" drawings shall be completed and certified by a Florida registered professional surveyor and mapped at CONTRACTOR'S expense in a form as required by ENGINEER. A final, complete, signed and sealed set of As-Builts shall be submitted with the final request for payment.

8.0 SUBSURFACE INVESTIGATION

The CONTRACTOR shall be responsible for having determined to his satisfaction, prior to the submission of his bid, the nature and location of the work, the ground conformation, the character of equipment and facilities needed preliminary to and during the prosecution of the work, the general and local conditions and all other matters which can, in any way affect the work under this Contract. The prices established for the work to be done will reflect all costs pertaining to the work described in these specifications. For purposes of this specification the definition of "substrata" shall mean "a layer of earth beneath the surface soil".

9.0 MEASUREMENT AND PAYMENT (PIPE ITEMS)

Except as otherwise provided, the length of potable water pipe, forcemain or re-use main of the type and size shown in the contract proposal quantities shall be measured along the centerline of the pipe including fittings, and to a minimum

depth to provide 36" of cover and a maximum depth of 60" or as approved. PVC fittings only will be included as pipe.

Payment will be made on a per linear foot basis for all directional drilled pipe and shall include all other related incidental work and materials including excavation, remove and replace unsuitable backfill, layout and reference points, fence and shrub restoration, leakage and bacteriological testing, pressure testing, thrust restraint, silt barriers where required, locate wiring and testing, interior lining and exterior coating, restrained joints, retainers, glands and couplings, system connections, drainage maintenance, and traffic maintenance.

10.0 MEASUREMENT AND PAYMENT (OTHER ITEMS)

Items, other than pipe quantities, as shown in the contract proposal shall be furnished and installed in accordance with the specifications or as described in the proposal quantities. Payment will be made based on final quantities installed and accepted.