

ARTICLE 33

HORIZONTAL DIRECTIONAL DRILLING

Index	<u>33.01 GENERAL CONSIDERATIONS</u>
	<u>33.02 DESIGN BASIS</u>
	<u>33.03 DETAILS OF DESIGN AND CONSTRUCTION</u>
	<u>33.04 PRODUCTS</u>
	<u>33.05 EXECUTION</u>

BACK TO TABLE OF CONTENTS

Section	<u>33.01 GENERAL CONSIDERATIONS</u>
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33.01.01	<u>Type of Horizontal Installation</u>
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The City will approve plans for horizontal directional drill installation of pipe and /or casing pipe for utility extensions as required for crossing under roadways, rail lines, streams, or other vertical conflicts as necessary in accordance with approved design and recommendation of the Engineer of Record. Such installations may be required to meet minimum standards as set forth by other jurisdictions having authority over the feature being crossed including Orange County, FDOT, or Railroad. The utility mains and extensions shall be installed in conjunction with the horizontal drilling only when such mains are designed and constructed in accordance with the criteria set forth in other Articles of this Manual.

Section	<u>33.02 DESIGN BASIS</u>
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33.02.01	<u>General</u>
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- A. Horizontal directional drilling is a method of installation commonly referred to as directional drilling or guided horizontal boring.
- B. Refer to applicable water, reclaimed water and force main design standards in ARTICLE 29, ARTICLE 31, and ARTICLE 32.

33.02.02	<u>Location</u>
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- A. Directional drilling is allowed for pressurized mains and is not allowed for gravity mains.
- B. Directional drilling of restrained PVC and ductile iron is allowed in City of Ocoee right-of-way. Ductile iron shall only be utilized for water and reclaimed water mains.

- C. Directional drilling of HDPE pipe shall be limited to wetlands, canal crossings and road crossings as approved by the City Engineer. The City will consider allowing directional drilling for other circumstances with specific approval, such as limited R/W or easement areas that conventional open cut cannot be performed due to other utilities or conflicts. A written request must be submitted to the City that outlines the need for directional drilling.

Section 33.03 DETAILS OF DESIGN AND CONSTRUCTION

33.03.01 General

- A. Horizontal alignment shall be as shown on the PLANS. The pipe shall have a minimum 36 inches of cover.
- B. The maximum depth shall be determined based on the size of the drill and the necessary clearance from the existing or proposed utilities or feature being crossed.
- C. For subaqueous crossings, a minimum cover of five feet shall be maintained over the pipe measured from the lowest part of the stream bed at the point of crossing.
- D. Compound curvatures may be used, but shall not exceed the maximum deflections, as set forth by the pipe manufacturer or AWWA Standards, whichever is more stringent.
- E. Entry angle shall not exceed 15 degrees. Exit angle shall be 6 to 12 degrees to facilitate pullback. Entry angle and exit angle shall not exceed manufacturer recommendations on deflection, angle or radius of curvature.
- F. A cross section drawn to scale shall be provided on the PLANS showing the proposed bore path and all existing utilities within the directional drill corridor.

33.03.02 Scope of Work

The WORK specified in this section consists of furnishing and installing underground utilities using the horizontal directional drilling (HDD) method of installation, also commonly referred to as directional boring or guided horizontal boring for pressure pipe. This WORK shall include all piping services, equipment, materials and labor for the complete and proper installation testing, restoration of underground utilities and environmental protection and restoration.

33.03.03 Quality Assurance

A. Qualifications:

1. Directional drilling CONTRACTOR (or SUBCONTRACTOR) shall have a minimum of four years experience constructing water, wastewater, or reclaimed water experience to include pipelines of the same or larger diameter and the same or greater lengths. All pipe and appurtenances of similar type and material shall be furnished by a single manufacturer.
2. The CONTRACTOR's operations shall be in conformance with the Directional Crossing Contractors Association (DCCA) published guidelines (latest edition) and pipe manufacturer's guidelines and recommendations.

Section 33.04 PRODUCTS

33.04.01 General

A. The directional drilling equipment shall consist of the following:

1. A directional drilling rig of sufficient capacity to perform the bore and pull-back of the pipe;
2. A drilling fluid mixing, delivery and recovery system of sufficient capacity to complete the crossing;
3. A drilling fluid recycling system to remove solids from the drilling fluid so that the fluid can be reused;
4. A magnetic guidance system to accurately guide boring operations,
5. A vacuum truck of sufficient capacity to handle the drilling fluid volume; and
6. Trained and competent personnel to operate the system.

B. All equipment shall be in good, safe operating condition with sufficient supplies, materials and spare parts on hand to maintain the system in proper working order.

33.04.02 Drilling System

The directional drilling machine shall consist of a hydraulically powered system to rotate, push and pull 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 drilling operations. Hydraulic system shall be free of leaks. Rig shall have a system to monitor and record maximum pullback pressure during pullback operations. The rig shall be grounded during drilling and pullback operations. There shall be a system to detect electrical current from the drilling string and an audible alarm that automatically sounds when an electrical current is detected.

33.04.03 Pipe

A. Pipe shall be HDPE pipe with ductile iron pipe outside diameters in accordance with AWWA C900 (C905) or C906 respectively. The dimension ratio shall be verified by the CONTRACTOR based on the pipe, joint and material pull strength required for the directional drilling. Alternate material such as PVC or DIP may be allowed in special circumstances and must be approved by the City Engineer. Alternate material shall comply with specification as outlined by this manual and other conditions as required by approval by the City Engineer.

B. HDPE Pipe

1. HDPE pipe and related fittings shall be made with prime virgin resins exhibiting a minimum cell classification as defined in ASTM D3350 and meeting the PE 3408 code designation with maximum dimension ratios equal to the following.

Table 33-1. Maximum Dimension Ratios for HDPE Pipe.	
Type of Pipe System	Maximum Dimension Ratio
Wastewater	11
Reclaimed Water	11
Water	11

2. HDPE pipe 4-inch and larger nominal diameter shall be joined by means of zero leak-rate butt (thermal heat) fusion welds and/or approved flanged joints. Joints shall provide axial pullout resistance. Compression style fittings shall not be allowed. Pipe shall meet the requirements of ANSI/AWWA C906, and have an outside diameter dimension of ductile iron pipe. Flanged joints shall not be used below finished grade for horizontal directional drilling applications.

3. HDPE pipe shall have been continuously marked by the manufacturer with permanent printing indicating at a minimum the following.
 - a. Nominal size (inches);
 - b. Dimension ratio (DR);
 - c. Pressure rating (psi);
 - d. Trade name;
 - e. Material classification (PE 3408);
 - f. Plant, extruder and operator codes;
 - g. Resin supplier code;
 - h. Date produced; and
 - i. HDPE pipe used for portable water mains shall bear the NSF Seal of Approval.

4. HDPE pipe shall be black in color with permanent colored stripes extruded into the pipe length or shall be one solid color, per the applicable service.

Table 33-2. Pipe Color.	
Pipe Use	Color Coding
Potable Water	Blue
Wastewater	Green
Reclaimed Water	Purple

5. Installation Curvature:

The pipeline curvature shall not have a radius less than as shown in Table 33-3, or exceed the manufacturers suggested minimum bending radius.

Table 33-3. HDPE Pipe Deflection Information.		
Pipe Diameter (inches)	Minimum Radius of Curvature (feet)	Offset per 20-ft Length (inches)
4	23	9.3
6	34	6.1
8	44	4.6
10	56	3.5
12	67	3.0
16	88	2.3

33.04.04 Drilling Fluids

Drilling fluids shall consist of a mixture of potable water and gel-forming colloidal material, such as bentonite or a polymer surfactant mixture producing slurry of a consistency sufficient to expedite the pull-back installation within the standards of practice detailed in the DCCA guidelines, (latest edition).

Section 33.05 EXECUTION

33.05.01 Personnel Requirements

- A. Responsible representatives of the CONTRACTOR and SUBCONTRACTOR(s) shall be present at all times during directional drilling operations. A responsible representative as specified herein is defined as a person experienced in the type of WORK being performed and who has the authority to represent the CONTRACTOR in a routine decision making capacity concerning the manner and method of carrying out the WORK.

- B. The CONTRACTOR and SUBCONTRACTOR(s) shall have sufficient number of competent workers on the project at all times to ensure the utility placement is made in a timely, satisfactory manner. Adequate personnel for carrying out all phases of the directional drilling operation (where applicable: tunneling system operators, operator for removing spoil material, and laborers as necessary for various related tasks) must be on the job site at the beginning of WORK. A competent and experienced supervisor representing the CONTRACTOR or SUBCONTRACTOR that 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 project site during the directional drilling operation.

33.05.02 Work Plan

A. Work Plan: Prior to beginning WORK, the CONTRACTOR must submit a Work Plan to The City Engineer detailing the procedure and schedule to be used to execute the project. The WORK plan should include the following.

- 1. A description of all equipment to be used;
- 2. Down-hole tools;
- 3. A list of personnel and their qualifications and experience;
- 4. List of SUBCONTRACTORS;
- 5. A schedule WORK activity;
- 6. A safety plan, traffic control plan (if applicable);
- 7. An environmental protection plan and;
- 8. Contingency PLANS for possible problems.

WORK plan should be comprehensive, realistic and based on actual working conditions for this particular project. Plan should document the requirements to complete the project.

B. Equipment:

1. The CONTRACTOR will 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 the following.
 - a. Drilling rig;
 - b. Mud system;
 - c. Mud motors (if applicable);
 - d. Down-hole tools;
 - e. Guidance system and;
 - f. Rig safety systems.
2. Calibration records for guidance equipment shall be included. Specifications for any drilling fluid additives that the CONTRACTOR intends to use or might use shall be submitted.

33.05.03 Coordination of the Work

- A. The CONTRACTOR shall notify the City Engineer at least three days in advance of starting WORK. In addition, the actual crossing operation shall not begin until An engineering representative is present at the project site and agrees that proper preparations for the crossing have been made. City Engineer's approval for beginning the crossing shall in no way relieve the CONTRACTOR from the ultimate responsibility for the completion of the WORK.
- B. The CONTRACTOR and the City Engineer shall select a mutually convenient time for the crossing operation to begin in order to avoid schedule conflicts.

33.05.04 Procedure

The installation of appropriate safety and warning devices in accordance with the "FDOT Manual on Traffic Control and Safe Practices" shall be completed prior to beginning WORK.

33.05.05 Installation

- A. Erosion and sedimentation control measures and on-site containers shall be installed to prevent drilling mud from spilling out of entry and/or exit pits. Drilling mud will be disposed of off-site in accordance with local, state and federal requirements and/or permit conditions.
 1. No other chemicals or polymer surfactant shall be used in the drilling fluid without written consent of the City Engineer and after a determination is made that the chemicals to be added are not harmful or corrosive to the facility and are environmentally safe.

B. Pilot Hole:

Pilot hole shall be drilled on bore path with no deviations greater than two percent of depth over a length of 100 feet. In the event that pilot does deviate from bore path more than two percent of depth in 100 feet, the CONTRACTOR will notify ENGINEER. The ENGINEER may require the CONTRACTOR to pull-back and re-drill from the location along bore path before the deviation.

C. Reaming:

Upon successful completion of pilot hole, the CONTRACTOR will ream borehole to a minimum of 25 percent greater than outside diameter of pipe using the appropriate tools. CONTRACTOR will not attempt to ream at one time more than the drilling equipment and mud system are designed to safely handle.

D. Pullback:

After successfully reaming borehole to the required diameter, CONTRACTOR will put the pipe through the borehole. In front of the pipe will be a swivel and barrel reamer to compact bore hole walls. Once pullback operations have commenced, operations must continue without interruption until pipe is completely pulled into borehole. During pullback operations, the CONTRACTOR shall not apply more than the maximum safe pipe pull pressure at any time. A break away head rated at the maximum safe pull pressure shall be utilized.

E. As-built variance from the designed bore path shall not exceed plus or minus one foot in the vertical plane and plus or minus two feet in the horizontal plane. The CONTRACTOR shall submit any proposed deviations from the design bore path by submittal to the City Engineer for approval.

F. The pipe entry area shall be graded to provide support for the pipe to allow free movement into the borehole. The pipe shall be guided in the borehole to avoid deformation of, or damage to, the pipe by the use of support rollers, etc.

G. If unexpected subsurface conditions are encountered during the bore, the procedure shall be stopped. The installation shall not continue until the OWNER and ENGINEER have been consulted.

H. The pipe shall be pulled back through the borehole using the wet insertion construction technique. The pipe shall be installed full of water.

I. The pipe shall be installed in a manner that does not cause upheaval, settlement, cracking, movement or distortion of surface features.

- J. A boring log shall be kept with horizontal and vertical location every 10 feet. In addition, horizontal location of the bore shall be marked in the field during the bore. The SURVEYOR shall locate these marks and include this information with the bore depths in the Record Drawings. The Surveyor may make a note on the drawing page containing the directional drill and provide an exception for the directional drill only, as the directional drill route cannot be uncovered and physically located. Log should also contain drilling fluid pressure and drilling advancement and pull back rates.
- K. Locating wire shall be attached to the pipe. A minimum of three (3) locating wires shall be attached at different radial locations around the pipe to ensure continuity in at least one wire subsequent to installation. Failure of continuous continuity in the locating wire, at the discretion of the engineering representative, shall result in abandonment and reinstallation of the directional drill.

33.05.06 Field Testing

- A. PVC Pipe:
Perform hydrostatic testing for leakage following installation in accordance with the applicable test sections.
- B. HDPE Pipe:
 - 1. After installation the pipe shall be tested in accordance with the MANUAL with the following modifications:
 - a. Test Duration: The total test time including initial pressurization, initial expansion and time at test pressure, must not exceed eight hours. If the test is not completed due to leakage, equipment failure, etc., the test section shall be depressurized and allowed to “relax” for a minimum of eight hours before it is brought back up to test pressure. The test procedure consists of initial expansion phase and leakage test phase.
 - b. Initial Expansion Phase: During the initial expansion phase, the test section is pressured to the test pressure and enough make-up liquid is added each hour for three hours to return to test pressure.
 - c. Leakage Test Phase: The leakage test phase follows immediately and shall be either two or three hours in duration. At the end of the time test, the test section shall be returned to test pressure by adding a measured amount of liquid. The amount of make-up liquid added shall not exceed the values provided in Table 33-4 plus allowable leakage.

Contractor shall be required to pressure test the HDPE main prior to installation of the main.

Table 33-4. Allowance for Make-up Water Under Test Pressure*								
Test Duration (hours)	Pipe Diameter (inches)							
	2	4	6	8	12	16	20	24
	Allowance/100 feet of Pipeline (gallons)							
2	0.11	0.25	0.60	1.00	2.30	3.30	5.50	8.90
3	0.19	0.40	0.90	1.50	3.40	5.50	8.00	13.30

**Applies to test period and not to initial expansion phase*

C. Pressure Testing:

The test pressure for the pipe shall be 150 psi for water and reclaimed water and 150 psi for wastewater.

D. Mandrel Testing:

Perform mandrel testing through the entire length of the installed pipe. The mandrel size shall be 90 percent of the inside diameter of the pipe.