Item No. 501
Jacking or Boring Pipe

Notes to Specifier:

Delete these notes and not used paragraphs.

Where options are given, make appropriate selection and delete the other option, fill in all blanks.

Verify all references to paragraphs within this Section and to any applicable Sections, standards or other specified sources of information.

General: This specification is intended for applications that consist of relatively short (less than 200 feet) pipeline crossings for pipelines with nominal diameters of 48 inches or less, in favorable, uniform ground conditions that consist of cohesive soils that are above the groundwater table. This specification shall not be used for high-risk applications of longer (greater than 200 feet) or larger diameter pipeline crossings (pipelines with a nominal diameter greater than 48 inches) or for pipeline crossings in unfavorable ground conditions (non-cohesive soils, variable or mixed ground conditions, ground containing cobbles, boulders or other types of obstructions, in rock, below the water table, in contaminated soils, and/or other unstable conditions).

Geotechnical Information: Obtain site specific geotechnical information to understand the subsurface conditions associated with each pipeline crossing in order to mitigate risk. When planning a geotechnical investigation, borings should be drilled at each proposed shaft location to depths at least 15 feet below the subgrade elevation of the shaft. Borings should be performed at least every 300 feet along alignments that may be constructed by tunnel or trenchless construction methods and such borings shall be offset from the alignment and outside of the potential tunnel/trenchless alignment to prevent conflicts with future tunnel/trenchless construction activities. Deeper depths for borings should be considered if there is a possibility that the pipeline can go deeper to avoid unfavorable ground conditions, existing utilities, or undergo a potential change during detailed design.

Geotechnical Investigation or Geotechnical Reports: If geotechnical information and/or a geotechnical report has been performed for the Project, especially if it involves the pipeline crossing to be specified herein, the Supplementary Conditions or similar front end documents may need to be edited to denote the availability and reliance on the Technical Data contained in such reports and whether or not such reports are to be considered a part of the Contract Documents.

Tunnel or Trenchless Construction Methods: This specification includes guidance for tunnel or trenchless excavation with an auger boring machine, jacking shield (otherwise known as a digger shield), or by manual hand tunneling or mining, all of which can be referred to as jack and bore methods. This specification does not include provisions for advanced tunnel or trenchless construction methods such as the use of a tunnel boring

machine (e.g., earth pressure balance tunnel boring machine), microtunnel boring machine (e.g., slurry type microtunnel boring machine), or other trenchless methods such as horizontal directional drilling, pipe bursting, pipe ramming, or guided boring methods (e.g., pilot tube method).

Finished Pipe Materials: Coordinate this section with the finished pipe material specification, drawings and typical details, and pipe trenching and backfilling specifications to clearly denote which portion of the Project they apply to (the open cut portion of the pipeline or the tunnel or trenchless crossing portion of the pipeline). In some instances, the casing pipe can also serve as the carrier pipe. If such is the case the requirements herein will need to be modified, such as inclusion of requirements for coatings and linings, joint types, etc.

Minimum Clearances and Cover Depth: Tunnel or trenchless excavations shall maintain at least 4 feet of clearance from existing utilities (as measured from the outside diameter of the existing utility to the outside diameter of the new utility, including any casings) or greater if required by authorities having jurisdiction, such as the Texas Commission on Environmental Quality for clearances between water and wastewater lines. Tunnel or trenchless excavations shall maintain at least 6 feet of cover or two times the diameter of the tunnel or trenchless excavation, whichever is greater (beneath the bottom of the subgrade of highways, roadways, non-natural drainage channels, or other structures, beneath the flowline of natural drainage channels, or beneath the bottom of the sub-ballast of railways) or greater if required by authorities having jurisdiction.

501.1 Description

This item shall govern furnishing and installing of encasement pipe by methods of jacking or boring as indicated on the Drawings and in conformity with this specification. This item shall also include, but not be limited to other constructions activities such as traffic control measures, excavation, removal of all materials encountered in jacking or boring pipe operations, disposal of all material not required in the work, dewatering, contact grouting, backfill grouting, bulkhead installation, backfilling, and re-vegetation.

501.2 Standards

The applicable provisions of the following standards shall apply as if written here in their entirety:

A. American Association of State Highway and Transportation Officials (AASHTO):

AASHTO	Standard Specifications for Highway Bridges

B. American National Standards Institute (ANSI) / NSF International Standards:

ANSI/NSF 61	Drinking Water System Components – Health Effects

C. American Railway Engineering and Maintenance-of-Way Association (AREMA):

AREMA	Manual for Railway Engineering

D. American Society of Civil Engineers (ASCE):

ASCE MOP 106	Manual and Report on Engineering Practice No. 106, Horizontal Auger Boring Projects

E. American Water Works Association (AWWA):

AWWA C200	Steel Water Pipe, 6 In. (150 mm) and Larger
AWWA C206	Field Welding of Steel Water Pipe
AWWA C210	Liquid-Epoxy Coatings and Lining for Steel Water Pipe and Fittings
AWWA M11	Steel Water Pipe – A Guide for Design and Installation

F. Railroad Standards:

BNSF Railway	Public Projects Manual, Utility Accommodation Policy, and Guidelines for Temporary Shoring
Union Pacific	Union Pacific Railroad Public Projects Manual, Guidelines for Track & Ground Monitoring, Guidelines for Temporary Shoring, and General Conditions and Specifications

G. Occupational Safety and Health Administration (OSHA) Regulations:

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1926	Safety and Health Regulations for Construction
2226-10R	Trenching and Excavation Safety
3115-06R	Underground Construction (Tunneling)

H. TxDOT Test Procedures

Tex-114-E	Laboratory Compaction Characteristics and Moisture-Density Relationship of Subgrade, Embankment Soils, and Backfill Material
Tex-115-E	Field Method for Determining In-Place Density of Soils and Base Materials

I. TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges:

Item 476	Jacking, Boring, or Tunneling Pipe or Box

501.3 Definitions

A. Definitions pertaining to jacking or boring and associated work described herein shall be in accordance with the Glossary of Trenchless Terms published by the National American Society of Trenchless Technology (NASTT), which can be found at https://www.nastt.org/resources/glossary/.

B. The term “jacking” used herein shall be synonymous with the terms “pipe jacking” or the “shield tunneling method” as defined by the NASTT Glossary.

C. The term “boring” used herein shall be synonymous with the terms “auger boring” or “horizontal earth boring" as defined by the NASTT Glossary.

501.4 Submittals

The submittal requirements for this specification item shall include:

A. Work Plan: Prior to beginning the Work, the Contractor shall submit to the Owner’s Representative a work plan as Record Data detailing the procedure and schedule to be used to execute the Project. The work plan should include:

1. A description and product data of all jacking or boring equipment to be used including, capacity, number, and arrangement of hydraulic jacks, as applicable. Provide details of thrust ring, jacking controls, and pressure gages as applicable.

2. A description of the proposed procedures for performing jacking or boring operations, including handling and disposal of excavated materials, installing encasement pipe, including jointing and welding procedures, as applicable, installation of the carrier pipe, including product data and shop drawings of casing spacers and end seals, and batching, mixing, pumping, and placement of contact grout into the exterior or the encasement pipe and backfill grout in the annular place in the interior of the encasement pipe. Include means and methods of line and grade control for the jacking or boring equipment during installation of the encasement pipe and the carrier pipe.

3. Statement of qualifications and experience for the Project Superintendent, Project Manager, and Jacking or Boring Equipment Operators for the jacking or boring operations (including back-up personnel in the event that an individual is unavailable).

4. A list of Subcontractors (if applicable).

5. A schedule of all work activities.

6. A safety plan (including Safety Data Sheets of any potentially hazardous substances to be used).

7. Traffic control plan (if applicable).

8. Geotechnical instrumentation monitoring plan (if applicable).

9. A pit/shaft excavation work plan. Protective systems are required for pit/shaft excavations 5 feet deep or greater per OSHA requirements and Texas Health and Safety Code Sec 756.022. For pit/shaft excavations greater than 20 feet in depth, protective systems are to be designed by a professional engineer retained by the Contractor per OSHA 29 CFR 1926 Subpart P.

10. A site plan indicating all excavation locations, including dimensions of pit/shaft excavations, dimensions of equipment to be utilized, locations where excavated materials will be stockpiled, and storage area of encasement pipe materials or other materials used to perform the Work.

11. Construction dewatering plan (if applicable).

12. Utility relocation plan (if required)

13. Flow bypass pumping plan (if required).

14. Contingency plans that include corrective actions to be taken in the event of excessive ground movement (settlement or heave), excessive deviation from line and grade, slower than anticipated progress, stuck excavation equipment, damage to an existing utility, or encountering greater than anticipated groundwater inflows. Contingency plan should be comprehensive, realistic, and based on actual working conditions for the Project.

B. Shop drawings and mill test certificates of the encasement pipe with material specifications, including size, type, diameter, and manufacturer's data and certifications on piping and jointing methods. The contractor shall include a Certificate of Adequacy of Design stating the pipe and fittings are satisfactory for the loads which will be imposed during for all loading conditions.

501.5 Quality Assurance

A. The requirements set forth in this document specify a wide range of procedural precautions necessary to provide the very basic, essential aspects of a proper jacking or boring installation and are adequately controlled. Strict adherence shall be required under specifically covered conditions outlined in this Section. Adherence to the specifications contained herein, or the Owner's Representative approval of any aspect of any jacking or boring operations covered by this Section, shall in no way relieve the Contractor of their ultimate responsibility for the satisfactory completion of the Work authorized under the Contract.

1. Installer's Qualifications: Installation shall be by a competent, experienced Contractor or Subcontractor. The installation Contractor shall have a satisfactory experience record of at least 3 years engaged in similar work of equal scope to that of this project.

2. Performance Requirements: Horizontal or vertical variation in the final position of the encasement pipe from the proposed line and grade shall be permitted only to the extent of the tolerances provided herein, provided that such variation shall be regular and only in the direction that will not detrimentally affect the installation or intended function of the carrier pipe in the opinion of the Engineer.

501.6 Materials

A. Pipe: Encasement pipe and carrier pipe shall conform to Standard Specification Item No. 505, "Concrete Encasement and Encasement Pipe" and Item No. 510, "Pipe", respectively, and shall be size, type materials, thickness and class indicated on the Drawings, unless otherwise specified.

B. Grout

1. Contact grout shall consist of cement, water, and fluidizers as required to produce a satisfactory pumpable grout with a minimum compressive strength of 500 psi at 28 days.

2. Backfill grout shall be either structural grout or cellular concrete.

    a. Structural grout shall consist of a mixture of sand, cement, and water with a minimum compressive strength of 4000 psi at 28 days. Admixtures may be used to control set times and prevent washout of the cement paste.

    b. Cellular concrete shall consist of a mixture of cement, water, and a foaming agent with a minimum compressive strength of 150 psi at 7 days and 250 psi at 28 days. Cellular concrete shall have a minimum wet density of 50 pcf, unless water is present inside the encasement pipe, where a minimum wet density of 65 pcf shall be required. The foaming agent shall conform to ASTM C869 and shall be tested in accordance with ASTM C796. No aggregate or fillers shall be used. No admixtures shall be without specific written approval from the foaming agent manufacturer.

    c. Cement used in the grout mixes shall conform to ASTM C150, Type II.

    d. Water used in the grout mixes shall be potable and conform to ASTM C94.

501.7 Construction Methods

A. General

The Contractor is responsible for:

1. Adequacy of jacking and boring operations,

2. Installation of support systems as indicated on the Drawings,

3. Execution of work involving the jacking or boring operation and the installation of encasement pipe simultaneously.

The Contractor shall have sole responsibility for the safety of the jacking or boring operations and for persons engaged in the work. The Contractor's attention is directed to the Construction Industry Occupational Safety and Health Administration (OSHA) Standards (29 CFR 1926/1910), with particular attention to 29 CFR 1926, Subpart S. The Contractor shall conform to the requirements in accordance with Standard Specification Item 121, "Trench Safety System" and shall provide an appropriate Trench Safety Plan.

When the grade of the pipe at the jacking or boring end is below the ground surface, suitable pits or trenches shall be excavated to provide sufficient room to conduct the jacking or boring operations and for joining of pipe. In order to provide a safe and stable work area, the excavated area shall be securely sheeted and braced to prevent earth caving in accordance with the Pit/Shaft Excavation Work Plan.

The location of the work pits/shafts and associated traffic control measures required for the jacking or boring operations shall conform to the requirements of the City of New Braunfels and TxDOT's Texas Manual on Uniform Traffic Control Devices.

Where installation of encasement pipe and carrier pipe is required under railroad embankments, highways, streets, or other facilities by jacking or boring methods, construction shall be undertaken in such a manner that it will not interfere with operation of any railroad, street, highway, utility, or other facility and shall not weaken or damage any embankment or structure. All appropriate permits shall be acquired prior to the initiation of the Work.

[Owner] [Contractor] shall obtain and comply with **[licenses, agreements, or permits]** from the **[highway, roadway, or railroad agency]** as described or referenced herein. Contractor shall comply with regulations and instructions of the **[highway, roadway, or railroad agency]** as to the methods of performing the Work and shall take all necessary precautions for the safety of the public and protection of existing infrastructure. Coordination with the **[highway, roadway, or railroad agency]** shall be performed by the Contractor, as required, unless otherwise instructed by the [**Owner or Engineer**].

During construction operations, and until the work pits/shafts are backfilled and compacted, traffic barricades and warning lights to safeguard traffic and pedestrians shall be furnished and maintained by the Contractor. The review of the pit/shaft excavation work plan and traffic control plan by the Owner's Representative, however, will not relieve the Contractor from his responsibility to obtain specified results in a safe, workmanlike manner.

Contractor shall perform work in a manner that minimizes ground movement, settlement, or heave.

The pipe shall be jacked or bored from the low or downstream end, if possible. The casing pipe shall be installed to meet the following tolerances along the entire length of the tunnel or trenchless crossing. If the installation exceeds the specified tolerances herein or the required tolerances for the carrier pipe, Contractor shall perform corrective work that is acceptable to the Engineer and at no additional cost to the Owner.

Note to Specifier: Gravity wastewater lines should not be designed for the minimum slope at crossings.

Horizontal Tolerance: Plus or minus 6 inches from theoretical horizontal alignment for every 100 feet of tunnel or trenchless crossing, unless otherwise specified.

Vertical Tolerance: Plus or minus 2 inches from theoretical vertical alignment for every 100 feet of tunnel or trenchless crossing, unless otherwise specified.

After placement of the carrier pipe is complete, the annular space between the casing pipe and the carrier pipe shall be sealed with manufactured end seals.

As soon as possible after the carrier pipe(s) and end-seals are completed, the work pits/shafts, which are excavated to facilitate these operations, shall be backfilled. The backfill in the street ROW shall be compacted to not less than 95 percent of the maximum density conforming to TxDOT Test Method Tex-114-E. Field density measurements shall be made in accordance with TxDOT Test Method Tex-115-E.

B. Jacking

Jacking shall be performed in general accordance with “pipe jacking” methods as described in the ASCE Manual and Report on Engineering Practice No. 106, Horizontal Auger Boring Projects. Heavy duty jacks suitable for forcing the pipe through the ground shall be provided. In operating the jacks, an even pressure shall be applied to all jacks simultaneously so that the pressure will be applied to the pipe uniformly around the thrust ring of the pipe. A suitable jacking frame or back stop shall be provided. The pipe to be jacked shall be set on guides properly braced together, to support the section of the pipe and to direct it in the proper line and grade. The complete jacking assembly shall be placed in order to line up with the direction and grade of the pipe. In general, the ground shall be excavated just ahead of the pipe, the excavated material removed through the pipe, and the pipe forced through ground by jacking, into the space thus provided by the excavation.

The excavation for the underside of the pipe, for at least 1/3 of the circumference of the pipe, shall conform to the contour and grade of the pipe. A clearance of no more than 1 inch may be provided for the upper half of the pipe. This clearance shall be tapered to zero at the point where excavation conforms to contour of pipe.

The distance that excavation shall extend beyond the end of the pipe depends on the character of material encountered, but it shall not exceed 6 inches in any case. This distance shall be decreased, as determined by the Contractor for safety or when directed by the Engineer or Owner’s representative, if the character of the material being excavated makes it desirable to keep the advance closer to the end of the pipe.

The Contractor may use a cutting edge of steel plate around head end of the pipe extending a short distance beyond the end of pipe with inside angles or lugs to keep cutting edge from slipping back onto the pipe.

After commencement of jacking operations, all subsequent operations shall be carried on without interruption, insofar as practical, to prevent the pipe from becoming firmly set in the ground prematurely.

Contractor shall not exceed the maximum allowable jacking force of the encasement pipe when jacking the encasement pipe. Any encasement pipe damaged during jacking operations shall be removed and replaced by the Contractor at its entire expense.

C. Boring

Boring shall be performed in general accordance with “horizontal auger boring” methods as described in the ASCE Manual and Report on Engineering Practice No. 106, Horizontal Auger Boring Projects. The boring shall proceed from a work pit/shaft provided for the boring equipment and workmen. Excavation for the work pits/shafts and the installation of shoring shall be as outlined in the pit/shaft excavation work plan. The location of the pits/shafts shall be approved by the Engineer or designated representative. The boring shall be performed mechanically using either a pilot tube method or the auger boring method.

In the pilot tube method an approximate 2 inch, steerable pilot tube shall be installed over the entire length of the crossing and shall be checked for line and grade on the opposite end of the work pit/shaft. This pilot tube shall serve as the centerline of the larger diameter hole to be created by reaming and/or by performing the auger boring method to install the encasement

pipe. The use of specialized cutting heads or three-pass systems are acceptable and may be required given ground conditions. The equipment used to excavate the ground shall be removable from within the encasement pipe in the event an obstruction is encountered. If voids develop around the encasement pipe as it is bored, pump concrete or grout to fill all such voids, or fill by other means acceptable to the engineer. Fill all voids as specified hereinafter as soon as possible after completion of boring operation

When the auger boring method is used, a encasement pipe of the appropriate diameter may be equipped with a cutter head or other cutting tools to mechanically perform the excavation. Augers shall be used to perform the excavation and shall be of sufficient diameter to convey the excavated material back to the work pit/shaft. If non-cohesive or unstable conditions are encountered, the end of the auger and cutting tools, if used, shall be retracted into the encasement pipe a distance of at least three times the diameter of the encasement pipe to create a soil plug at the end of the encasement pipe to prevent ground movement. The diameter of the auger and cutter tools shall not be greater than the outside diameter of the pipe.

Excavated material will be removed from the working pit/shaft and disposed of properly. The use of water or other fluids in connection with the boring operation will be permitted only to the extent to lubricate cuttings. Water jetting will not be permitted.

In unstable soil formations, a gel-forming colloidal drilling fluid, that consists of at least 10 percent of high grade carefully processed bentonite, may be used to consolidate the drill cuttings, seal the walls of the hole, and furnish lubrication to facilitate removal of the cuttings from the bore, where allowed by authorities having jurisdiction.

D. Dewatering

Dewatering requirements can be found in TxDOT Standard Specification Item No. 400 “Excavation and Backfill for Structures”.

E. Installation of Contact Grout

Install contact grout in the void space between the outside of the encasement pipe and the excavation, especially in any voids created by over-excavation, caving, or collapse. For the encasement pipe, install contact grout mix immediately upon completion of setting the encasement pipe.

Unless specified otherwise, install contact grout through grout ports or grout fittings installed in the encasement pipe that are 42 inches in diameter or larger or if voids are suspected. Grout ports or fittings shall be fabricated into casing pipe at a maximum spacing of 10 feet.

Grouting operations shall be performed in such a manner to prevent damage to the encasement pipe, the surrounding ground, or adjacent facilities or existing utilities. Contact grout shall be injected at a pressure that will not distort or imperil any portion of the Work.

Remove fittings and plug grout ports and fittings after completion of contact grouting.

Note to Specifier: Include backfill grouting section below only if required by railroad or roadway utility.

F. Backfill Grouting

After installation of the carrier pipe, the annular space between the encasement pipe and the carrier pipe shall be completely backfilled throughout the entire length from the low (downstream) end of the pipeline crossing. Seal the low end of the encasement pipe and place backfill grout until grout is extruded from the opposite end.

The carrier pipe and any other piping or conduits whether temporary or permanent shall be firmly anchored or blocked in place, while maintaining required clearances, to prevent floatation or movement during backfilling operations.

After backfill grouting is completed, seal or plug the ends of the encasement pipe with End Seals as required herein.

G. Finishing

Touch up protective coating after field welds to provide coating equal to those specified in Item 505 “Concrete Encasement and Encasement Pipe.”

Note to Specifier: Include cathodic protection if required by project conditions.

H. Cathodic Protection

Include cathodic protection per Specification Item No. 540 “Cathodic Protection”.

I. Joints

All carrier pipe joints in encasement shall be restrained for water lines and force mains.

J. Site Restoration

Following drilling operations, Contractor will de-mobilize equipment and restore the work site to original condition. All excavations will be backfilled and compacted to 90% modified proctor in non-paved areas and 95% modified protector in paved areas of original density based on Specification Item No. 120 “Utility Trenching and Backfill”. Landscaping will be subcontracted to a local professional landscaping company.

501.8 Measurement

Jacking or boring pipe will be measured by the linear foot of pipe complete in place. Such measurement will be made between the ends of the pipe along the central axis as installed.

501.9 Payment

The work performed and materials furnished as prescribed by this item and measured as provided under "Measurement" will be paid for at the unit bid price per linear foot for "Jacking or Boring Pipe" of type, size and class of encasement pipe indicated on the Drawings. The price shall include full compensation for furnishing, preparing, hauling and installing required materials, encasement pipe, bulkhead, for grouting and for labor, tools, equipment and

incidentals necessary to complete work, including excavation, backfilling and disposal of surplus material.

The Carrier pipe shall be paid at the unit price bid for Standard Specification Item 510, "Pipe".

Payment when included as a contract pay item, will be made under one of the following:

Pay Item: Jacking or Boring __ In. Pipe, Class ___ Per Linear Foot.

End