TRENCHLESS PIPE

**From Barre City FEGC F 026-1(34) C/2

xx. DESCRIPTION. This work shall consist of furnishing and installing pipe utilizing trenchless construction at the locations indicated in the Plans and as directed by the Engineer. The work shall specifically include all labor, materials, equipment and incidentals for installing a 36 inch carrier pipe within a 48 inch steel casing that shall be installed under the railroad tracks as shown on the plans.

xx. LOCATION. This work is specified for installing 36 inch carrier pipe within a 48 inch casing pipe underneath the railroad tracks as shown in the Plans.

xx. GENERAL.

Work required for annular backfill, as required, shall meet the requirements of ANNULAR BACKFILL of Section 900.

Work required for contact grouting, as required, shall meet the requirements of CONTACT GROUTING of Section 900.

Work required for field-applied cement mortar lining, as required, shall meet the requirements of FIELD-APPLIED CEMENT MORTAR LINING of Section 900.

xx. DEFINITIONS. Wherever in these provisions or in other Contract Documents the following terms or pronouns in place of them are used, the intent and meaning shall be interpreted as follows:

Annular Backfill - Cementitious material placed in the annulus between a steel casing pipe and the carrier pipe used for a two-pass culvert lining system.

Auger Boring - Construction of a pipeline by hydraulically jacking consecutive sections of steel pipe into an augered hole in the ground. A continuous flight auger removes the soil concurrently with the excavation.

Auger Boring Site - Location from which the jacking frame is located and the auger penetrates into the side of the embankment.

Carrier Pipe - The product pipe that is installed within a steel casing pipe for a two-pass culvert lining system.

Casing - A pipe that is jacked into place and used to support a bore in which a carrier pipe is later inserted. See also Jacking Pipe.

Contact Grout - Cementitious grout placed in the annulus between a pipe and the ground in one-pass or two-pass culvert lining systems.

Jacking Frame - A structural component that houses the hydraulic cylinders used to propel the jacking shield and jacking pipe or product pipe. The jacking frame serves to transfer the thrust load to the jacking pipe and the reaction load to the thrust slab or other thrust reaction scheme.

Jacking Pipe - A pipe that is used to advance the jacking shield and which provides ground support within a bore. The jacking pipe can

consist of the product pipe for a one-pass culvert lining system or a steel casing pipe for a two-pass culvert lining system.

Jacking Site - Location from which trenchless technology equipment is launched and driven into the side of the embankment.

Jacking Shield - A fabricated steel cylinder from within which the excavation is carried out either by hand or machine. Incorporated within the shield shall be an articulation joint to allow for precise control of line and grade.

Lubrication - A fluid, normally bentonite and/or polymers, used to reduce jacking loads on the jacking pipe.

Maximum Anticipated Jacking Load - The maximum anticipated force required of the hydraulic jacks calculated by the Contractor.

Overcut - The radial distance between the excavated hole and the outside radius of the jacking pipe.

Pipe Jacking - Construction of a pipeline by hydraulically jacking consecutive sections of jacking pipe through the ground behind a shield or tunnel boring machine.
Product Pipe - A permanently installed drainage pipe.

Spacers - Fabricated items for positioning carrier pipe inside a steel casing pipe. Commonly contains wheels or skids to aid in the carrier pipe placement and positioning.

Spoil/Muck - Earth, rock, and other materials removed during installation.

Thrust Reaction Scheme - A Contractor designed structure used to transfer the jacking loads to the ground at the pipe jacking location.

Thrust Ring - A fabricated ring that is mounted on the face of the jacking frame. It is intended to transfer the jacking load from the jacking frame to the thrust bearing area of the pipe section being jacked.

Two-Pass Culvert Lining System - A culvert liner consisting of a carrier pipe installed within a steel casing. The annulus between the steel casing and the ground is then grouted, as is the annular space between the steel casing and carrier pipe.

Tunnel Boring Machine (TBM) - A machine with a shield and motorized rotating circular cutterhead used to excavate the ground. For the purposes of this project, personnel access to the face for removing obstructions is required.

Water Jetting - Cleansing mechanism of the cutterhead where high-pressure water is sprayed from nozzles in the cutterhead to help remove cohesive soils.

xx. REFERENCE STANDARDS.

ASCE 36-01 Standard Construction Guidelines for Microtunneling
ASTM A139 Standard Specifications for Electric-Fusion (Arc)-Welded Steel Pipe

ASTM D2412 Standard Test Method Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
ASTM F477 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
AWS D1.1 Structural Welding Code
AREMA 5.3 Specifications for Pipelines Conveying Non-flammable Substances

xx. MATERIALS.

(a) Pipe. Pipe for trenchless installation is defined as High Density Polyethylene Carrier/Product Pipe (HDPE) and Steel Casing Pipe.

Requests for substitutions for the above shall be submitted to the Agency's Office of Contract Administration a minimum of 10 days in advance of the bid opening date. Substitutions for the above after award shall be approved by the Resident Engineer.

(1) Requirements for Jacking and Product Pipe.

a. Steel. Pipe used for jacking shall have manufacturing tolerances in accordance with ASCE 36-00, including but not limited to:

1.	Circumference	< 0.5%
2.	Exterior roundness	< 0.5%
3.	End squareness	+/- 3 mm (1/8 inch)
4.	Straightness	< 3 mm (1/8 inch)
5.	Pipe length	+/- 6 mm (1/4 inch) per 3 m (10 feet) of pipe length

Test pipe in accordance with applicable provisions of ASTM A139.

Conform the basis of acceptance of steel pipe with ASTM A139 and these specifications.

b. HDPE. High density polyethylene pipe and fittings shall conform to the latest revisions of AASHTO M 294, Type S or AASHTO M 252, Type SP as appropriate.

Acceptable high density polyethylene pipe shall be one of the high density polyethylene pipe products on the Approved Products List on file with the Agency's Materials and Research Section.

(b) Trenchless Construction.

(1) Auger Boring.

a. Two-Pass Lining System. Casing pipe shall be 48 inch steel pipe. Product pipe shall be 36 inch CPEP. The annulus between the casing and product pipes shall be filled with annular backfill.

(2) Pipe Jacking.

a. Two-Pass Lining System. Jacking pipe (casing) shall be steel pipe. The carrier (product) pipe shall be HDPE. The annulus between the casing and product pipes shall be filled with annular backfill.

(c) Certification. A Type D certification shall be furnished in accordance with Subsection 700.02 for all specified materials.

xx. DESIGN CRITERIA.

(a) Pipe. Pipe shall be designed in accordance with the following requirements:

(1) Steel.

a. Steel Pipe for Two-Pass Culvert Lining System. Steel pipe shall be per ASTM A139, Grade B or better, with a minimum yield strength of 35,000 psi, designed by the Contractor and structurally capable of resisting the maximum anticipated earth loads, jacking loads, and grouting pressures determined by the Contractor, and shall meet the requirements of AREMA 5.3. The methods of analyses shall be acceptable to the Engineer.

Jacking pipe joints shall be watertight and capable of withstanding the maximum anticipated jacking loads. Joints shall be square cut with beveled ends for welding. Steel pipe joints shall be full penetration butt welded or Permalok™ T5.

Jacking pipe shall be fitted with cast iron 2 inch threaded grout holes and plugs. Three grout ports spaced at 120 degrees on center shall be installed at 4 to 6 foot intervals along the axis of the pipe.

(2) HDPE.

a. Carrier Pipe for Two-Pass Lining System. HDPE Carrier Pipe shall be per ASTM F2306, designed by the Contractor and structurally capable of resisting the maximum earth loads, installation loads, and annular backfilling pressures.

Size the carrier pipe in accordance with required minimum annulus between the casing.

Carrier pipe joints shall be per ASTM F2306.

Carrier shall be fitted with cast iron 2 inch threaded grout holes and plugs. Three grout ports spaced at 120 degrees on center shall be installed at 4 to 6 foot intervals along the axis of the pipe.

(b) Trenchless Construction. The Contractor is responsible for the selection and design of all auger boring and pipe jacking equipment, and all ancillary equipment, and its use (means and

methods). The selected equipment and means and methods shall be compatible with the subsurface conditions.

The system shall be capable of advancing each pipe section forward with the shield or TBM, as applicable, in such a way as to provide complete and adequate ground support at all times.

Design a thrust reaction scheme such as a thrust slab for transferring the jacking force to the ground underlying the auger boring sites or jacking locations. Verify with a test boring, test pit, or test pile prior to construction of the thrust reaction scheme the suitability of the soils at the jacking locations to fully resist the jacking forces.

Bracing and thrust reaction shall be so designed and jacks shall be of sufficient rating so that the jacking can progress without stoppage, except for adding lengths of pipe.

Develop a uniform distribution of the jacking force around the circumference of the pipe. Maximum forces applied to the pipe shall not exceed 80 percent of the design compressive strength of the pipe or the manufacturer’s recommended allowable stresses, whichever is lower.

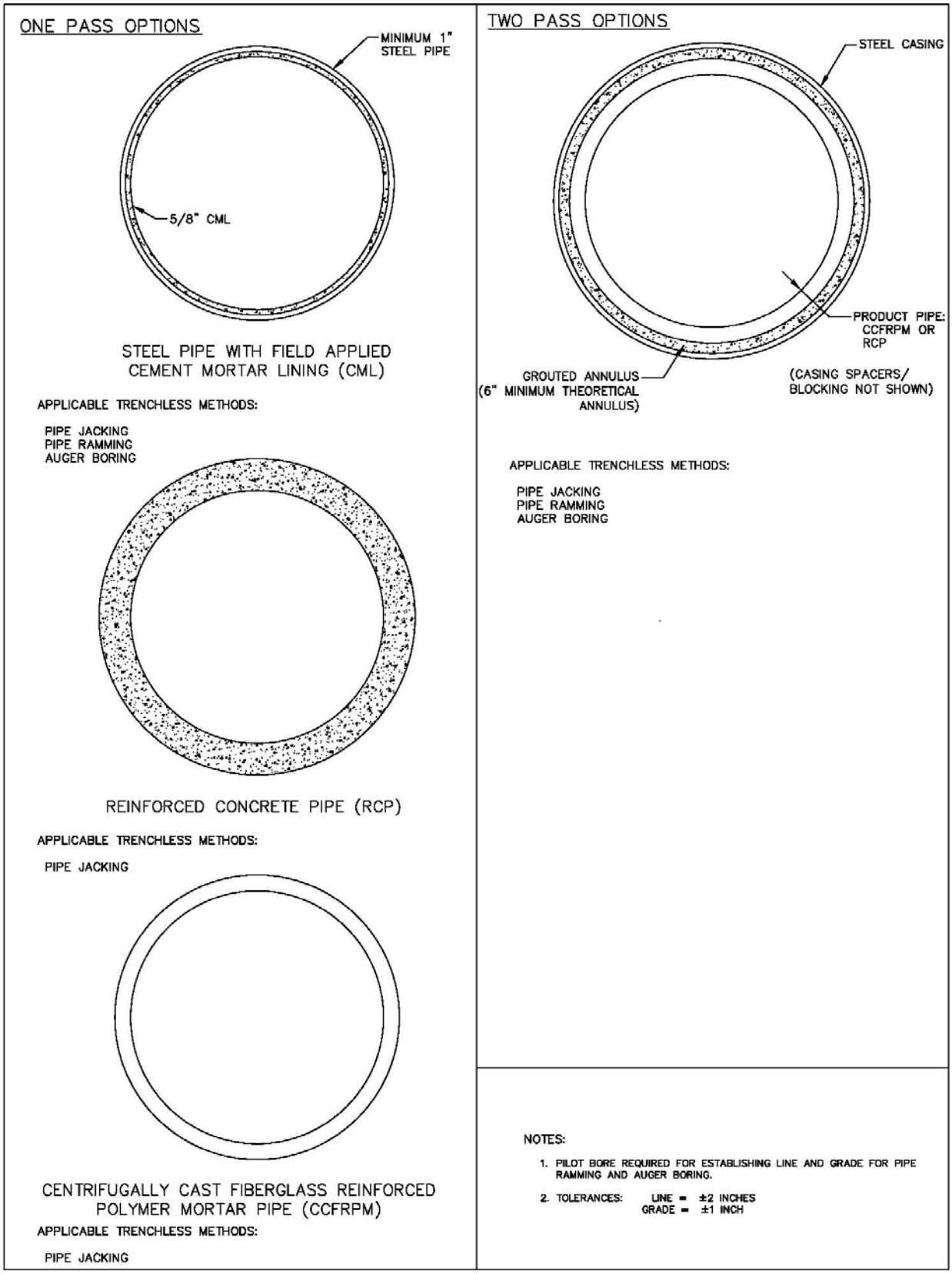
Provide for efficient removal of spoils.
Select and design a culvert lining system based on the options provided herein. See Figure 1.

The line and grade tolerance for the completed culvert shall be ±2 inches and ±1 inch, respectively. Where auger boring is used, a pilot bore shall be used to assist achieving the line and grade tolerance. The Contractor is responsible for the selection and design of the pilot bore method and equipment and its use (means and methods). Pilot bore equipment and installation methods shall be compatible with the anticipated ground conditions. Where pipe jacking is used, provide a means for controlling line and grade and making steering corrections using an optical or laser guidance system and shield jacks.

Develop means and methods for maintaining stability of the face and control rate of soil excavation at all times.

Note: The product pipe materials indicated in Figure 1 below are superseded by the materials specifications of this Section.

FIGURE 1 - CULVERT MATERIALS AND TRENCHLESS INSTALLATION OPTIONS



xx. QUALIFICATIONS.

(a) Trenchless Construction. The auger boring or pipe jacking contractor must have successfully completed five auger boring or pipe jacking projects, respectively, or installed over 610 m (2000 feet) of 36 to 72 inch steel pipe in the last four years using auger boring or pipe jacking equipment and materials, respectively, of the type that meet the minimum requirements of these specifications.

At least one of the projects must have been completed within one year prior to the date of work under this project. In addition, at least one project must have been in an area with geological and subsurface conditions similar to those described for this project.

The project supervisor(s) and equipment operator(s) shall have a minimum of three years experience and two years of experience, respectively, using similar type of equipment required for this project. Submit the names, resume, and experience summary of at least three project supervisors and three equipment operators who will be available for this project. Two of the proposed project supervisors and two of the proposed equipment operators must be assigned to this project.

The auger boring or pipe jacking engineer shall be a Professional Engineer registered in the State of Vermont. Experience shall include design calculations on three auger boring or pipe jacking projects, respectively, within the last five years. The Engineer shall have experience with the culvert lining options provided herein.

(b) Welding. Welding shall be performed by qualified welding operators in accordance with the requirements of ANSI/AWS D1.1.

xx. SUBMITTALS.

(a) Pipe.

(1) Steel.

a. Fabrication Drawings. Submit complete Fabrication Drawings for all diameters and classes of steel pipe, fittings, and specials showing dimensions, strength, and material specifications and standards, and joint details for review prior to manufacture.

b. Material Compliance. Submit notarized affidavit of material compliance with ASTM A139.

c. Product Compliance. Submit notarized affidavit of pipe compliance with ASTM A139 and these specifications.

d. Joint Compliance. Submit notarized affidavit of joint compliance with these specifications.

e. Quality Control. Submit certified results of shop tests for approval. Include test results of the weld for steel pipe.

(2) HDPE.

a. Fabrication Drawings. Submit complete Fabrication Drawings for all diameters and classes of HDPE pipe, fittings, and specials showing dimensions, strength, and material specifications and standards, and joint details for review prior to manufacture.

b. Material Compliance. Submit notarized affidavit of material compliance with AASHTO M 294, Type S or ASTM F2306 as appropriate.

c. Product Compliance. Submit notarized affidavit of pipe compliance with AASHTO M 294, Type S or ASTM F2306 as appropriate and these specifications.

d. Joint Compliance. Submit notarized affidavit of joint compliance with these specifications.

e. Quality Control. Submit certified results of shop tests for approval.

(b) Trenchless Construction. Not less than two (2) weeks prior to beginning any auger boring or pipe jacking, and pilot bore (if used), the Contractor shall submit the following to the Engineer for review and, where specified, approval:

(1) A complete description of projects for which actual work was performed by the auger boring or pipe jacking contractor. This list is to include project locations, dates of projects, owner, owner's construction representative, owner's construction representative's current telephone number, type of equipment utilized, type and size of steel pipe used in auger boring operations, contract or subcontract amount, description of all litigation and/or unresolved claims in connection with these projects, and any other information relevant to the issue of the successful completion of the projects. Include projects where the trenchless contractor was prime contractor or a subcontractor. If the trenchless contractor has not completed any such project(s) other than those which are in progress upon submittal of the information required herein, the trenchless contractor must demonstrate to the satisfaction of the Engineer that the cause of the lack of completion is unrelated to criteria determining qualification for this project.

(2) Resumes of proposed project supervisor(s) and other specified personnel that demonstrate the minimum qualifications and experience described above.

(3) Welder certifications as applicable. For each welding process and for each welder, the appropriate Welding Procedure Specifications (WPS), Procedure Qualification Records (PQR) for non-qualified procedures, and Welding Operator Performance Qualifications (WPQ) are required.

(4) A narrative describing the proposed execution of the work specified herein. Clearly demonstrate that the methods and materials used to execute the work have a proven track record of at least four years.

(5) For approval in accordance with Section 105, complete Working Drawings showing details of the proposed method of construction and the sequence of operations to be performed during construction. Supporting calculations shall be prepared, stamped, and signed by a qualified Licensed Professional Engineer registered in the State of Vermont.

Working Drawings shall include, but not be limited to, the following:

a. A detailed description of the auger boring or pipe jacking and pilot bore (if used) procedure(s), including construction techniques to install pipe in conformance with the Contract Documents.

b. Manufacturer’s literature describing in detail the auger boring or pipe jacking and pilot bore (if used), systems to be used.

c. Calculations and drawings indicating limits and slopes of temporary embankment excavations and any ground support to be utilized.

d. Certification by the auger boring or pipe jacking equipment manufacturer of the thrust, condition, and operational characteristics of all equipment to be used for installing pipe.

e. Provisions for supporting the excavation face and to prevent caving beyond the outside circumference of the pipe.

f. Layout of auger boring or pipe jacking and ancillary equipment at each auger boring or jacking location.

g. Configuration of the jacking shield or TBM cutterhead tools and muck openings, or cutterhead shoe and overcut, as applicable for the proposed means and methods.

h. Pipe lubrication system details.

i. Grade and alignment control system details.

j. Detail of mucking and spoil removal system(s), and soil disposal methods.

k. Pipe jointing details, including field welding procedure where steel pipe is used.

l. Calculations demonstrating that the pipe selected has been designed to support the maximum anticipated earth loads and superimposed live loads, both static and dynamic, which may be imposed on the pipe. Determine the additional stresses imposed on the pipe during jacking operations and upgrade the quality and strength of the pipe and pipe joints to the extent necessary to withstand the additional stresses imposed by the jacking operation.

m. Complete information on auger boring or pipe jacking contractor's safety plan for personnel conducting the pipe jacking operations and appurtenance installation. The plan shall include provisions for lighting and electrical safeguards.

n. Methods for collecting, treating, and discharging groundwater and construction water associated with auger boring or pipe jacking work. Provide a layout showing water collection points, designated water flow paths, pumps, sumps, water storage and settlement containers, treatment facilities, and discharge points.

(6) Certification from the pipe manufacturer meeting ASTM Standards of the pipe material to be used.

(7) Contingency plans for line and grade out of tolerance, jacking forces exceeding the maximum anticipated jacking load, excessive settlement or other ground movement, significant increases of groundwater inflows or soil emanating from a pilot bore or auger bore, and pipe advance halted due to subsurface obstructions.

(8) Pipe repair procedures shall be submitted for review prior to performing any repairs.

The Contractor shall submit daily field reports from the prior day by 10:00 a.m. each work day. At a minimum, daily field reports shall contain:

(1) The position of the pipe in relation to the design line and grade.

(2) The date, starting time, and finish time.

(3) Inclination.

(4) Advance rates.

(5) Operating pressure.

(6) Muck quantities removed.

The Contractor shall submit the following additional information:

(1) As-builts at the end of pipe jacking.

(2) Pipe repair certifications.

xx. EQUIPMENT. Equipment for trenchless construction shall meet the following requirements:

(a) Auger Boring. The equipment shall be capable of providing the Maximum Allowable Jacking Force to push the steel pipe string between the launch and receiving exit locations identified on the Plans. Develop a uniform distribution of jacking forces on the end of the pipe.

The jacks shall be of ample capacity to provide more than the necessary or anticipated jacking capacity.

The jacking system and thrust reaction shall be properly designed and constructed and shall have design capacity equal to the maximum anticipated jacking loads with a factor of safety of two.

The jacking frame, upon which the steel pipe being installed will rest, shall be of railroad rails or other suitable steel or wooden members set to the correct line and grade to act as guides for true alignment of the pipe.

The jacking apparatus shall be strongly constructed, and set and maintained in proper relative position and alignment, in order to minimize forces which would tend to bend the pipe, cause it to deflect from true alignment, or displace the reaction blocks.

(b) Pipe Jacking.

(1) Jacking Shield. The jacking shield system selected shall be designed with consideration of the project site constraints shown on the Plans and the anticipated ground conditions. At a minimum, the shield shall be of steel construction designed to support the required soil loading and jacking stresses, be adequately braced, and be provided with the necessary appurtenances for completely bulkheading the face with horizontal or vertical breastboards. The shield shall be capable of being steered by the use of an articulated joint and steering jacks located in the shield.

(2) TBM and Components. The TBM system selected shall be designed with consideration of the project site constraints shown on the Plans and the anticipated ground conditions.

Only TBMs that meet the requirements of this specification shall be permitted. Those TBMs which operate with a pressurized face which is not accessible to personnel such as earth pressure balance machines (EPBM) and microtunnel boring machines (MTBM) are not allowed.

The TBM shall:

a. Be steerable.

b. Incorporate a water tight seal between the TBM and the leading pipe.

c. Protect the electric and hydraulic motors and operating controls against water damage.

d. Use bi-directional drive on the cutter head wheel, and/or adjustable fins or other means, to control roll.

The TBM, in conjunction with other means as needed, shall be capable of preventing loss of ground through the machine during shutdowns and controlling of the rate of excavated material removed at the tunnel face.

(3) Pipe Jacking Equipment. The equipment shall be capable of providing the Maximum Allowable Jacking Force to push the jacking shield or TBM and the pipe string between the launch and receiving locations identified on the Plans. Hydraulic cylinder extension rates shall be synchronized with the excavation rate of the TBM. Develop a uniform distribution of jacking forces on the end of the pipe.

The jacking frame, upon which the jacking pipe being installed will rest, shall be of railroad rails or other suitable steel or wooden members set to the correct line and grade to act as guides for true alignment of the pipe.

The jacks shall be of ample capacity to provide more than the necessary or anticipated jacking capacity.

The jacking system and thrust blocks shall be properly designed and constructed and shall have design capacity equal to the maximum anticipated jacking loads with a factor of safety of two.

The jacking apparatus shall be strongly constructed, and set and maintained in proper relative position and alignment, in order to minimize forces which would tend to bend the pipe, cause it to deflect from true alignment, or displace the reaction blocks.

xx. EXECUTION. Trenchless construction operations shall be performed in accordance with the following requirements:

(a) Sites. Investigate the soil conditions at the auger boring or jacking sites shown on the Plans to confirm that the Maximum Anticipated Jacking Load can be fully transferred to the ground with the Contractor-designed thrust reaction scheme. Modify the design of the thrust reaction scheme if needed based on the results of the Contractor’s investigation of the subsurface conditions at no additional cost to the State.

Construction techniques required to provide access for auger boring or pipe jacking shall be such as to ensure the safety of all work activities. Acceptable temporary embankment excavation methods include but are not limited to the use of interlocked steel piling, soil nailing, or open excavation with shotcrete facing to control slope raveling and sloughing.

Steel or jacking pipe lengths selected by the Contractor for installation shall be compatible with the limits of the auger boring or jacking sites shown on the Plans.

The Contractor shall properly support all excavations and limit movement of soil, pavement, utilities, or structures outside of the excavation.

All excavations shall conform to applicable local safety, VOSHA, trenching, and shoring standards.

If at any time the method being used by the Contractor for supporting any material or structure adjacent to any excavation is not safe in the opinion of the Engineer and/or applicable Federal, State, or local inspection authorities, the Contractor shall provide additional bracing and support necessary to achieve the degree of safety required.

The auger boring or jacking sites must be constructed to accommodate the installation of pipe and the jacking frame and appurtenant components as required. Install seals in the excavation support walls as required to control ground movement where the pipe enters and exits the ground.

All work for or associated with excavating, shoring, bracing, and pipe jacking shall be executed so that settlement is minimized. The in-place pipe shall have full bearing against the earth and no voids or pockets left in any portion of the work.

Before beginning construction, structures and other permanent objects shall be adequately protected. The repair of damage to permanent facilities due to negligence or lack of adequate protection on the part of the Contractor shall be performed by the Contractor at no additional cost to the State.

Surface drainage shall be provided as required under the Plans and Specifications. All groundwater inflows emanating from pipe jacking work shall be collected, treated, and discharged in an approved manner.

(b) Establishing Line and Grade. The Contractor shall establish the baseline and benchmarks indicated on the Plans. Baselines and benchmarks shall be checked at the beginning of the Contract period and any errors or discrepancies reported to the Engineer.

Use these baselines and benchmarks to furnish and maintain all reference lines and grades for the pipe installation. Use these lines and grades to establish the exact starting location of the jacking pipe, pilot bore (if used), and product pipe.

No auger boring shall be performed until a pilot bore has been completed for the purpose of establishing the culvert line and grade and accepted by the Engineer.

The Contractor shall submit to the Engineer copies of field notes used to establish all lines and grades; however, the Contractor remains fully responsible for the accuracy of the work and the correction of the work as required.

After installation is complete, the Contractor shall provide the Engineer with access to both pipe ends for visual inspection of the line and grade of the pipe.

(c) Pilot Bore. Perform a pilot bore to assist in achieving the line and grade shown on the Plans during auger boring. Provide and install a steel casing within the pilot bore to maintain the stability of the ground. The casing diameter and means and methods of installation shall be determined by the Contractor. The installed pilot bore casing shall be fitted to the leading edge of the steel pipe to be installed by auger boring at the entry point in the embankment, in a manner that allows for the simultaneous advancement of the pilot bore casing with the steel pipe during auger boring.

A soil displacement-type pilot bore method is not allowed.

(d) Auger Boring and Pipe Jacking. No auger boring or pipe jacking work shall begin until the required Working Drawings have been approved in writing by the Engineer. The Contractor is responsible for the performance of the equipment and methods selected for all auger boring or pipe jacking procedures. Invert elevations of existing drainage structures must be field verified before the auger boring or pipe jacking operations begin.

The jacking frame and thrust ring or hammer frame shall be positioned to develop a uniform distribution of forces around the periphery of the pipe. Special care shall be taken by the Contractor to ensure that the launch seal is properly designed and constructed. Special care should be taken when setting the pipe guardrails to ensure correctness of the alignment.

Where auger boring is used, each pipe section shall be jacked into the augered bore as the excavation progresses, in such a way as to provide complete and adequate ground support at all times. Jack extension rates shall be coordinated with the advance rate of the auger cutting face. Advancing the auger cutting face in front of the leading edge of the steel pipe, or excavating ahead of the forward end of the pipe, are prohibited unless approved in writing by the Engineer.

Where pipe jacking is used, each pipe section shall be jacked forward as the excavation progresses in such a way to provide complete and adequate ground support at all times. Excavation ahead of jacking shield or TBM is prohibited, unless approved in writing by the Engineer.

A lubrication system shall be provided that injects bentonite or other approved lubricant on the outside of the shield and pipe to lower the friction developed on the sides of the pipe during jacking. Spacing of lubricant points shall be at the Contractor’s option with approval from the Engineer. The over cut on the pipe, jacking shield, or TBM shall not exceed 25 mm (1 inch) without the approval of the Engineer. The annular space created by the over cut shall be filled with a lubricant that has proven suitable for the particular soil conditions.

Monitor effluent from the existing culverts for lubricant and grout migration into surface waters. Contain and dispose of lubricant and grout-contaminated surface waters in an approved manner.

The Contractor shall be responsible for monitoring ground movements associated with the work and making suitable changes in the construction methods to control ground movements and prevent damage or detrimental movement to the work, traveling motorists, and adjacent structures and pavements.

Where voids are created outside the pipe, jacking shield, or TBM during the advance, or due to the removal of material at the front of the pipe, jacking shield, or TBM, such voids shall be immediately filled with sand, clay, bentonite, or other non-decomposable material and rammed into place. When the steel pipe has been completely installed, all voids that were filled with temporary material shall be finally filled with Portland cement grout pumped through the grout holes in the pipe by starting at the low end.

All excavated material from auger boring or pipe jacking and from site construction shall be disposed of off-site by the Contractor.

Control groundwater inflows at the excavation face. Do not allow groundwater to accumulate at the face.

The Contractor shall keep a record, independent of that which may be kept by the Engineer, of all pertinent data relative to the installation. This record shall be available for the Engineer's inspection until the completion of the project, and a copy shall be transmitted to the Engineer within three (3) days of the completion of each installation of trenchless pipe. This record is to include for each pipe installed:

a. The position of the pipe in relation to the design line and grade.

b. The date, starting time, and finish time.

c. Inclination.

d. Advance rates.

e. Hammer strokes per minute, as applicable.

f. Operating pressure.

g. Muck quantities removed.

The Contractor shall keep and maintain up to date at the construction site a complete set of field drawings for recording as-built conditions, which shall have marked or noted thereon all properly dated field information and recorded as-built conditions.

(e) Contact Grouting. Contact grout shall be injected into the annular space outside the installed casing or product pipe if the overcut is greater than 0.75 inches, a void extending outside the pipe circumference is known to have occurred during the installation of the pipe, or if the installed pipe is to be used as the product pipe.

(f) Product Pipe Installation. Visually inspect the installed pipe. No groundwater leakage will be permitted. Clean the inside of the pipe and leave it free of debris.

For a two-pass culvert lining system, support the product pipe within the casing pipe to the design line and grade while maintaining an actual minimum annular space of 3 inches. Use casing spacers. Install blocking supports at the crown to prevent flotation of the pipe during annular backfilling.

xx. METHOD OF MEASUREMENT. The quantity of Special Provision (Trenchless Pipe) of the size specified to be measured for payment will be on a lump sum basis in the complete and accepted work.

xx. BASIS OF PAYMENT. The accepted quantity of Special Provision (Trenchless Pipe) of the size specified will be paid for at the Contract lump sum price. Payment will be full compensation for furnishing, transporting, handling, and placing the materials specified; fabricating, saw cutting, joint fusing, and placing all pipe materials, including pull wire and end caps; investigating and constructing the jacking sites; performing pilot bore construction; disposing of excess excavation from pipe jacking operations; preparing and providing required submittals and records of installation; restoring each pipe jacking site to its original condition to the satisfaction of the Engineer; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
900.645 Special Provision (Trenchless Pipe)(X mm (X”))	Lump Sum