DEPARTMENT OF TRANSPORTATION

Planning & Engineering
Office of Project Development
700 E Broadway Avenue
Pierre, South Dakota 57501-2586
O: 605.773.3275 | F: 605.773.2614
dot.sd.gov

July 11, 2025

ADDENDUM NO. 2

RE: Item 4 – 07/16/2025 Letting – PT 0905(117)261, PCN 080A, Lyman County – Pipe Culvert Improvements

TO WHOM IT MAY CONCERN:

The following addenda to the plans shall be inserted and made a part of your proposal for the referenced project.

SPECIAL PROVISIONS: Please remove Section 33 05 24 (Microtunneling) and replace with enclosed Section 33 05 24 (Microtunneling) dated 7/11/2025.

The following parts of Section 33 05 24 were revised:
- 1.3.D Jacking Record
- 1.3.F Microtunnel Boring Machine (MTBM)
- 1.3.G Microtunneling
- 1.5.C.5.a Jacking Records

The following parts in 1.6 QUALITY CONTROL were revised:
- 1.6.B
- 1.6.C
- 1.6.D

PLANS: No Change

Sincerely,

Sam Weisgram
Engineering Supervisor

SW/rb

CC: Travis Dressen, Mitchell Region Engineer
Jay Peppel, Mitchell Area Engineer

SECTION 33 05 24
MICROTUNNELING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section establishes the minimum requirements for installing pipe by trenchless methods at locations indicated on the Drawings. The Contractor shall furnish all labor, equipment, power, water, and materials necessary for microtunneling pipe installation and other associated work.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 31 09 20 - Settlement Instrumentation and Monitoring.
   2. Section 31 23 50 - Shaft Excavation and Support.
   3. Section 33 05 03 - Contact Grouting.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. The publications listed below form a part of this Specification to the extent referenced. Where conflicts between these Specifications and the referenced specification, code, or standard occur, the more restrictive specification shall govern. The publications are referenced in the text by basic designation only. Where a date is given for referenced standards, that edition shall be used. Where no date is given for referenced standards, the latest edition available on the date of issue of Contract Documents shall be used.
      a. Safety Codes:
         1) Occupational Safety and Health Administration (OSHA) Regulations and Standards for Underground Construction, 29 CFR Part 1926, Subpart S, Underground Construction, and Subpart P, Excavations.
      b. Standard Specifications and Guidelines:
         1) South Dakota Department of Transportation Standard Specifications for Roads and Bridges.
         2) ASCE Standard Design and Construction Guidelines for Microtunneling, ASCE/CI 36-14.

B. Subsurface Information:
   1. Site Plan and Subsurface Profile, Appendix A.

1.3 DEFINITIONS

A. Carrier Pipe: Permanent pipe for operational use that is used to convey flows. Carrier pipes may be installed inside a casing pipe, or direct-jacked, if designed for direct jacking and permitted for the crossing.

B. Intermediate Jacking Station (IJS): A fabricated steel cylinder fitted with hydraulic jacks spaced around the circumference which is incorporated into the pipeline between two specially fabricated pipe sections. The function of an intermediate jacking station is to distribute the jacking load along the pipe string during pipe installation. The hydraulic jacks are removed at the completion of a drive and the gap between adjacent pipe sections is fully closed by pushing the pipes together with the main shaft jacks or another IJS. The steel cylinder remains as an extended sleeve or coupling. The steel cylinder should be protected from corrosion, consistent with corrosion protection used for the jacking pipe and joints.

C. Jacking Pipe: Pipe jacked behind the microtunneling machine. The jacking pipe shall be the carrier pipe or casing pipe, specifically designed to be installed by pipejacking using microtunneling equipment.

D. Jacking Record: A computer-generated or manually recorded report that contains information on microtunneling operations and may include: date, time, name of operator, tunnel drive identification, installed tunnel length, rate of advance, jacking forces, cutterhead speed and torque, bypass valve position, use of any cutting or high-pressure nozzles, face pressure, steering jack positions, line and grade offsets, any movement of the guidance system, machine inclination and roll, intermediate jacking station use and jacking forces, pressure, volume, and location of any lubricant pumped, problems encountered with the tunneling machine or other components or equipment, and durations and reasons for delays.

E. Lubrication/Grout Port: A port located within the MTBM or in the jacking pipe fitted with a one-way valve for injection of lubrication material or grout into the annular space between the pipe and the ground.

F. Microtunnel Boring Machine (MTBM): Remote-controlled, guided shield that can provide continuous support to the excavation face. The MTBM is operated from a control container located on the ground surface. Soil excavation is achieved by a rotating cutterwheel. The guidance system consists of a laser or theodolite and EDM device mounted in the jacking shaft communicating a reference line to a target mounted in the MTBM's articulated steering head. The target in an MTBM provides the operator with information about machine altitude and pitch and can allow for accurate steering control.

G. Microtunneling: A remotely controlled, guided, pipejacking process that provides continuous support to the excavation face. The microtunneling process does not require routine personnel entry into the tunnel. A key element of microtunneling is the ability to control the stability of the face to balance the earth and groundwater pressures.

H. Obstruction: Objects located wholly or partially within the cross-sectional area excavated by the microtunneling machine that prevent the forward movement of the microtunneling machine after all diligent efforts to advance past the object by the Contractor have failed.

I. Portal Stabilization: Stabilization of the soil and groundwater outside the portal to prevent soil or excessive groundwater inflows into the shaft that may lead to settlement around the shaft or flooding of the excavation. Portal stabilization may be accomplished using ground improvement (such as jet grouting), double sheeting methods combined with contact grouting (guillotine method) or may be integral to the shaft construction method (as for auger-drilled shafts and secant pile shafts.

J. Settlement Point: A point with elevation and spatial location established by survey prior to construction. The point is re-surveyed periodically to monitor ground movements. The point may be a nail, pin, subsurface settlement rod, borehole extensometer, or other device that can be readily located and surveyed.

1.4 DESIGN CRITERIA

A. Microtunneling Equipment:
   1. Only remotely operated microtunneling equipment using spoil removal, shall be used for all microtunneling work required for this project as defined in this Section. The microtunneling machine shall be manufactured by Akkerman, Herrenknecht, Iseki, Lovat, Wirth/Soltau, or approved equal that specializes in the design and fabrication of this type of equipment. The machine shall be capable of fully supporting the face during both excavation and shutdown periods, and shall have the capability of preventing loss of ground and groundwater inflows. The system shall be capable of adjustment required to counterbalance the groundwater and soil pressures at the tunnel face to an accuracy of ±1 FT of equivalent hydrostatic pressure (i.e., ± 62.4 psf). A pressure gage shall be provided so the operator can monitor the pressure exerted at the heading.
   2. Microtunneling equipment selected for the project shall be suitable for and capable of efficiently advancing through the geologic conditions described in the Subsurface

Profile and the geologic conditions anticipated by the Contractor. The microtunneling machine shall be capable of crushing or excavating boulders or other objects up to 25 percent of the outside diameter of the MTBM and up to an unconfined compressive strength of 30,000 psi.

3. The Contractor is advised that it may not be permitted to retrieve the MTBM using a rescue shaft excavated within the Interstate right-of-way. The machine shall be capable of being retrieved, i.e. withdrawn through the jacking shaft without the need for an intermediate rescue shaft, if forward progress cannot be achieved. Reversible jacks with a closure device and grouting nipple at the entry seal shall be provided for this project. The Contractor may propose an alternate, subject to Engineer's approval. The method proposed for retrevability must be capable of ensuring stability of the aborted bore and avoiding settlement and/or subsidence.
4. The machine shall have a watertight articulation joint between two segments of the shield. The shield shall be steerable in both the vertical and horizontal directions to allow the operator to maintain line and grade within the specified tolerances. The guidance system shall be designed to function at the maximum required drive length without loss of accuracy or reliability of function. A display showing the position of the machine in relation to design line-and-grade shall be provided at the control panel to allow the operator to continuously monitor line and grade deviations.
5. The cutterhead shall have a reversible drive system so that it can rotate in either direction and shall have other suitable provisions to minimize rotation or roll of the machine or pipe during installation.
6. The maximum radial overcut shall be 1 IN. The minimum radial overcut shall be 1/2 IN. The radial overcut shall be determined as the difference between the maximum diameter created by the overcut band on the machine and the outer diameter of the pipeline or casing, divided by two.
7. A lubrication injection system shall be provided and used to inject pipe lubricant around the MTBM and jacking pipe to decrease frictional resistance. Lubrication materials may include a mixture of bentonite and/or polymers and water. Lubrication ports shall be provided in the MTBM and jacking pipe to allow for lubrication along the pipe string at intervals of not more than 10 FT.
8. The MTBM shall be equipped with a computerized data acquisition system for collecting information for the jacking record. An on-site printer and disk drive will also be required for production of a printed daily jacking record and an electronic copy of the data. As a supplement to the computerized data acquisition system, the Contractor shall also use manual data acquisition for collecting information for the jacking record.
9. Where there is a potential for flammable or noxious gases to be encountered, or if required by OSHA, the machine shall have an automatic shut-off switch and provisions for continuous gas monitoring.

B. Methods and equipment shall control surface settlement and heave above the pipeline to prevent damage to existing utilities, facilities, and improvements. Ground movements (settlement/heave) shall be limited to values that do not cause damage or distress to surface features, utilities, or improvements. The Contractor shall be responsible for any damage to existing features, improvements, or utilities, and shall repair any damage to the satisfaction of the Engineer, at no additional cost to the Owner, and without schedule extension.

C. The slurry separation plant shall be designed to achieve the rates of spoil separation and slurry cleaning required for planned production rates. Shaker screens, hydrocyclones and centrifuges will likely be required for efficient separation of spoils. The separation plant must fit within the allowable work areas shown on the Plans. Excavated slurry pits or ponds will not be allowed. Additionally, all excavated materials and slurry must be discharged into, and completely contained within tanks, trucks, or other containers at all times. On-site stockpiling or disposal shall not be permitted.

D. Intermediate jacking stations (IJSs) for direct-jacked carrier pipe shall be fully gasketed between the interjack shell and each pipe special, with two (2) gaskets installed on each pipe. The IJS sleeve must be made of material with the same corrosion resistance as the jacking pipe joint. The number of IJSs and pipe specials is to be determined by the Contractor and their planned usage shall be described in the Contractor's submittal. The Contractor shall install and use IJSs as indicated in its accepted submittal; however, an intermediate jacking station must be used immediately if jacking forces for any segment reach or exceed 70 percent of the safe design capacity of the jacking pipe, IJS pipe, jacking frame, or thrust block, whichever is lowest. The Contractor may elect to use IJSs before jacking forces reach the threshold values.

E. Pipe design for jacking loads and acceptable fabrication tolerances is the responsibility of the Contractor. Maximum jacking loads applied to the jacking pipe shall not exceed 40 percent of the ultimate compressive strength of the pipe material or the maximum design strength of the pipe as established by the manufacturer, whichever is lower.

F. A thrust block shall be used to transfer jacking loads to the soil behind the jacking shaft. The thrust block face shall be constructed perpendicular to the proposed pipe alignment. The thrust block shall be designed to withstand the maximum jacking forces developed by the main jacks, without excessive deflection or displacement. Forces applied to the soil shall not exceed the allowable passive earth pressure described in Contractor's approved submittal, with a minimum factor of safety of 1.5, or the strength of the ground support system with consideration of passive soil resistance and allowable deformations of the support system and soil mass. (See also Section 31 23 50, Submittals.)

G. Provide launch and retrieval seals at all shaft exit and entry locations. Provide portal stabilization as required to prevent loss of ground and uncontrolled inflows at entry and exit seal locations.

1.5 SUBMITTALS

A. Submittals shall be made a minimum of four weeks before any work referred to in the submittals is scheduled to commence and shall provide sufficient detail to allow the Engineer to judge whether the proposed equipment, materials, and procedures will meet the Contract requirements. All drawings shall be legible with dimensions accurately shown and clearly marked in English. Poor quality drawings and photographs will not be accepted.

B. The Engineer's review of submitted details and data will be based on consideration of requirements for the completed work, protection of existing utilities, and the possibility of unnecessary delays in the execution of the work to be constructed under this Contract. Review and approval of the Contractor's submittals by the Engineer shall not be construed in any way as relieving the Contractor of its responsibilities under this Contract.

C. The Contractor shall prepare and submit to the Engineer, the following:
   1. Qualifications: Submit the name of the Contractor that will perform the microtunneling work and written documentation summarizing the qualifications of the firm, description of reference projects including owner's name and contact information, project superintendent, machine operators, and site safety representative. Submit personnel qualifications in accordance with Paragraphs 1.7 B through F. Provide qualifications and training records for site safety representative, personnel responsible for air quality monitoring, and licensed surveyor.
   2. Microtunneling Equipment: Submit the following describing the microtunneling equipment and construction methods to be employed:
      a. A detailed description of the equipment to be used in completing each microtunnel drive.
      b. Manufacturer's literature describing the microtunneling system(s) including the machine(s) and all ancillary equipment. Provide descriptions of projects on which this system has been successfully used including names, addresses, and telephone

numbers of owner's representatives for these projects as well as length, diameter, and pipe material used. If a used or refurbished MTBM is proposed, list previous usage, modifications made and dates of modifications, and detailed description of the extent and dates of refurbishment. Include the following information concerning the MTBM:

1) Dimensions.
2) Torque, rotation speed range, and no-load or "dry" torque reading.
3) Cutter types, number, configuration, and gauge cutter setting for overcut, (include photographs).
4) Articulation and steering capability.
5) Cutterhead jets/ports.
6) Face/excavation chamber pressure gauge locations and types.

c. The excavation diameter based upon the outermost dimensions of the shield. Also provide the radial overcut which shall be determined as the difference between the maximum shield diameter and the outer diameter of the jacking pipe, divided by two.

d. A description of the alignment control systems including manufacturer's literature and drawings showing setup, support provisions, and other details for the laser, theodolite, and water level system. Submit a description of surveying methods to set guidance system positions and a description of procedures to check and reset or realign guidance system during construction. Submit a description of methods to ensure that thrust block, exit and entry seals, and jacking frame are installed on proper line and grade. Submit results of line and grade survey to ensure that the thrust block, jacking frame, guide rails, entry seal, and exit seals are installed properly prior to launch of each drive. Confirm that these systems can achieve the required pipeline line and grade within the specified tolerances.

e. Capacity, number, and arrangement of main jacks including details of the thrust ring, thrust block, jacking frame, jacking controls, pressure gauges, and jack calibration data (pressure vs. force relationship for each stage of the jacks). Also, submit pipe restraint device to prevent pipe movement into shaft when rams are retracted, where necessary.

f. Details of intermediate jacking stations, including material of IJS sleeve, number of hydraulic cylinders per IJS, thrust capacity, quantity to be used, and anticipated placement within the pipe string,

g. Details of pipe lubrication injection system and pipe lubricants to be used during microtunneling, including manufacturer's literature and MSDS sheets. Include a description of proposed lubrication procedures during jacking, including estimated volumes of lubricant that will be pumped. Confirm that sufficient volume of lubricant will be pumped at all times to completely fill the annular space outside the jacking pipe.

h. Details of spoil and slurry handling, separation, transport, and disposal equipment and procedures including details of slurry additives, slurry separation plant, and the location of slurry and spoil disposal sites. Confirm that slurry and spoils shall be contained at all times and shall not be stockpiled or dumped on site or allowed to spill and collect around slurry separation plant. Provide manufacturers description for slurry additives and Material Safety Data Sheets (MSDSs).

i. Ventilation and air quality monitoring system, including monitors for MTBM deactivation and alarm activation.

3. Work Area Layout Drawings: The Contractor shall submit shaft layout drawings detailing dimensions and locations of all equipment, including overall work area boundaries. Shaft layout drawings will be required for jacking and receiving shaft locations and shall be to scale, or show correct dimensions. The Contractor's layout drawings shall show that all equipment and operations shall be completely contained within the allowable construction zones shown on the Plans.

4. Schedule: Provide a schedule for all microtunneling work, identifying all major construction activities as independent items. The schedule shall include, as a minimum, the following activities: mobilization, groundwater control at jacking and receiving shafts, shaft excavation and support, working slab construction, thrust wall construction, jacking equipment setup, ground stabilization, entry ring installation for launch of machine, microtunneling, retrieval of the MTBM, removal of shaft supports and shaft backfill, site restoration, cleanup, and demobilization. The schedule shall also include the work hours and workdays for each activity, and a written description of the construction activities. The schedule will be reviewed by the Engineer and shall be updated and resubmitted by the Contractor every two (2) weeks or more frequently if requested by the Engineer.
5. Daily Records: The following daily records shall be submitted to the onsite Engineer by noon on the day following the shift for which the data or records were taken.
    a. Jacking Records: The Contractor shall provide complete jacking records to the Engineer. These records shall include, at a minimum: date, time, name of operator, tunnel drive identification, installed pipe number and corresponding tunnel length, rate of advance, jacking forces, cutterhead speed and torque, bypass valve position, use of any cutting or high-pressure nozzles, face pressure, steering jack positions, line and grade offsets, any movement of the guidance system, machine inclination and roll, intermediate jacking station use and jacking forces, problems encountered with the tunneling machine or other components or equipment, and durations and reasons for delays. Computer-recorded data should be referenced to time and distance and should be recorded at time intervals of one minute or less. Manually recorded observations should be made at intervals of not less than three times per pipe, whenever conditions change, and as directed by the Engineer. At least seven (7) days prior to the launch of the machine, the Contractor shall submit samples of the automated and manual jacking records. Samples shall include electronic data and any necessary programs to interpret data, and the manual logs or records to be used.
    b. Lubrication Records: The Contractor shall provide lubrication records to the Engineer. These records shall include the injection locations along the pipe string, lubrication type and additives, and amount, in gallons, of lubricant pumped throughout a drive. The record will also include the type of additive used and date, time, and drive distance when used.
    c. Slurry Additives: The Contractor shall provide records of all slurry additives including any bentonite and polymers. The time and volume, or weight, of the additive shall be noted. Measurements of mud weights, specific gravity, and viscosity shall be made at the beginning, middle, and end of each shift, and submitted with the daily logs. Measurements shall be made on slurry samples taken from the slurry tanks and noted accordingly.
6. Calculations: Calculations shall be submitted in a neat, legible format. Assumptions used in calculations shall be consistent with information provided in the Subsurface Profile. All calculations shall be prepared by or under the direct supervision of a Professional Engineer licensed in State of South Dakota, who shall stamp and sign calculations.
    a. Design calculations demonstrating that the proposed jacking pipe is capable of supporting the maximum stresses to be imposed during jacking. The calculations shall take into account earth and hydrostatic loads, jacking forces, external loads such as live loads due to traffic, and any other loads that may be reasonably anticipated during jacking and during the service life of the pipe. All loads shall be shown and described. Include assumed maximum drive length. Additionally, provide an estimate of the maximum jacking force expected to complete each drive, accounting for both face pressures and frictional resistance along the pipe string.

b. Calculations demonstrating that the soils behind the thrust block can transfer the maximum planned jacking forces exerted by the main jacks to the ground during pipe installation with a factor of safety of at least 1.5, without excessive deflection or displacement. (See also Section 31 23 50, Submittals.) The thrust block capacity submittal shall be coordinated between the General Contractor and microtunneling subcontractor, if applicable.

7. Intermediate Jacking Stations: Drawings and design details for intermediate jacking stations including dimensions, shell materials, proposed spacing, method of operation, number of stations, method of abandonment, and final seal configuration.
8. Portal Stabilization: The Contractor shall submit details on portal stabilization and the method of controlling groundwater inflows and loss of ground into the shafts at all times, including the periods during launch and retrieval of the microtunneling machine.
   a. Provide a description of the methods to be used for each portal stabilization technique proposed. Provide a description of the method for verifying soil stability prior to removing shoring at entry and exit portals. Provide shop drawings showing the details and dimensions of each stabilization system and full narrative describing the procedures.
   b. Provide a description of the secondary or remedial methods that will be employed if the initial stabilization efforts fail to achieve the required stabilization.
9. Jacking Pipe: Submit detailed drawings of the jacking pipe indicating the location and spacing of lubrication fittings, joint details, joint cushioning materials, gaskets, and intermediate jacking station pipe details. Indicate the ultimate and allowable jacking capacity, the required fabrication tolerances to prevent damage to the pipe during installation and provide a certification indicating that the pipe meets these tolerances and is designed to meet all anticipated loading conditions with a factor of safety of 2.5.
10. Contingency Plans: The following list includes problem scenarios that may be encountered during the microtunneling operations. The Contractor shall submit contingency plans for dealing with each problem scenario while satisfying the specifications. These plans shall include the observations and measurements required to clearly identify the cause of the problems.
    a. Machine unable to advance:
       1) Possible obstructions (including boulders, old foundations, well casing, metallic debris, or reinforced concrete).
       2) Insufficient jacking capacity.
       3) Machine or component malfunction.
    b. Slurry separation problems:
       1) Cuttings are not adequately separated using the slurry separation plant.
       2) Cuttings settle out in the slurry lines before reaching the separation plant.
    c. Strong hydrocarbon smell is detected in the slurry returns, MTBM, tunnel, or in the shaft. Combustible gas meters at MTBM or in tunnel exceed 10 percent of LEL for methane or possible volatile organic compounds.
    d. Laser distorted by heat, humidity, or physical disturbance.
    e. Jacking Forces:
       1) Jacking forces increase dramatically or suddenly.
       2) Jacking forces reach design capacity of pipe, jacking frame, or thrust wall (treat these scenarios as separate incidents).
    f. Settlement and Subsidence:
       1) Survey measurements indicate deformations exceed allowable limits.
       2) Excavated volumes significantly exceed pipe volume installed.
       3) Slurry face pressures and/or torque on head decrease suddenly and significantly.
    g. Groundwater inflows to shaft increase significantly and/or transport fines into shaft in measurable quantities.
    h. Steering or guidance/tracking system difficulties result in line and grade tolerances being exceeded.

i. Pipe has been damaged or has been found to be out of compliance with specifications:
   1) Before installation.
   2) During, or after installation.
j. Thrust block deforms excessively under jacking loads, or provides insufficient capacity to advance pipe.
k. Control signal is lost. Cannot monitor position, torque, thrust, steering jack position, or other performance parameters.
l. Excessive pipe separation at joints or pipe string movement into shaft is experienced when jacks are retracted.

11. Safety Plan: A Safety Plan for the microtunneling operations including air monitoring equipment and procedures, and provisions for lighting, ventilation, and electrical system safeguards.

1.6 QUALITY CONTROL

A. Failure to meet the qualification requirements is failure to fulfill the Contract and the Contractor will be required to obtain a subcontractor that meets the qualification requirements.

B. All microtunneling work shall be performed by an experienced Contractor who has experience in performing trenchless work of similar diameter, in similar ground conditions, and of similar length to this project. The Contractor shall submit a description of referenced projects including owner's name and contact information, project superintendent, and machine operators.

C. The project superintendent shall have at least five (5) years of experience supervising trenchless construction. The Contractor shall submit a description of referenced projects including owner's name and contact information, project superintendent, and machine operators.

D. The machine operator(s) shall have technical training in the operation of the proposed equipment and shall have completed, as a primary operator, projects of similar diameter, in similar ground conditions, and of similar length to this project. The Contractor shall submit a description of referenced projects including owner's name and contact information, project superintendent, and machine operators.

E. The site safety representative and personnel responsible for air quality monitoring shall be experienced in tunnel construction and shall have current certification by OSHA.

F. The Contractor shall secure and pay for a surveyor who shall be responsible for line-and-grade control. The surveyor responsible for line-and-grade control shall be a Licensed Surveyor registered in the State of South Dakota who has prior experience in similar projects.

G. The Contractor shall provide at least 72 HRS advance written notice to Engineer of the planned launch of the MTBM.

H. All work by the Contractor shall be done in the presence of the Engineer unless the Engineer grants prior written approval to perform such work in Engineer's absence.

I. The Contractor shall immediately notify the Engineer, in writing, when any problems are encountered with equipment or materials, or if the Contractor believes the conditions encountered are materially and significantly different than those represented within the Contract Documents.

J. The Contractor shall allow access to the Engineer and shall furnish necessary assistance and cooperation to aid the Engineer in observations, measurements, data and sample collection, including, but not limited to the following:
   1. The Owner and/or Engineer shall have reasonable access to the operator control container prior to, during, and following all microtunneling operations. This shall include, but not be limited to, providing visual access to real-time operator control screens, gauges, and indicators.
   2. The Owner and/or Engineer shall have reasonable access to the jacking and reception shafts prior to, during, and following all jacking operations. This shall include, but not be limited to, visual inspection of installed pipes, and verification of line and grade. The Contractor shall provide safe access in accordance with all safety regulations.
   3. The Owner and/or Engineer shall have reasonable access to the slurry separation plant prior to, during, and following all microtunneling operations. This shall include, but not be limited to, reasonable access to shaker screens, hydrocyclones, conveyor belts, centrifuge equipment, and slurry and spoil holding tanks. The Engineer shall be allowed to collect soil samples from the shaker screens and/or spoil holding tanks on the slurry separation plant a minimum of once per installed pipe section, or every 10 FT, whichever is more often, and at any time when soil conditions change or debris or foreign objects are apparent or suspected.
   4. The Owner and/or Engineer shall have reasonable access to the bentonite lubrication plant prior to, during, and following all jacking operations. This shall include, but not be limited to, reasonable access to visually inspect storage and mixing tanks, lubricant pressures and pumping rates, and amount and type of lubricants on site.

1.7 SAFETY

A. The Contractor is responsible for safety on the job site. Methods of construction shall be such as to ensure the safety of the Work, Contractor's and other employees on site, and the public. Perform all work in accordance with all current applicable regulations and safety requirements of the Federal, State, and local agencies. Comply with all applicable provisions of 29 CFR Part 1926, Subpart S, Underground Construction and Subpart P, Excavations, by OSHA. In the event of conflict, comply with the more stringent requirements.

B. No gasoline powered equipment shall be permitted in jacking and receiving shafts. Diesel, electrical, hydraulic, and air powered equipment is acceptable, subject to applicable local, State, and Federal regulations.

C. Furnish and operate a temporary ventilation system in accordance with applicable safety requirements when personnel are in the shaft or in the pipe. Perform all required air and gas monitoring. Ventilation system shall provide a sufficient supply of fresh air and maintain an atmosphere free of toxic or flammable gasses in all underground work areas.

1.8 MEASUREMENT AND PAYMENT

A. Items spelled out in this section shall override measurement and payment provisions of all Plan Notes.

B. Incidental Items: There are numerous incidental items of work that are required to complete the trenchless installations for the project. While these items may not be specifically mentioned or illustrated by the Contract Documents and there may be no specific pay items listed for them, the Contractor will be required to perform those incidental tasks that can be anticipated through review of the Contract Documents, inspection of the construction areas, and experience in this class of trenchless construction.
   1. Items considered incidental work shall not be measured for payment or paid for as such unless specified as unit price by items on the Bid Form. These items and their costs

shall be included in the unit prices or lump sum bid for the pay items unless bid separately. Incidental items may include but are not limited to the following:

a. Development of Contingency Plan(s).
b. Development of Safety Plan(s).
c. Dewatering.
d. Disposal of material from pipe cleaning. Proper disposal of all waste.
e. Equipment (either rented or owned) used in the trenchless operation.
f. Excavation, sheeting or shoring of all receiving shafts.
g. Insurance.
h. Material Royalties.
i. Permits.
j. Portal stabilization.
k. Rental fees.
l. Settlement instrumentation and monitoring.
m. Site security.
n. Submittals or calculations as required or outlined in this Specification Section or in related specification sections.
o. Surveyor responsible for line and grade control of the trenchless installation.
p. Temporary lighting of work areas or signage.

C. Bid Items related to this work are listed in Estimate of Quantities in Design Drawings.

D. If a changed condition occurs or the Contractor deems that additional compensation is warranted for work or materials not covered in the Contract, the Contractor shall give the Engineer written notice of the claim as outlined in the Standard Specifications and Guidelines.

1. As discussed in Article 3.5 of this Specification, obstructions up to 25 percent of the diameter of the cutter head are to be included in the Contractor's bid for the trenchless work. The Contractor will receive compensation for removal of obstructions, as defined as metallic debris, reinforced concrete, whole trees, rocks and other hard objects larger than 25 percent of the outer diameter of the shield or cutter head, which cannot be broken up by the cutting tools with diligent effort, and that are partially or wholly within the cross-sectional area of the bore. Compensation for cost and time will be negotiated with the Contractor by the Owner on a case-by-case basis. The Owner will not consider damage to or the loss of the shield or cutter head as acceptable for compensation in this negotiation. The sole risk of such equipment impacts are solely on the Contractor.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Pipe.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Microtunneling shall not begin until the following tasks have been completed:

1. Contractor has requested locates from all utility owners, in accordance with State One-call Laws and Common Ground Alliance best practices, and all requested utility locates have been made, or area marked clear.
2. Contractor shall conduct visual site inspection and records search of as-builts to investigate potential unmarked, mismarked, and abandoned utilities.
3. Contractor shall confirm locates of all marked and discovered utilities, using vacuum potholing or other soft dig techniques for all crossing utilities and all adjacent utilities within the tolerance zone defined by State One-Call Laws.

4. All required submittals have been provided, reviewed, and accepted.
5. Jacking shaft and receiving shaft excavations and support systems for each drive have been completed in accordance with approved submittals. Elevations of working slab surfaces have been surveyed to confirm that work can be completed in accordance with alignment and grade shown on Plans.
6. The Contractor has stabilized the soils at entry and exit locations as required to stabilize weak, running, or flowing soils. The Contractor has confirmed that the ground has been stabilized to the extent that ground will remain stable without movement of soil or water while the entry/exit location shoring is removed and while the machine is being launched or received into a shaft or during jacking operations.
7. All settlement monitoring instruments have been installed, surveyed, and baseline survey measurements have been provided to and accepted by the Engineer.
8. The location, orientation and grade of the jacking frame or guide rails have been surveyed to ensure they are on the proper line and grade and to verify that they are properly supported. Special care shall be taken when setting the guide rails or jacking frame in the jacking shaft to ensure stability and accuracy of the alignment and grade.
9. Guide rails or jacking frame shall be securely attached to the shaft supports and concrete working slab to prevent movement or shifting during the work.
10. A start-up inspection of all mechanical and hydraulic systems associated with the microtunneling operations has been completed. The system shall be tested on the surface to ensure that the microtunneling machine and supporting equipment are functioning properly. The Engineer shall be notified at least 72 HRS prior to the start-up inspection and a site inspector representing the Owner will be present during the start-up inspection. Key machine performance data will be measured and recorded by the Contractor during this inspection, including cutterhead rotational torque, functionality of main and steering jacks, laser/theodolite/water level, and target, and other components. The records of the start-up inspection will be submitted to the Engineer within 24 HRS of the completed inspection.
11. Site safety representative has prepared a code of safe practices and an emergency plan in accordance with the Safety Plan. Provide the Engineer and Owner with a copy of each prior to starting microtunneling. Hold safety meetings and provide safety instruction for new employees. Conduct a pre-construction safety conference. Arrange this conference and inform the Engineer of the time and place of the conference at least seven (7) days in advance.

B. The Contractor shall properly manage and dispose of groundwater inflows to the shafts in accordance with all permit conditions. The Contractor shall not discharge groundwater inflows into storm sewers, sanitary sewers, water bodies, or streets.

C. The Contractor shall furnish all necessary equipment, power, water, and utilities for pipejacking, pipe lubricant mixing and pumping, spoil removal and disposal, grouting, and other associated work required for the Contractor's methods of construction.

D. Conduct all operations such that trucks and other vehicles do not interfere with traffic or create a mud, dust, or noise nuisance in the streets and to adjacent properties. Promptly clean up, remove, and dispose of mud, spoils and slurry spillage, and any slurry discharges.

E. All work shall be done so as not to disturb roadways, adjacent structures, landscaped areas, or existing utilities. Any damage shall be immediately repaired to original or better condition and to the satisfaction of Engineer at no additional cost to the Owner.

F. Whenever there is a condition that is likely to endanger the stability of the excavation or adjacent structures, the Contractor shall operate with a full crew 24 HRS a day, including weekends and holidays, without interruption, until those conditions no longer jeopardize stability.

3.2 JACKING OPERATIONS

A. Provide a suitable jacking frame and thrust block to carry out the work. Provide, install, and operate intermediate jacking stations as necessary to complete the microtunneling drives indicated on the Plans and in accordance with design criteria.

B. The Contractor shall install and use IJSs if jacking forces for any segment reach or exceed 70 percent of the safe design capacity of the jacking pipe, IJS pipe, jacking frame, or thrust block, whichever is lowest. The Contractor may elect to use IJSs before jacking forces reach the threshold values.

C. Transport the jacking pipe from storage to the jacking shaft without damage. Transport methods shall be acceptable to pipe manufacturer. Damaged jacking pipe shall not be used in the Work, unless permitted in writing by the Engineer. Set the pipe to be jacked on properly braced and supported guide rails or jacking frame.

D. Testing of the joints of each jacking pipe shall be in accordance with the testing requirements of the applicable pipe specification.

E. The axial forces from the thrust jacks shall be distributed to the jacking pipe uniformly through a thrust ring and cushion material to prevent damage to the ends of the pipe. The Contractor or pipe manufacturer shall install pipe cushion materials between each direct-jacked pipe joint. The cushion materials or compression rings will be made of plywood or other materials recommended by the pipe manufacturer and reviewed by the Engineer. The compression rings shall not protrude beyond the inner or outer diameter of the pipe. The compression rings shall be of sufficient thickness and stiffness to distribute the jacking load between successive pipe sections, and minimize eccentric loading. Jacking forces applied to the pipe shall not exceed the specified allowable compressive stresses stated in Paragraph 1.4E of this Specification.

F. Jacking pipe sections shall be jacked into position following the design line and grade without damaging the pipe. In the event a section of pipe is damaged during the jacking operation, the Contractor, with written approval from the Engineer, shall make temporary repairs to the pipe and shall jack the pipe through to the next shaft for removal. Other methods of repairing the damaged pipe may be used if approved in writing by the Engineer.

3.3 MICROTUNNELING

A. Microtunneling shall be completed in accordance with approved submittals, and all applicable permit conditions.

B. Microtunneling operations shall control surface settlement and heave above the pipeline to prevent damage to existing utilities, facilities, and improvements. The Contractor shall repair any damage resulting from construction activities, at no additional cost to Owner and without extension of schedule for completion. The Contractor shall pressure grout any voids caused by or encountered during microtunneling, as specified in Section 33 05 03 - Contact Grouting. The Contractor shall modify equipment and procedures as required to avoid recurrence of excessive settlements, heave, or damage.

C. Provide an automated lubrication system, and inject pipe lubricants through injection ports at the rear of the microtunneling machine and ports in the jacking pipe, to minimize pipe friction. Pipe lubricants shall be injected continuously as the pipe is advanced and in sufficient volume to at a minimum completely fill the calculated overcut volume.

D. Pressure shall be applied at the tunnel face to maintain face stability and shall be monitored continuously. Face pressure shall be maintained between calculated active and passive earth pressure.

E. The microtunneling machine shall be operated to restrict the excavation of the materials to a volume equal to the MTBM and pipe jacked, to prevent loss of ground and settlement or possible damage to overlying structures. Control the advance rate and monitor the volume

of material excavated and adjust advance rate, as required, to avoid loss of ground, over-excavation, or surface heave.

F. Control slurry pressure and avoid excessive pumping pressures to prevent the discharge of slurry at the ground surface or into any water body. Contain and clean up any slurry discharges immediately. Wash any paved areas with water to avoid the tracking of slurry away from the discharge area.

G. Completely contain, transport, and dispose of all excavated materials, waste slurry, and drilling fluids away from the construction site. All spoils and slurry must be contained in trucks, tanks, or other containers at all times. Dumping of spoil or slurry on the ground, discharge into sewers, or discharge into the shafts is not permitted. Slurry shall be pumped into tanker trucks and disposed of at acceptable facilities in accordance with current State regulations for disposal of these materials. Only use the disposal sites identified in approved submittals for muck and slurry disposal.

3.4 CONTROL OF LINE AND GRADE

A. The Contractor shall verify survey benchmarks prior to the start of construction, and shall confirm positions or report any errors or discrepancies in writing to the Engineer.

B. After confirming all established benchmarks, use these benchmarks to furnish and maintain all reference lines and grades for microtunneling. The Contractor shall use these lines and grades to establish the exact location of the MTBM as it is being advanced using a laser and theodolite guidance system and water level. Submit to Engineer copies of field notes used to establish all lines and grades and allow Engineer to check guidance system setup prior to beginning each microtunneling drive. Provide access for Engineer to perform survey checks of guidance system and line-and-grade of jacking pipe on a daily basis during microtunneling operations. The Contractor is fully responsible for the accuracy of the Work and the correction of it, as required.

C. The jacking pipe shall be installed in accordance with the following tolerances:
   1. Variations from design line: ±3 IN maximum.
   2. Variations from design grade: ±2 IN maximum.

D. The machine shall be steered to maintain line and grade within the tolerances specified. This shall be achieved by continuously monitoring and adjusting line, grade, machine inclination, roll, and steering attitude during the operation. If the installation deviates from line or grade, make the necessary corrections, and return to the design alignment and grade at a rate of not more than 1 IN per 25 FT.

E. The guidance system shall be mounted independently from the thrust block and jacking frame to maintain alignment if there is movement of equipment during jacking. Stop microtunneling operations and reset guidance system if its alignment shifts or is moved off design alignment and grade for any reason. Check guidance system setup at least once per shift. Guidance system should only be reset by experienced, competent surveying personnel in accordance with approved procedures outlined in the submittals.

F. Monitor line and grade continuously during microtunneling operations. Record deviation with respect to design line and grade at least once per foot and submit records to Engineer. Control line and grade of the jacking pipe to within the specified tolerances.

G. If the pipe installation does not meet the specified tolerance, the Contractor shall correct the installation including any necessary redesign of the pipeline or structures and acquisition of necessary easements. All corrective work shall be performed by the Contractor at no additional cost to the Owner and without schedule extension, and is subject to the written approval of the Engineer.

3.5 OBSTRUCTIONS

A. If the microtunneling operations should encounter an object or condition that impedes the forward progress of the machine, the Contractor shall notify the Engineer immediately. The Contractor shall propose one of the plans previously submitted per Paragraph 1.5.C.10 of this Specification to correct the condition, and remove, clear, or otherwise make it possible for the microtunneling machine and jacked pipe to advance past any and all objects or obstructions that impede forward progress of the machine. Upon written notification of the Engineer, the Contractor shall immediately proceed with removal of the object or obstruction by means of an obstruction removal shaft or by other approved methods, as submitted by the Contractor. An obstruction removal shaft shall consist of a small excavation for the purpose of removing the obstruction. The Contractor will receive compensation for removal of obstructions, as defined as metallic debris, reinforced concrete, whole trees, rocks and other hard objects larger than 25 percent of the outer diameter of the shield or cutter head, which cannot be broken up by the cutting tools with diligent effort, and that are partially or wholly within the cross-sectional area of the bore. Compensation for cost and time will be negotiated with the Contractor by the Owner on a case-by-case basis. The Contractor will receive no additional compensation for removing, clearing, or otherwise making it possible for the microtunneling machine to advance past objects consisting of cobbles, boulders, wood, non-reinforced concrete, and other nonmetallic objects or debris with maximum lateral dimensions less than 25 percent of the outer diameter of the shield or cutterhead, whichever is larger.

3.6 CLEANUP

A. After completion of microtunneling and carrier pipe installation, all construction debris, slurry, oil, grease, and other materials will be removed from the microtunneled pipe, jacking and receiving shafts, and all Contractor work areas. Cleaning shall be incidental to the construction. No separate payment shall be made for cleanup.

B. Restoration shall follow construction as the work progresses, and shall be completed as soon as possible. Restore and repair any damage resulting from surface settlement caused by shaft excavation, or pipejacking. Any property damaged or destroyed, shall be restored to a condition equal to or better than existing prior to construction. Restoration shall be completed no later than thirty (30) days after the microtunneling is complete. The restoration shall include all property affected by the construction operations.

END OF SECTION