

**BUFFALO SEWER AUTHORITY
CAPITAL PROJECTS PROGRAM
QUEEN CITY CLEAN WATERS - SIDNEY OLS**

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GUIDE SPECIFICATIONS

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SECTION 33 05 07
MICROTUNNELING

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section includes requirements for installing casing pipe by use of a Microtunneling operation as defined herein.
- B. Contractor Responsibilities
 - 1. Responsible for selection of Microtunneling means and methods subject to review by Engineer.
 - 2. Furnish labor, equipment, and material required to complete work by Microtunneling including but not limited to; Microtunneling system, jacking and receiving pit exit and entry equipment and procedures, spoil transportation and separation, hoisting, lifting, safety, and control equipment.
 - 3. Furnish labor, equipment, and material for jacking and receiving pit construction, complete in place including, but not limited to:
 - a. Sediment Controls
 - b. Re-handling and disposal of unsuitable materials
 - c. Dewatering
 - d. Utility adjustments/support
 - e. Tests
 - f. Sealing jacking and receiving pit exit and entry locations to prevent inflow of soil and groundwater
 - g. Excavation
 - h. Sheeting and shoring
 - i. Backfilling
 - j. Cleanup
 - k. Security

- l. Restoration of surface features
 - m. Other related work necessary for construction as specified or as shown on Drawings.
- C. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:
- 1. Section 03 30 00 - Cast-In-Place Concrete
 - 2. Section 31 23 16 - Excavation
 - 3. Section 31 23 23 - Backfill
 - 4. Section 31 41 00 - Shoring
 - 5. Section 33 05 19 - Ductile-Iron Utility Pipe
 - 6. Section 01 45 23 - Testing and Inspection Services

1.2 REFERENCES

- A. Codes and standards referred to in this Section are:
- 1. ASTM A 139 - Specification for Electric-Fusion (Arc) -Welded Steel Pipe (NPS in 4 in. and Over)
 - 2. OSHA PL-91-596 - Occupational Safety Health Act of 1970 Public Law 91-596
 - 3. AWWA C600 - Standard for Installation of Ductile Iron Mains and Their Appurtenances
 - 4. AWWA C151 - Standard for Ductile Iron Pipe, Centrifugally Cast
 - 5. AWWA C206-11 - Standard for Field Welding of Steel Water Pipe
 - 6. ASTM C1501 - Standard Specification for Portland Cement C150M-11

1.3 DEFINITIONS

- A. **Microtunneling:** Installation of casing pipe by jacking pipe behind a remotely controlled, steerable, guided Microtunnel Boring Machine (MTBM) which fully supports excavated face with either slurry or earth pressure balance at all times.
- B. **Casing Pipe:** Pipe capable of withstanding installation forces due to jacking and other construction or temporary loads in addition to permanent live and dead loads.
- C. **Jacking and Receiving Pits:** Working pits between which casing is installed by means of Microtunneling technique for Microtunnel jacking and equipment retrieval.
- D. **Drive:** Section of casing pipe installed by Microtunneling from Jacking Pit to Receiving Pit.

E. Slurry Pressure Balance System

1. Microtunneling system that mixes excavated material with slurry in a chamber located behind cutting head.
2. Low pressure slurry is used to balance ground and water pressure at face of tunnel, limit settlement and convey cuttings back to ground surface.
3. Cuttings are removed or separated and slurry is re-circulated back to MTBM.

F. Earth Pressure Balance System

1. Microtunneling system which incorporates continuous flight auger enclosed in separate casing inside casing pipe being jacked.
2. Positive pressure is maintained at excavated face by regulating volume of cuttings removed relative to advance rate of MTBM.

G. Spoil: Excavated material that has been mixed with either water or slurry and pumped to surface to be separated and recycled or disposed.

H. Tunnel: Microtunnel casing pipes complete in place.

1.4 QUALITY ASSURANCE

A. Supervision

1. Microtunneling and work associated with Microtunneling:
 - a. Supervised by at least 1 person with previous experience of Microtunneling process.
 - b. See minimum requirements under Submittals herein.

B. Operators

1. Personnel experienced in Microtunneling with prior knowledge and ability in proper operation of systems being employed.
2. See minimum requirements under Submittals herein.

C. Operation

1. Operate systems following manufacturer's instructions.
2. Make available at all times copies of operations manuals to Engineer and operational personnel on site.

D. Run Test: Test full system on completion of set up and before commencing drive.

E. Drive Start Up

1. Before commencement of any drive, demonstrate to Engineer that required set up procedures and system checks are complete and required materials are at hand to commence drive.
2. Do not commence drive until construction of Receiving Pit has been completed.

1.5 SUBMITTALS

A. Submit following Section 01 33 00:

1. If modifications are required during construction, submit to Engineer for approval information illustrating such modifications, including reasons.
2. Microtunneling Qualifications for Contractor Performing Microtunneling Work.
 - a. Cover sheet with date, company name, address, telephone and fax numbers, email address, and contact person.
 - b. Resumes of managerial, supervisory and operational key personnel:
 - (1) Experience: Minimum of 3 previous Microtunneling projects of similar size and scope.
 - (2) Detailed descriptions of Microtunneling Projects.
 - c. Summary sheet of previous projects performed using Microtunneling that demonstrates expertise and experience. Named projects may be used more than once under separate paragraphs if their criteria apply.
 - (1) Minimum 3 years' experience performing Microtunneling of similar size and scope.
 - (2) List 3 separate projects completed that used either Slurry or Earth Pressure Balance based system.
 - d. Submit for each named project above, and in same order, following detailed information.
 - (1) Date, full name of project, and location.
 - (2) Owner's name, address, telephone and fax numbers, email address, and contact person.
 - (3) Employees in charge of work at both head office and site.
 - (4) Description of relevant work successfully completed, including ground conditions.
 - (5) Features under which pipe passed, depth below the water table, photos, and published articles if available.
 - (6) Additional information as necessary.

e. Equipment

- (1) Supply full details of Microtunneling System to be employed.
- (2) Manufacturer and date(s) of manufacture.
- (3) Type and model number for whole system if from single source or separate details for each element of system.
- (4) Confirmation from manufacturer that machine set up is suitable to limit annular space, as specified, for external diameter of casing pipe proposed.
- (5) System of alignment monitoring and steering control and activation.
- (6) Hydraulic jacking system maximum capacity and method of limiting jacking capacity to that of maximum capacity of specified casing.
- (7) Gasketed pit exit and entry seals, pressure chamber, or other equipment to be utilized for prevention of inflow of pressurized soil and groundwater into the jacking and receiving pits during break-out and break-in operations.

f. Procedures

- (1) Supply full details of procedures and resources that will be employed to carry out work including method and sequence.
 - (a) Establishment of drive line of MTBM and elevation at base of pits.
 - (b) Pit exit and entry procedures including use of gasketed seals, pressure chamber, or other equipment and including supplemental soil stabilization by means of grouting, dewatering, or depressurization as required to prevent inflow of soil and groundwater to the pit.
 - (c) Casing Pipe handling and connections.
 - (d) Maintaining line and grade, and reestablishment of line and grade as required.
 - (e) Spoil separation and disposal.
 - (f) Spoil and slurry containment during Microtunneling work.
 - (g) Installation of carrier pipe.

g. Materials

- (1) Supply full details of following materials.
 - (a) Design mixes for concrete, grout, or flowable fills.
 - (b) Casing pipe including manufacturer, grade, and specification, outside diameter, thickness, and any coatings, if required.

- h. Calculations that clearly state:
 - (1) Maximum calculated jacking resistance for installing complete casing.
 - (2) Maximum allowable face pressure or slurry pressure that can be exerted at tunnel face without fluid loss to surface, other structures or features or heave of ground.
 - (3) Relationship between hydraulic jacking pressure and force applied to casing pipe during jacking.

3. Jacking and Receiving Pits

- a. Submit station specific Working Drawings to include but not limited to:
 - (1) Jacking and receiving pit configurations.
 - (2) Design and construction of jacking and receiving pits.
 - (3) Details for ground support systems.
 - (4) Special requirements for jacking and receiving pit penetrations including exit and entry seals or other equipment and supplemental ground stabilization, thrust blocks, backstops or other reactions required for Microtunneling, casing pipe jacking or any other jacking.
 - (5) Full calculations supporting maximum jacking capacity that jacking pit will withstand without movement exceeding 0.5 inches with an appropriate factor of safety.
 - (6) Areas for storage, material and spoil handling, dewatering, ground stabilization if required, excavation procedures, and backfilling.
 - (7) Dewatering and ground water control plans for jacking and receiving pits.

4. Settlement Monitoring Plan

- a. Submit surveying and monitoring plan for review before construction. Identify location of settlement monitoring points, reference benchmarks, survey schedules and procedures, and reporting formats.
- b. Submit Building and Structures Assessment Plan, if applicable, for review before construction.
 - (1) Furnish pre-construction and post-construction assessment for building and structures located within distance of 100 feet from centerline of proposed tunnel, and jacking and receiving pits.
 - (2) Include photographs or video of existing damage to structures near alignment.

1.6 RECORD DRAWINGS

- A. Maintain a construction site complete set of field drawings for recording as-built conditions.
- B. Mark or note thereon up-to-date as-built conditions properly dated.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Unload and handle materials with equipment of adequate capacity, equipped with slings to protect materials from damage.
 - 1. Store materials on site in reasonably level well-drained area free from brush.
 - 2. Store individual pieces and bundles with safe walking space between to allow full view for inspection purposes.

1.8 PROJECT CONDITIONS

- A. Perform Microtunneling so as not to interfere with, interrupt or endanger surface and activity thereon, and minimize subsidence of surface, structures, and utilities above and near tunnel.
- B. Repair and restore damaged property from tunnel operation settlement to its original condition before being disturbed at no cost to the Owner.
- C. Review and interpret available geotechnical reports and investigate work site soil conditions before bidding.
 - 1. Encountering rock or water will not entitle Contractor to additional compensation.
- D. Follow applicable ordinances, codes, statutes, rules, and regulations of applicable City building codes, and applicable regulations of Federal Government, OSHA 29CFR 1926, and applicable criteria of ANSI A10.16-1995 (R2001), "Safety Requirements for Tunnels, Shafts, and Caissons."

PART 2 PRODUCTS

2.1 MATERIALS

- A. Casing Pipe
 - 1. Steel pipe
 - a. Smooth walled with minimum yield strength of 36,000 psi (ASTM A1011 Grade 36).

- b. Minimum wall thickness 1/2 inch or greater as required by the casing pipe manufacturer.
 - c. Joints: Press-fit interlocking connection.
 - d. Coating: Coal tar epoxy
 - e. Modifications to design of steel casing pipe for MTBM compatibility.
 - (1) Make request to Engineer.
2. Manufacturer
- a. Permalok Steel Casing Pipe, by Northwest Pipe Company.
 - b. Other Pipes: Refer to Section 01 60 00 - Material and Equipment for "Or Equal" Submittal requirements.
- B. Carrier Pipe
- 1. Meet requirements specified in Sections 01 45 23 - Testing and Inspection Services and 33 05 55 - Buried Ductile Iron and Fittings.
- C. Surface Settlement Markers
- 1. Within Bituminous Concrete Paved Areas: "p.k." nails.
 - 2. Within Non-paved Areas: Wooden hubs.
- D. Dielectric Material
- 1. Thermoplastic; Minimum strength of 400 volts for each mil, and water absorption less than 0.02 percent (24-hour period).
- E. Equipment
- 1. Microtunneling System
 - a. Closed face capable of providing positive supporting pressure to full excavated area (face) at all times and capability of controlling and measuring pressure at face.
 - b. Achieve balancing of earth and ground water pressures by use of slurry pressure, auger-earth pressure balance, or combination of the two.
 - c. Includes jacking and receiving pit exit and entry seals, pressure chamber, or other equipment and utilizes supplemental ground stabilization or dewatering to prevent inflow of soil and groundwater to the pit.

- d. System capable of adjustments required to maintain face stability for anticipated ground conditions.
- e. Control slurry pressure systems, using slurry spoil transportation, earth and groundwater pressure at face by use of variable flow slurry pumps, pressure control valves and minimum of 2 flow meters, 1 on feed side and 1 on return side.
- f. For earth pressure balance systems using screw auger spoil transportation from the face, control excavated material by maintaining an earth pressure balancing plug of material at face with advance of system being matched with excavation removal through auger.
 - (1) Control soil through auger by use of pitch spacing and/or an auger gate or throttle.
- g. Sufficient power and ability in normal operation to cut or crush hard material of sizes up to 1/3 internal diameter of pipe and up to 30,000 psi compressive strength.
- h. Ability to control axial rotation to within 3-degrees of normal operating datum.
- i. Ability to articulate and steer to correct vertical and horizontal deviation from alignment datum by remote activation.
- j. Means to inject lubricant over lead pipe, if required.
- k. Spoil transportation system that has capacity for removal of spoil in balance with excavation and advance.
- l. Slurry system
 - (1) Spoil separation system with sufficient capacity to remove solids from flow while system is excavating spoil.
 - (2) Discharges safely with negligible remaining fines, the re-circulated or excess fluid.
- m. Overall control system that enables remote control of all main operating functions of system from one location, either at surface or within jacking shaft.
- n. Main jacking pit capable of exerting uniform load to casing pipe at speed commensurate with speed of excavation advance.
 - (1) Set jacking hydraulics to relieve pressure at maximum safe working capacity of casing pipe.

PART 3 EXECUTION

3.1 GENERAL

- A. Dewatering: When water is encountered, develop and maintain dewatering system of sufficient capacity to remove water continuously, keeping excavations free of water until backfill operation is in progress.
 - 1. Keep removal of soils particles to minimum.
 - 2. Dewater into sediment trap following Section 31 23 19.
 - 3. Monitor to detect settlement or displacement of surface facilities due to dewatering and adjust systems accordingly to mitigate surface displacement.
 - 4. Should settlement or displacement be detected, notify Engineer immediately and act to maintain safe conditions and prevent damage.

3.2 DAILY ACTIVITY LOG

- A. Maintain daily activity log during jacking operations for casing. Submit to Engineer for record purposes on a daily basis.
 - 1. Start and finish time of casing pipe advancement.
 - 2. Total length of casing pipe installed.
 - 3. Horizontal and vertical alignment deviation at not greater than 1 foot intervals or period not exceeding 5 minutes, whichever is most frequent.
 - 4. Maximum jacking force exerted during installation of each casing pipe section including forces required to re-initiate jacking following periods of system shutdown.
 - 5. General description for each discernible ground condition mined.
 - 6. Settlement monitoring readings.
- B. Where microtunneling system utilizes an electronic data logger, set up so the above information is recorded and can be readily identified.
 - 1. Identify known errors with recorded data and explain in daily log submittal.

3.3 PREPARATION

- A. Maintain clean working conditions inside jacking operation area and remove spoil, debris, equipment, and other material not required for operations.
- B. For construction below railroads, highways and utilities perform installation to prevent interference or disruption with normal operation of these facilities.

- C. During construction, maintain access to private and commercial properties at all times, unless approval from both property owner and Engineer has been obtained.
 - 1. Costs associated with providing alternative access will be at no additional cost to the Owner.
- D. Provide power generation equipment and other equipment operating on or with fuel or lubrication oils with suitable barriers and safeguards to ensure no loss of oil to drains or waterways or to contaminate ground.

3.4 JACKING AND RECEIVING PIT CONSTRUCTION

- A. Responsible for design, construction, maintenance and removal, including any damage attributed to jacking and receiving pit construction.
- B. Approximate Jacking and Receiving Pit Locations: See Contract Drawings.
- C. Excavation, Backfill, and Grading: Refer to Sections 31 23 16 and 31 23 23.
- D. Responsible for necessary utility relocation or supporting of utilities for jacking and receiving pits construction.

3.5 MICROTUNNELING OF CASING PIPE

- A. Tolerances
 - 1. Place casing pipe to within 1 inch of vertical and horizontal alignment shown on Drawings.
 - 2. Limit annular space, between excavated material and outside diameter of casing pipe, to maximum of 0.5-inch.
 - 3. Outside diameter of MTBM not to exceed outside diameter of casing pipe by more than 1 inch.
 - 4. Redesign of pipeline or associated structures if jacked casing pipe is off design line or grade, will be at no additional cost to the Owner.
- B. Obstructions During Microtunneling
 - 1. Responsible for selection of type of MTBM and type of cutting.
 - 2. Remove, clear, or otherwise make it possible for Microtunneling system and casing pipe to progress past or through any obstructions encountered.
 - 3. Removing, clearing or otherwise making it possible for Microtunneling System to progress past any obstructions encountered will be at no additional cost to the Owner.

3.6 INSTALLATION OF CARRIER PIPE

- A. Follow Sections 33 05 05 - Buried Piping Installation, 01 45 23 – Testing and Inspection Services, and 33 05 19 - Ductile-Iron Utility Pipe, Standard Details, and Drawings.
- B. Use thermoplastic or other dielectric material (except wood) between carrier pipe and steel sleeve to prevent metal-to-metal contact and damage to pipe and coating during placement.
- C. Casing Spacers (Steel Casing Pipe)
 - 1. Secure polymer casing spacers to the carrier pipe at intervals conforming to the manufacturer's recommendations (but not exceeding 6-feet) inside the casing pipe. Arrange the spacers to provide support for and to prevent floatation or shifting of the carrier pipe. Spacers shall be designed to support the weight of the pipe full of water.
 - 2. Two types of polymer spacers are acceptable as follows:
 - 3. Provide polymer casing spacers comprised of a shell of minimum 14-gauge Type 304 stainless steel with runners of ultra-high molecular weight polymer as manufactured by Cascade Waterworks Manufacturing Company, Yorkville, IL, or equal. Line the shell with polyvinyl chloride and support the runners with Type 304 stainless steel risers.
 - 4. Provide Projection Type Casing Spacers which shall be totally non-metallic, spacers constructed of preformed sections of high-density polyethylene. Projection Type Casing Spacers shall be as manufactured by the RACI Spacers North America Inc., Vernon BC or equal. Spacers shall be ISO 9002 certified for strength and quality. Projection type spacers shall have a minimum of number of projections around the circumference totaling the number of diameter inches of the pipe ID. Spacers shall be provided with double back tape for bonding application of the spacers to the pipe, and a spacer locking system that clamps the spacer onto the pipe in tension to ensure the spacers do not move during the installation of the carrier pipe into the casing pipe. The projection spacer manufacturer shall demonstrate at least five years experience with similar projects by providing a submittal documenting verifiable details of previous projects.
 - a. Bulkhead: Refer to details on the Contract Drawings.

3.7 DETECTION OF MOVEMENT

- A. Surface Settlement Markers
 - 1. Unless otherwise specified, shown on Contract Drawings or directed by Engineer, locate surface settlement markers not less than 20 feet either side of the tunnel centerline and at a minimum interval of 25 feet along the centerline.

2. Establish elevation of settlement markers to bench marks unaffected by tunnel operations.
 3. Prior to excavation of jacking and receiving pits, shoring installation and commencement of microtunneling activities, take baseline readings, permanently record and submit to the Engineer for record purposes.
 4. Before start of dewatering operations and/or shaft excavation take baseline readings, permanently record and submit to the Engineer for record purposes.
 5. After steel casing has been advanced beyond pavement limits of each roadway.
 6. Take elevation measurements to nearest 0.01 foot and furnish reports to Engineer.
 7. In event of settlement or heave on any marker:
 - a. Immediately cease work and take immediate action to prevent further settlement or heave and concurrently report settlement or movement to Engineer
 - b. Restore surface elevations to that existing before start of tunnel operations at no cost to the Owner.
- B. Report settlement or movement immediately to Engineer and take immediate remedial action, at no cost to the Owner, except when from dewatering operations.

END OF SECTION

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