DRAFT SPECIFICATIONS FOR MICROTUNNELING

GENERAL

Microtunneling has been selected as the method for installing sewer pipe on this project in order to reduce the inconvenience to, and provide the greatest degree of safety for, local residents and businesses, and motorist or pedestrians passing through the project area.

The project life, as it pertains to the pipe materials specified, is a minimum design life of 100 years.

A. This specification for microtunneling provides the minimum requirements for the trenchless installation of sanitary sewer pipe.

B. For the purpose of this specification, microtunneling is defined as the trenchless installation of pipe by jacking the pipe behind a remotely controlled, steerable, laser-guided, articulating tunnel shield and is construed to be tunneling of non-man sized entry (i.e. 36" internal diameter and smaller).

DESCRIPTION OF METHOD

The tunneling shield, which is connected to and followed by the pipe being installed, shall ensure that the soils being excavated through are fully supported at all times (without the use of any ground stabilization, de-watering, or other support techniques).

The minimum depth of cover for microtunneling in normally six (6) feet or 1.5 times the outer diameter of the pipe being installed, which ever is greater. With special precautions, and the approval of the Engineer, this depth can be decreased. All tunneling work shall be executed so as to minimize settlement or heave within the tolerances set forth in the contract documents.

Microtunneling systems have four major components:
The Tunnel Shield and Cutting Head

The tunnel shields may be driven either electrically or hydraulically. The shield is articulated to enable steering of the system. Steering rams and valves are controlled by a low pressure power pack located in the shield or by other approved means.

Line and grade are controlled by a laser beam transmitted from the drive shaft along the centerline of the pipe to a target mounted in the shield. The position of the laser on the target shall be transmitted back to the operator either electrically or by a closed circuit television. The operator shall also have other information including, roll pitch, steering attitude and position of valves (either open or closed).

The Soil Transport System
There are two types of soil transport.

The Auger System is designed to remove the excavated soil by auger to the jacking shaft, where it is removed by conventional means. This system controls the stability of the face of the excavation by metering the amount of material which enters the auger. In water bearing sands or under the water table, air is injected at the face of the excavation to help control the amount of material being removed.

The Slurry System must be able to be matched the excavated soil transportation speed to the excavation rate to achieve a minimum velocity to prevent settlement of solids in the slurry lines and to balance the ground water pressure. This is achieved by using variable speed pumps, pressure control valves and a flow meter. A slurry bypass unit is included in the system to allow the direction of flow to be changed or isolated as necessary. The final stage of the slurry system is the separation equipment that removes the soil from the water. This may be either tanks or lagoons upon approval of the Engineer.

The Jacking System
The main jacks are located in the drive shaft and must be able to successfully push the tunneling shield together with a string of connected pipes. The capacity of the jacks and the rate of extension are synchronized with the excavation rate of the shield, which is determined by the particular soil conditions.

The Controls
The control equipment integrates the system of excavation and removal of soil and its simultaneous replacement by a pipe. As each pipe section is jacked forward, the control system synchronizes all of the operational functions to maintain the system in balance in such a way as to provide complete ground support at all times.

DRIVE AND RECEPTION SHAFTS

Jacking and Receiving shafts (pits) shall be constructed as small as practical. However, when the construction requires operations within a street, the "footprint" of the microtunneling operation, including the construction of the jacking and receiving shafts (pits) shall be limited and confined to one (I) traffic lane or one-half of the roadway, whichever is less.

The contractor shall furnish and install all pump and related equipment to keep the jacking shaft free of water. The design of the shafts shall ensure safe exit from the driving shaft and entry into the receiving shaft of the tunneling shield and provide sufficient backstop capacity to resist forces developed by the thrust jacks.

The distances between the shafts is a function of the pipe size, depth of cover, and soil condition. The microtunneling equipment manufacturer shall be consulted when determining the distances between the shafts.

All jacking shafts and receiving shafts (pits) sizes and configurations shall be specified at the time of the bid. Any subsequent changes to shaft (pit) size or configuration must be approved in writing by the Engineer. Preference in award of contract may be given for the use of small shafts (pits).

EQUIPMENT SPECIFICATION

All microtunneling equipment shall be remotely controlled. No persons shall be directly in tunneling shield.

1) The tunnel shield shall be a full faced with the capability of supporting the face both during excavation and during shutdown. The shield shall have the ability to balance the earth/water pressure at the face, either by the use of compressed air or slurry.

2) The system shall be laser controlled and monitored by the operator at all times. All functions of the system shall be monitored and transmitted to the remote operations console. The minimum information available to the operator on the consoles shall include rate of advance, length of conduit installed, thrust force, deviation from line and grade, role, inclination and valve positions.

3) The jacking system, including any intermediate jacks used, shall be capable of continuously monitoring the jacking pressure, the rate of advancement and the distance jacked.

4) When soil conditions dictate, the tunnel shield must be capable of removing cobbles and boulders. The excavation system shall be fully capable of excavating all material that it will encounter.

5) The tunnel shield must be articulated and maneuvered by trunion mounted steering jacks or other approved method to enable accurate control of line and grade.

6) The equipment shall have the capability of limiting the jacking force applied the pipe/tunnel shield so as not to exceed the maximum compressive loads allowed for the pipe.

7) A lubrication system shall be provided that injects an approved lubricant at the rear of the tunneling shield to lower the friction developed on the exterior of the pipe during jacking.

8) The overcut on the tunneling shield shall not exceed 1" on the radius without approval of the Engineer. The angular space created by the overcut shall be filled with the lubricant that is suitable for the soil type encountered.

9) The tunneling system must be capable of maintaining line and grade to 1" plus or minus over the distance of the drive.

10) All ground water encountered during the excavation of the tunnel must be balanced by the tunneling machine.

11) Slurry tunneling systems shall use a minimum volume of water in the slurry system.

12) The tunneling shield must be capable ofkeeping drift and rotation or role to a minimum.

13) The manufacturer of the specific equipment to be used on this project shall be specified at the time of the bid. Any subsequent changes with respect to microtunneling equipment manufacturer must be approved in writing by the Engineer.

PIPE SPECIFICATIONS

A. General

Pipes used for microtunneling are specialized. They must be capable of withstanding all forces imposed upon them during the construction phase as well as the final in-place loading conditions. All pipe must be able to withstand a compressive loading greater than the jacking load anticipated on this project. The maximum jacking force anticipated on this project is based on a 0.06 tons per square foot of pipe/soil contact area and may be calculated by the following equation:
0.06 x pi x 0.0. (in ft) x longest drive length (in ft.)

Pipe that does not have an allowable safe jacking load, with a minimum safety factor of2.5, of at least the tonnage calculated using the equation above are not acceptable for use on this project.

The driving ends of the pipe and intermediate points must be protected against damage. The detailed method proposed to cushion and distribute the jacking force at the joint is subject to approval by the Engineer. Any pipe showing signs of failure may be required to be jacked through to the reception shaft and removed. Other methods of pipe repair may be used subject to approval of the Engineer.

The pipe manufacturer shall be designated at the time of the bid. Any subsequent change of pipe manufacturer must be approve by the Engineer in writing. A record of experience and product information shall be provided by the Contractor at the time of the bid.

B. NO-DIG Microtunneling Pipe. NO-DIG microtunneling pipe shall be the standard of quality for all pipe on this project. NO-DIG pipe shall meet the requirement of ASTM C 1208, Standard Specification for Vitrified Clay Pipe and Joints for Use In Jacking, Sliplining, and Tunnels, latest revision. NO-DIG vitrified clay microtunneling pipe is manufactured by MCP Industries, Inc. The pipe shall have a minimum compressive strength of 7000 psi. The pipe joint collar shall be manufactured using Series 316 stainless steel or better. Pipe shall have Equalizer compression rings.

C. Reinforced Concrete Pipe Alternate. The pipes will be jointed by a Series stainless steel or better collar or joint ring. The joint ring must fully comply with the hydrostatic requirements. The RCP shall conform with ASTM C 76 and C 361 and have a minimum compressive strength of 6000 psi. Pipe joints shall meet the requirements of ASTM C 443 and have plain ends, i.e. not tongue and groove or bell and spigot. The pipe shall not deviate from straight by more than 0.05 inches per linear foot when the maximum offset is measured from the concave side of the pipe. The joints between pipes will be protected by the installation of compression rings to distribute the jacking load evenly. A sheet type polyvinyl chloride liner plate (Amerplate. Ameron T-Lock or equal) shall be installed along the interior surface of the pipe for corrosion protection.

D. Glass Fiber Reinforced Thermosetting Resin Pipe (FRP) alternate. FRP pipe shall be centrifugally cast fiberglass reinforced vinyl ester resin manufactured in accordance with the requirements of ASTM D 3262 latest revision. Pipe shall not deviate from straight by more than 0.05 inches per linear foot. Reinforcing glass fiber shall be E-glass filaments with binder and sizing compatible with the resins. Sand shall be minimum 98% silica with a maximum moisture content of 0.2%

SUBMITTALS

A. Submit for review complete working drawings showing details of the proposed method of construction and the sequence of operations to be performed during construction. Show the method of microtunneling, including the microtunneling system to be used, location of working shafts, including method of excavation, shoring and bracing, and de-watering techniques that are proposed to be used. The following is not intended to limit, but to provide the minimum of, details which must be included:

1) Manufacturer's literature describing in detail the microtunneling system to be used. Detailed description of projects on which this system has been used, including the names, addresses and telephone numbers of owner's representative for these projects.

2) Method of muck disposal.

3) Method of controlling ground water.

4) Shaft dimensions, locations, surface construction, profile, depth, method of excavation, and shoring and bracing.

5) Literature describing the microtunneling pipe to be used on this project. The literature shall include allowable safe jacking loads with a safety factor of 2.5. A list of names, addresses and telephone numbers of contacts on successfully completed microtunneling projects shall be provided for verification.

B) The Engineer will base the review of submitted details and data with consideration of requirements for the completed work, utilities, and the possibility of unnecessary delays in the execution of the work to be constructed under this and subsequent contracts. Review and acceptance of the Contractor submittals by the Engineer shall not be construed in any way as relieving the Contractor of his responsibilities under this contract.

EXECUTION

A. Methods of construction for the shafts. jacking pits, or other components of the construction shall be such as to ensure the safety ofthe work, contractor's employees, the public and adjacent property, whether public or private. All damage to property shall be restored to equal or better condition than prior to construction.

B. All shafts and jacking pits shall conform with applicable City of Trench Safety Standards and OSHA excavation, trenching, andshoring standards which are contained in the Code of Federal Regulations 29 (CFR) 1926.650-1926.653.

C. Shafts and jacking pit shall be.adequately ventilated. Air monitoring pf the shafts or pits shall be conducted on a continuous basis. Threshold limits of the gas concentrations monitored shall be:

Carbon Monoxide
< 0.005 %

Methane
< 0.25 %

Hydrogen Sulfide
< 0.001 %

Oxygen
> 20.0 %

D. All work of excavating, shoring and bracing and tunneling shall be so executed that settlement is minimized.

E. Before beginning construction at any location, the contractor must adequately protect existing structures, Utilltles, trees, shrubs and other permanent objects. The repair of or compensation for damage to permanent facilities due negligence for lack of adequate protection on the part of the Contractor will be at no cost to the City.

F. The Contractor shall provide surface drainage assuring the period of construction to protect the work and to avoid nuisance to adjoining property and to assure that surface runoff does not enter the entrance or exit shafts. This is important to protect adjacent utilities as well as the microtunneling equipment.

G. The Contractor shall conduct his operations is such a fashion that trucks and other equipment do not create a dirt nuisance in the streets. The Contractor shall immediately remove and dispose of any spillage or excess dirt on the roadway.

H. Blasting will not be permitted. I. The tunnel machine operator shall be fully trained on other tunneling projects on the use of the machinery on this project.

J. The machine shall be operated so as to prevent either surface heave or loss of ground during tunneling and shall be steerable to maintain line and grade within the tolerances specified. This is achieved by continuously monitoring line, level inclination and steering attitude during the operation. When the earth pressure slurry balance system is used, the composition of the slurry must be carefully monitored for specific gravity and viscosity.

K. The thrust reaction backstop shall be properly designed and constructed. The backstop shall be normal to the proposed pipe alignment. The thrust wall shall be designed to support the maximum obtainable jacking pressure developed by the main jacking system. Special care shall be taken when setting the pipe guide rails in the starter shaft to ensure correctness of the alignment, grade, and stability. The shield is not to be jacked until the concrete thrust block (if selected) and the treated soil zone (if required) in the driving shaft have attained their required strength.

L. The pipe shall be jacked in place without damaging the pipe joints or completed pipe section. Any pipe which has been damaged during installation shall be replaced by the Contractor.

M. All excavated material from the tunnel and shaft construction shall be disposed of away from the construction site. No stockpiling of materials on the job-site will be permitted. Material shall be removed at regular intervals not exceeding 48 hours.

N. The Contractor shall monitor all ground movements associated with the work and maintain these within permissible tolerances. It is recommended that surface settlement and heave monitoring points may be located along the line of tile tunnel. If there is a concern of damage by settlement, these should be monitored after completion of the project. The Contractor, if required, shall install instrumentation, take readings, and provide the Engineer with copies, all in accordance with the specification.

O. While available geotechncial data will be supplied by the Owner, choice of cutting heads and resulting efficiency of the microtunneling operation will be the contractor's responsibility.

P. A written record of each drive is to be kept. This record shall include the jacking force and drive length of each individual drive. These records are to be made available to the Owner or his designated representative upon request.

Q. The jacking system shall develop a uniform distribution of jacking forces on the end of the pipe. If less than the full jacking surface of the pipe is used, the maximum allowable jacking forces shall be decreased by the proportional amount. The jacking force shall be applied perpendicular to the jacking surface of the pipe.

R. The maximum deviation from line and grade shall be one inch (1 "). When the excavation is offline or grade return to the plan line/grade at a rate of not more than one inch (1 ") per twenty five feet (25'). If the tunnel deviates sufficiently off plan line and/orgrade to require a redesign of the sewer or appurtenances, the Contractor shall have the system redesigned at no cost to the Owner.

S. The jacking force applied to the pipe shall at no time exceed that allowed by the pipe manufacturer with a Safety Factor of 2.5.

T. The contractor shall confine all phases of operation, including machinery and equipment to the allowable footprint defined above.

TESTING

After the completion of each line segment, before the jacking frame has been removed, each completed drive section shall either be low pressure air tested in accordance with ASTM C 828, latest revision or hydrostatically tested in accordance with ASTM C 1091, latest revision. In addition, all lines may be televised by closed circuit television and a copy of the video tape provided to the Engineer.

When reinforced concrete pipe is installed, the pipe shall be air tested after it is in its final position, but prior to any grouting, if any, and welding of the plate liner joint strip.

PAYMENT

All work necessary to complete the project, including but not limited to shafts, manholes, de-watering etc are considered subsidiary to the bid items. Payment will be made based on the bid items, " (line size) Microtunneling, complete and in place".

The recommendations in this draft specification should not be substituted for the judgement of a professional engineer as to the best way of achieving specific design requirements. Data presented are considered reliable, but no guarantee is made or liability assumed.

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