

**SECTION 810
SLIP LINING**

810-1 DESCRIPTION: This Work consists of the rehabilitation of existing sewer host pipe by the insertion of a liner pipe. The liner pipe will be inserted by a winch cable inserted through the host pipe and attached to the front of the liner pipe which is then pulled and pushed through the host pipe. The voids or annulus between the host pipe and liner pipe will be filled with grout.

810-2 MATERIALS: All slip liner pipe shall meet the following requirements:

- a. Pipe shall be constructed of corrosion resistant, thermoplastic or thermosetting resin. Pipe shall pass impact testing of 220 ft-lbs. All pipe shall have a smooth interior.
- b. Closure pieces shall be constructed of the same material, thickness, dimensions, and jointing system as the pipe.
- c. Slip Lining shall be performed using liner pipe with inside diameters as follows:

<u>Host Pipe (I.D.)</u>	<u>Slipliner Pipe (nominal I.D.)</u>
18"	15"
21"	18"
24"	21"
27"/30"	24"
36"	30"
42"	36"
48"	42"
54"	48"

- d. All products used shall be selected from the Qualified Products List (QPL) or approved equal.
- e. All slip line pipe shall be light in color.
- f. Closed Profile PVC Slip Liner:
 - 1. General: Pipe shall be manufactured to meet the requirements of ASTM F1803. Joints shall meet the requirements of ASTM D3212. Gaskets shall meet the requirements of ASTM F477.
 - 2. Materials: Pipe shall be manufactured of PVC compound having a minimum cell classification of 12364A as defined by ASTM D1784. Gaskets shall be made of polyisoprene (SBR) rubber.
 - 3. Manufacturing: Pipe shall have a minimum long term pipe stiffness of 46 psi when tested in accordance with ASTM D2412. The joint shall be of the tongue and groove coupling type so that neither the O.D. of the pipe is increased, nor the I.D. of the pipe decreased at the joint. Pipe shall have a nominal length of 20 feet, however, shorter lengths will be allowed where needed.
- g. Solid Wall PVC Slip Liner:
 - 1. General: Pipe shall be manufactured to meet the requirements of ASTM F679. Joints shall meet the requirements of ASTM D3212. Gaskets shall meet the requirements of ASTM F477.

2. Material: Pipe shall be manufactured of PVC compound having a minimum cell classification of 12164A as defined in ASTM D1784. Gaskets shall be an elastomeric material conforming to ASTM F477.
 3. Manufacturing: Pipe shall have a minimum long term pipe stiffness of 46 psi when tested in accordance with ASTM D2412. The joint shall be of the bell and spigot lap joint type so that neither the O.D. of the pipe is increased, nor the I.D. of the pipe decreased at the joint. Pipe shall have a nominal length of 20 feet, however, shorter lengths will be allowed where needed.
- h. Closed Profile HDPE Slip Liner:
1. General: Pipe shall be manufactured to meet the requirements of ASTM F894. Joints shall meet the requirements of ASTM D3212. Gaskets shall meet the requirements of ASTM F477.
 2. Materials: Pipe shall be manufactured of high density polyethylene compound having a minimum cell classification of 345434C as defined in ASTM D3350. Gaskets shall be made of polyisoprene (SBR) rubber.
 3. Manufacturing: Pipe shall have a minimum long term pipe stiffness of 46 psi when designed and tested in accordance with ASTM D2412. Tensile modulus of elasticity used in design of pipe shall be 28,250 psi. Construction of pipe wall shall be of the corewall type. Pipe shall have a smooth exterior and interior. The bell and spigot joint shall neither increase the O.D. of the pipe, nor decrease the I.D. of the liner pipe at the joint. Nominal lengths shall be 20 feet, however, shorter lengths will be allowed where needed.
- i. Solid Wall HDPE Slip Liner:
1. General: Pipe shall be manufactured to meet the requirements of ASTM F714. Fusing of pipe joints shall meet the requirements of ASTM D2657. Installation practices shall follow the standard practices as set forth in ASTM F585.
 2. Material: Pipe shall be manufactured of high density polyethylene compound having a minimum cell classification of 345434C as defined in ASTM D3350.
 3. Manufacturing: The Standard Dimension Ratio (SDR) is the ratio of the outside diameter (OD) of the pipe to its minimum wall thickness. Pipe shall have a minimum wall thickness of SDR 17.
 4. Joining: Fusion of joints shall be performed by a technician with a minimum of five years of experience. The roll over bead at the point of fusion shall be removed from the interior and exterior of pipe before inserting into the host pipe.
- j. Fiberglass Reinforced Polymer (FRP) Pipe:
1. General: Pipe shall be manufactured to meet the requirements of ASTM D3262 and AWWA M45. Joints shall meet the requirements of ASTM D4161. Gaskets shall meet the requirements of ASTM F477.
 2. Materials: Pipe shall be manufactured from fiberglass reinforcing materials, polyester resin and pure silica sand. The pipe shall conform to ASTM D3262 standards. Gaskets shall be of a rubber material conforming to ASTM F477.

3. Manufacturing: Pipe shall have a minimum long term pipe stiffness of 46 psi when tested in accordance with ASTM D2412. The joint shall be low-profile fiberglass bell and spigot type or flush fiberglass bell and spigot type, when the fit requires. Nominal lengths shall be 20 feet, however, shorter lengths will be allowed where needed.

k. Grout Materials and Mixes:

1. Neat Cement Grout (Cementitious): Neat cement grouts shall contain only cement, water, and possibly a flowability performance-enhancing additive such as flyash, silica fume, chemical dispersants, or thixotropic agents. The grout mixture shall not contain thickening aggregates, or sand, and shall be handled by high speed colloidal mixers or an approved ready mixer.
2. Cellular Grout (Cellular Concrete): Cellular grout shall contain the same materials as neat cement grouts, blended with pre-generated aqueous foam to form macroscopic non-interconnected air cells uniformly distributed throughout the grout. The "air cells" may account for up to 90% of the grout mix. Foam shall be added to the grout on-site by a licensed Foam Contractor.
 - i. Compressive Strength: The grout shall have a minimum compressive strength of 25 psi in 24 hours when tested in accordance with ASTM C403 and a minimum of 100 psi in 28 days when tested in accordance with ASTM C495 or C109. Grouts with compressive strengths from 200 psi to 1,000 psi will be acceptable provided.
 - ii. Density: The Contractor shall design a grout mix with a density that will not float the slip liner pipe while maintaining an apparent viscosity that does not to exceed 18 seconds as tested in accordance with ASTM C939. Density shall be verified by ASTM C138 or by other methods as approved by the Engineer.
 - iii. Performance Requirements: The Contractor shall establish proposed grout material and mixes, equipment, placement procedures, applicator, set-up, and criteria that the grouting operations shall meet. The grouting system shall have sufficient gauges, monitoring devices and tests to determine the effectiveness of the grouting operation. The Contractor must document compliance with the project and slip liner pipe specification design limits. The grouting operation shall be modified if the grouting does not perform as submitted and not approved by the Engineer.
 - iv. Mix Designs: Mixes shall be developed to completely fill the annular space between the host pipe and the slip liner pipe and shall meet the following requirements:
 - A. Accommodate the size of the annular void.
 - B. Accommodate the void size of the surrounding soil.
 - C. Accommodate the absence or presence of groundwater.
 - D. Provide the acceptable strength and durability.
 - E. Set-up or harden to prevent movement of the slip liner pipe.
 - F. Shrinkage shall not exceed 1% by volume.

810-3 SUBMITTALS:

- a. A Traffic Control Plan will be submitted to DPW. The plan shall include an outline of

the permit acquisition procedure for lane closure, methods for proper signing and barricades which complies with state requirements, local requirements and the MUTCD.

- b. The Contractor shall submit samples of sliplining pipe products to be used for certification. The Contractor shall also submit a copy of the manufacturer's product installation recommendations if any.
- c. The Contractor shall submit the following to the Engineer for review prior to the start of the grouting operation:
 - i. The proposed grouting mix and all performance data relative to this section such as, but not limited to: flow characteristics, viscosity, set time, bleed segregation, shrinkage and manufacturer.
 - ii. The proposed densities.
 - iii. The proposed grouting method.
 - iv. The maximum injection pressures.
 - v. Twenty-four hour and 28 day projected compressive strengths.
 - vi. Proposed grout stage volumes.
 - vii. Proposed bulkhead designs.
 - viii. Grout flow control.
 - ix. Buoyancy force calculations for the liner pipe.
 - x. Provisions for service connections and laterals.

These shall be submitted as a complete package for the grouting requirements and the Contractor shall notify the Engineer of any changes to be made at any time after approval is granted.

810-4 EQUIPMENT:

- a. Grouting Equipment: The materials shall be mixed in equipment of sufficient size and capacity to provide the desired amount of grout material for each stage in a single operation. The equipment shall be capable of mixing the grout at densities required for the approved procedure and shall also be capable of changing densities as dictated by field conditions any time during the grouting operation. Gauges shall be attached immediately adjacent to an injection port at the bulkhead; the gauge shall conform to an accuracy of no more than 2% error over the full range of the gauge operation.

810-5 CONSTRUCTION:

810-5.1 Preparations: The following preparation/steps shall be completed, unless approved otherwise by the Engineer. The Owner and Engineer make no guarantee regarding the information, data, and physical condition of underground facilities or the existing sanitary sewers. Before commencing with any work, or ordering any materials, the Contractor will be responsible for physically measuring and CCTV inspecting the existing sanitary sewers to verify that the rehabilitation specified herein will be appropriate. No claims will be considered for any work performed, downtime, material ordered or restocking of material ordered prior to the Contractor verifying that the existing sewer lines are coincident with the conditions listed in the Contract Documents. This physical inspection will be considered incidental to the Contractor's price for slip lining.

- a. Safety: The Contractor shall carry out his operations in strict accordance with all applicable OSHA Standards. Particular attention is directed to those safety requirements involving entry into a confined space. It shall be the Contractor's

responsibility to familiarize himself with OSHA Standards and Regulations pertaining to all aspects of the work.

- b. Pre-Lining Cleaning: It shall be the Contractor's responsibility to wash, clean and video the existing sewer pipe before lining as described in Sections 812 and 815, at a cost incidental to the insertion of liners. The Contractor will plan his work after review of CCTV inspection video and CCTV reports.
- c. Insertion and Pulling of Mandrel: It shall be the responsibility of the Contractor to pull a mandrel with a minimum length of one joint of pipe completely through each sewer line to be rehabilitated from manhole to manhole. The mandrel will be of the same outside diameter as the slip lining pipe. Any cost incurred in inserting and pulling the mandrel through the sewer line shall be incidental to the construction of the liner.
- d. Line Obstructions: If a pre-Installation inspection with a mandrel reveals an obstruction (such as heavy solids, dropped joints, or collapsed pipe) in the existing pipe that cannot be removed by sewer cleaning equipment as specified in Section 812, a point repair must be performed prior to slip lining as approved by the Engineer. All point repairs must be satisfactorily completed; equipment and material mobilized, and the Engineer shall be informed of the impending work schedules for liner installations. Point repairs, approved by the Engineer, shall be performed and paid in accordance with Sections 801 and 802.
- e. Bypass Pumping: If required, the Contractor shall provide for continuous bypass sewage flow around the section or sections of pipe designated for the liner process. The pump and bypass lines, shall have adequate capacity and size to handle the flow as per Section 813 (Sewer Flow Control). Any costs derived from this task shall be considered incidental and included in the cost of slip lining.

810-6 INSTALLATION:

- a. Removal and replacement of fences, damage to yards, lawns, streets, sidewalks, driveways, etc., due to installation and movement of the mandrel, cleaning, boiler, steam or other trucks and/or erection of equipment shall be incidental.
- b. If a point repair is deemed necessary at any point on the existing sewer line by the Engineer, the Contractor will be required to locate his insertion pit at the point repair location. Any additional pits the Contractor deems necessary for construction shall be at his cost.
- c. All sewer service connections shall be identified, located, excavated, and disconnected prior to the slip line pipe insertion. The complete list of service laterals, including relevant footage and diameter of lateral, shall be submitted to the Engineer, prior to slip lining, for informational purposes only. Upon completion of insertion of the slip line pipe and pipe relaxation period, the Contractor shall expedite the reconnection of services in accordance with Section 802-7, to minimize any inconvenience to the customers. All re-established services shall be smoke tested prior to backfilling.
- d. All coupon materials cut from the slip line pipe shall be retrieved at the next downstream manhole and submitted to the Engineer. The Contractor shall be responsible for any sewer flow control and sewer backups during slip lining operations. These issues shall be addressed as directed in Section 813 Sewer Flow Control.
- e. If the slip line pipe is HDPE, the installed pipe shall be allowed to relax and cool

following installation in accordance with manufacturer's recommended time, but not less than four (4) hours, prior to any reconnection of service lines, grouting of the annulus, or backfilling of the insertion pit. Sufficient excess length of new pipe, not less than four (4) inches or greater than six (6) inches, shall be allowed to protrude into the manhole to provide for further length reduction with the use of electrofusion flex restraints.

- f. Where a Contractor performs a "pull-through" through a manhole for two or more consecutive lines, he will be responsible for restoring the invert in the manhole. The Contractor will cut the slip line pipe even with the benches and grout the annular space between the existing manhole invert and the new pipe. In any case the maximum pull-through shall be two segment lengths maximum.
- g. Finishing inside the manhole shall be accomplished using a quick-set, non-shrink grout to raise the invert to the grade of the liner pipe.
- h. Prior to the introduction of grout and backfilling of re-established service connections, a dye water test will be performed on the liner pipe to test the bulkheads at each end for leaks. Grout shall be placed within 48 hours of slip lining. If grout access conduits are located within a street, they shall not be allowed to protrude from the pavement. As soon as the grout is placed the Contractor shall permanently restore the pavement. If any access conduits located in the street are to be exposed to traffic between the insertion of the liner pipe and placement of grout, the Contractor shall restore the street by placing temporary asphalt pavement over the conduit.
- i. The slip liner pipe shall serve as the inside form for the grout placement. Bulkheads, where required, shall completely fill the annular space, and be of a material compatible with the type of grout and constructed to withstand the loads imposed by the grout during placement, curing and the pressure of groundwater without leakage. Bulkheads shall have appropriate venting to dewater the annular space, while sealing the space from sewer flow, thereby permitting the grout to set. The bulkheads shall be constructed to allow the air to escape as grout is introduced. Air vent pipe locations shall be determined by pipeline conditions. The vent pipes may also be used to monitor the grout level.
- j. Placement of grout shall be by means of one or a combination of the following:
 - 1. preset threaded grout access outlets in the slip liner pipe wall
 - 2. a set of top-side grout access ports through the crown of the existing host pipe
 - 3. injection through access ports in the bulkheads

Where placement of grout is via an access port in the slip liner pipe wall, adequate air circulation shall be maintained to ensure safe working conditions and heat dissipation due to cement hydration. The access port shall also provide for a water source to make emergency clean-ups. In constricted or small annular spaces, the installation of an air vent of 2 in. diameter PVC pipes shall be required to prevent air from creating large voids in the fill. The Contractor shall inject the theoretical volume of grout to fill the annular space and allow verification by the Engineer to determine if additional grout is needed. The Contractor shall inject additional grout as directed by the Engineer.

- k. When the weight of the volume of grout displaced by the slip liner pipe is greater than the weight of the slip liner pipe, a net buoyancy force will exist and cause the liner pipe to float. The acceptable methods to negate the buoyancy potential are as follows:

- i. Use a grout that weighs less than the weight of the pipe divided by the displaced volume of the pipe.
- ii. Increase the weight of the pipe by filling with water or other material and reduce the weight of the grout.
- iii. Use annular bridging such as casing spacers or blocking to hold the liner pipe in the required position.
- iv. Place the grout in stages or "lifts" with detailed methodology to determine when a stage is completed.

Prior to grouting the Contractor shall submit to the Engineer a detailed plan that will anchor the liner in the invert for a period of time long enough to allow the grout to set where buoyancy factors exist.

- l. The gauged pumping pressure shall not exceed 5 psi, which provides a 4:1 factor of safety against buckling the slip liner pipe. Pressure gauges shall indicate in 1-2 psi graduations, and be located in the grout transport line or very near the point of injection. Pumping equipment shall have sufficient capability to inject grout at velocities and pressure relative to the size of the annulus. Calculations must be made to determine if gravity flow will exert sufficient pressure to complete the required grouting operation.
- m. The Contractor shall, every half hour, check and record the grout density at or close to the discharge point. These records, combined with records of cement and other materials delivered to the job site, as well as the volume of water used shall be submitted to the Engineer to confirm the volume of grout placed.

810-7 TESTING:

- a. Testing shall be performed by a low pressure air test as specified in Section 802.
- b. The Contractor and the Engineer shall inspect each installation visually by CCTV. Variations from true line and grade may be inherent because of the conditions of the original piping. No infiltration of groundwater should be observed. All service entrances should be accounted for and be fully functional unless otherwise directed by the Engineer in writing. The pre- and post-installation documentation in DVD format will become the property of the Owner.

810-8 MEASUREMENT:

- a. **Sewer Pipe Slip Lining:** Measurement for installed pipe slip lining shall be on a linear foot basis, to the nearest whole foot, measured from center of manhole to center of manhole, for the slip liner pipe sizes listed under this item in the Contract Documents.
- b. **Grout:** Grout shall be estimated and placed by the cubic foot as required.

810-9 PAY ITEMS:

- a. **Sewer Pipe Slip Lining:** Payment for this Item will be full compensation for slip line pipe, fittings, insertion pits, bulkheads, pipe cleaning, CCTV inspection, plugging, bypass pumping, traffic control, sealing at manholes, locating, excavating, disconnecting, and backfilling service lateral connections, and testing, in accordance with the Contract Document; and all else incidental thereto for which separate payment is not provided under other Items in the Bid Form. Re-establishment and

grouting of service lateral connections required for slip lining will be paid for under the relative pay item in Section 802.

- b. **Grout:** Payment for this Item will be full compensation for all equipment, labor, materials required to grout the annular space between the liner pipe and the host pipe, and all else incidental thereto for which separate payment is not provided under other items in the Bid Form.

810-10 PAY ITEMS:

Pipe Inner Diameter (I.D.) Schedule
(as Shown on Drawings)

A = 4" Pipe	N = 27" Pipe
B = 6" Pipe	O = 30" Pipe
C = 8" Pipe	P = 32" Pipe
D = 10" Pipe	Q = 36" Pipe
E = 12" Pipe	R = 42" Pipe
F = 14" Pipe	S = 48" Pipe
G = 15" Pipe	T = 54" Pipe
H = 16" Pipe	U = 60" Pipe
I = 18" Pipe	V = 64" Pipe
J = 20" Pipe	W = 66" Pipe
K = 21" Pipe	X = 72" Pipe
L = 24" Pipe	Y = 76" Pipe
M = 26" Pipe	Z = 80" Pipe

Note: Pipe sizes less than 15" in diameter will not be allowed for slip lining.

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
810100_	__" Sewer Pipe Slip Lining	Linear Foot
8103000	Grout	Cubic Foot