

San Antonio Water System Standard Specifications for Construction

**ITEM NO. 1101
Slip-Lining Grout**

1101.1 DESCRIPTION: This item shall consist of slip-lining grout which is accomplished by placing grout in the annular space between the slip-lining pipe and the host sewer. Completely fill the annular space without deflecting the pipe.

1101.2 SUBMITTALS: Contractor shall submit manufacturer’s product data, instructions, recommendations, shop drawings, and certifications.

1101.3 MATERIALS:

1. Manufactures/Application: The applicator of the grout mix shall be certified by the grout mix manufacturer and approved by the Engineer. The certified applicator shall be regularly engaged in the placement of grout, including completion of pipeline grouting installations having at least 1,000 cubic yards in the past 3 years.

2. Materials:

- a. Cement: Comply with ASTM C150/C150M-12. Pozzolans and other cementitious materials are permitted.
- b. Fly Ash: Comply with ASTM C618-12a; either Type C or Type F shall be used.
- c. Sand (if provided): comply with ASTM C144-11, except as modified below:

U.S. Standard Sieve Size	Percent Passing By Weight
No. 16	100
No. 30	60 – 85
No. 50	10 – 35
No. 100	5 – 25
No. 200	- 10

- d. Water: Use potable water free from deleterious amounts of alkali, acid, and organic materials which would adversely affect the setting time or strength of the slip-lining grout.

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- e. Admixtures: Admixtures shall be selected by the slip-lining grout manufacturer to meet performance requirements, improve pumpability, control set time and reduce segregation.
 - (1) Compressive Strength: The grout shall have a minimum penetration resistance of 100 psi in 24 hours, when tested in accordance with ASTM C403/C403M-08 and a minimum compressive strength of 300 psi in 28 days when tested in accordance of ASTM C495/C495M12 or C109/C109M-12.
 - (2) Performance Requirements: The Contractor shall submit the proposed grout mixes, methods, plans and criteria of the grouting operations. The grouting system shall have sufficient gauges, monitoring devices, and test to determine the effectiveness of the grouting operation and to ensure compliance with the liner pipe specifications and design parameters.
 - (3) Mix Designs: One or more mixes shall be developed to completely fill the annular space based upon, but not restricted to, the following requirements:
 - (a) Size of annular void;
 - (b) Void (size) of the surround soil;
 - (c) Absence or presence of groundwater;
 - (d) Sufficient strength and durability to prevent movement of the liner pipe;
 - (e) Provide adequate retardation;
 - (f) Provide less than 1 percent shrinkage by volume.
 - (4) Density/Viscosity - The Contractor shall design a grout mix with a density to prevent floating of the liner pipe. The apparent viscosity shall not exceed 20 seconds in accordance with ASTM C939-10, unless otherwise approved by the Engineer.

1101.4 CONSTRUCTION:

- 1. The grout mix designed and method of installation shall be approved by the Engineer prior to beginning operation. Shop drawings and product data shall include, but not be limited to, the following:

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- a. Detailed descriptions of equipment and operational procedures to accomplish the annular grouting operation, including mixing and pumping schedule, grouting pressures, rates of pumping, and methods for monitoring the effectiveness of the grouting;
 - b. Detailed descriptions and drawings indicating proposed locations, of surface mixing equipment, subsurface injection points, flowlines, waste grout recovery, grout pressure limiting equipment, bulkheads, and venting system. Show details of bulkhead design;
 - c. Qualifications and experience of grout mix applicator;
 - d. Grout mix design and trial mix tests, with set time, compressive strength, viscosity, and density test results;
 - e. Initial set time of the grout;
 - f. The 24 hour and 28 day minimum grout compressive strengths;
 - g. The grout working time, before a 15% change in density or viscosity occurs;
 - h. The proposed grouting method and resume of successful uses on previous projects;
 - i. The maximum injection pressures;
 - j. Proposed grout stage volumes;
 - k. Bulkhead designs;
 - l. Buoyant force calculations during grouting;
 - m. Flow control;
 - n. Provisions for service connections;
 - o. Pressure gauge and recorder certifications;
 - p. Vent location plans;
 - q. Written concurrence that the Contractor had coordinated this work with the grout installer and the liner pipe manufacturer;
 - r. For each different type of grout, or variations on procedure of installation, a complete package shall be submitted. The submittal shall include each of the above items and the sewer locations of conditions to which it applies. The Contractor shall notify the Engineer of any changes to be made in grout, mix, grouting procedures or installation.
2. Preparation:
- a. Notify the Inspector at least 24 hours in advance of grouting operations.
 - b. Select and operate grouting equipment and carry out procedures with sufficient safety and care to avoid damage to existing underground utilities and structures.
3. Equipment:

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- a. Mixers and Pumps:
 - (1) 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.
 - (2) The system shall mix the grout to a homogeneous consistency.
 - (3) Deliver grout to the injection point at a steady pressure with a nonpulsating centrifugal or triplex pump at the mix tank.
 - (4) Provide ways to increase or decrease the water-cement ratio and accurately measure grout component quantities, pumping pressures, and volumes pumped.
- b. Pressure Gauges:
 - (1) Pressure gauges shall be equipped with diaphragm seals, have a working range between 1.5 to 2.0 times the design grout pressure, and have an accuracy within 0.5% of full range.
 - (2) Provide one pressure gauge at the point of injection and one pressure gauge at the grout pump.
 - (3) Grouting shall not proceed without appropriate gauges in place and in working order.
 - (4) Grout pressure gauge and recorder shall be installed immediately adjacent to each injection port. During grouting operations, the recorder shall continuously record the actual grouting pressure versus time on paper with ink. The gauge shall conform to an accuracy of ± 0.5 psi. The range of the gauge should not be more than 100 percent greater than the design grout pressure. Pressure gauges shall be instrument oil filled and attached to a saddle-type diaphragm seal (gauge saver) to prevent clogging with grout. All gauges shall be certified and calibrated in accordance with ANSI/ASME B40.100-2005, Grade 2A.
 - (5) The grout pressure recordings shall be identified as a minimum, with date, batch, and time of day grouting was performed and shall be submitted to the Inspector at the end of the work day that grouting was performed.
- c. Procedure:
 - (1) Place grout for a given pipeline segment between bulkheads. Place bulkheads at the ends of each pipeline segment to seal the annular space from sewer flow. Do not remove bulkheads until after grout has set.

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- (2) Equip slipliner pipes with weirs to fill the pipes with water to prevent flotation during grouting operations.
- (3) Remove or control standing or running water in annular spaces to maintain the correct water ratio of the grout mixture. Grout the annular space by injecting grout from one end of the pipeline segment, allowing it to flow toward the other end. Vent the annular space to assure uniform filling of the void space.
- (4) Limit pressure on the annular space to prevent damage to the liner; do not exceed 5 psi. Regardless of the pressure, Contractor shall be solely responsible for any damage or distortion to slipliner pipe due to grouting. At the bulkhead opposite to the point of grouting, provide and monitor an open-ended high point tap or equivalent vent.
- (5) Pump grout until grout within 0.3 pounds per gallon of specified grout injection density discharges from the end opposite the injection point. This procedure is intended to ensure that the grout is not diluted by extraneous water in the annulus.
- (6) The drilling of additional injection holes from the surface to facilitate grouting may be allowed, if approved by the Engineer.
- (7) Upon completion of slip-lining, but prior to grouting, bulkheading of the ends and appropriate venting shall be required. This is to seal the annular space from sewer flow to permit the grout to set and withstand the loads imposed by the grout and groundwater. The Contractor shall test the integrity of the installed liner pipe and constructed bulkheads for any leaks by performing the following:
 - (a) Dewater and inject dye water into the annular space (this will not be permitted if the crown or any portion of the host pipe is severely deteriorated to the point where water may escape through the host pipe).
 - (b) Pressurize the annular space to the maximum permissible grouting pressure per manufacturer's recommendation with approval of the Engineer.
 - (c) The Contractor shall submit a detailed plan to the Engineer that shows how the liner pipe will be held on the invert for a period of time long enough to allow the grout to set when buoyant uplift is a factor.

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- d. Pumping:
 - (1) Design grout mix to be pumped through a 2 inch-diameter hose for a distance of 1,000 feet, with a maximum allowable pressure at point of placement of 5 psi. The cast density shall be 55 pcf, plus or minus 5 pcf. Minimum penetration resistance after 24 hours shall be 100 psi, in accordance with ASTM C403/C403M-08. The minimum compressive strength at 28 days shall be 300 psi in accordance with ASTM C495/C495M-12. Grout mix shall have less than 1% shrinkage by volume.
 - (2) The application system shall have sufficient gages, monitoring devices and tests to determine the efficiency and effectiveness of the grouting work and to provide a means of accurately determining the amount of grout injected. Contractor shall be prepared to modify the operation should grouting not perform as proposed. Such modifications and changes shall be done in a timely manner to avoid unnecessary delay in completion of the Project.
 - (3) No deleterious amounts of toxic or other poisonous substances shall be included in the grout mix nor otherwise injected underground.
- 4. Final Cleanup: No hardened grout is permitted in the slipliner pipe invert after completion of grouting operations.
- 5. Dewatering System Operation: Operate dewatering systems until the grouting of slipliner pipe is complete.
- 6. Testing: Test grout equipment and procedures in accordance with approved submittals.
 - a. Perform testing on the first pipeline segment to be grouted. Testing must be performed under observation by the Inspector. If the grout does not totally fill the annular space, adjust the procedure or the mix, and rerun the test on the first pipeline segment.
 - b. Density/Viscosity: During placement of grout, measure density in accordance with ASTM C138/C138M-12a and C939-10, at least twice per hour. Adjust the mix as required to obtain the specified cast density.
 - c. Sampling:
 - (1) Take 4 test specimens for each 100 cubic yards of grout, or for each 4 hours of placing.
 - (2) Test in accordance with ASTM C495/C495M-12 except:

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- (a) Specimens shall be 3 inch by 6 inch cylinders covered after casting to prevent damage and loss of moisture. Moist-cure specimens for at least the first 7 days; perform at least one compressive strength test of each set of samples at 28 days.
- (b) Do not oven-dry specimens to be tested. Specimens may be tested at any age to monitor compressive strength. The material may require special handling and testing techniques.
- (c) The Contractor shall be required to perform a test on each type of grout and grout system proposed to be used. The test section to be grouted, and the size of the annular space considered for each type of grout system, shall be determined by the Inspector.
- (d) The Contractor shall engage the services of an approved, nationally accredited, independent testing laboratory to certify that the proposed materials and methods comply with these requirements.

1101.5 MEASUREMENT AND PAYMENT:

- 1. Unit Prices: No separate payment will be made for work performed under this section. Include the cost of such work in contract unit prices for slip-lining sanitary sewers.
- 2. Stipulated Price (Lump Sum): If the Contract is a Stipulated Price Contract, payment for work in this section is included in the total Stipulated Price.

No direct payment shall be made for incidental cost associated with the quality control testing of the grout, and all costs in connection therewith shall be included in the applicable contract price for the item to which the work pertains.

Any retesting costs attributed to substandard results shall be at the contractor's sole expense.

- End of Specification -