**SECTION 0000**

**GROUTING AND SEALING OF**

**SANITARY MANHOLES AND OTHER STUCTURES**

**PART 1 - GENERAL**

1.01 SUMMARY

A. Sealing Work - The intent of this section is the elimination of all infiltration/inflows (I&I) into manholes or other structures that are otherwise structurally sound, or those manholes and structures that are not structurally sound but require sealing before rehabilitation may commence, using various products and methods either singularly or in combination. The Contractor shall be responsible for sealing all visible leaks and/or areas with evidence of leaks (deposits or staining) in the listed manholes or structures for this project. The Contractor shall verify the condition of manholes or structures before bidding. This document may be utilized for the following applications:

1. Sealing of precast manhole barrel joints, when general structure sealing is not required,

2. Sealing of pipe intrusions only when general structure sealing is not required,

3. Sealing in total of riser sections, cones, corbels, benches, bases, pipe intrusions, and/or other sections of pre-cast concrete, cast-in-place concrete, brick and mortar, block, or other manhole types,

4. Sealing of other structures including but not limited to wet wells, lift stations, and other pre-cast concrete, cast-in-place concrete, brick and mortar, or other structure types as specified by the Engineer, and

5. “Pre-sealing” leaking manholes or structures as a preparatory step for those structures requiring structural rehabilitation (liners and/or coatings) also due to damage, corrosion, etc.

1. Contractor Obligations - The Contractor shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to perform manhole or structural sealing via the chemical grout injection method.

1.02 SCOPE OF WORK

A. Pre-Cleaning and Inspection – The Contractor shall clean the manholes or structures thoroughly before commencement of the grouting process. Root masses, debris, and other attached deposits as specified or interfering with the grouting process, or any other matter not herein defined, shall be removed from the structure. A complete inspection of each structure shall be included in this process to document the condition of structure after cleaning but prior to grouting.

B. Bypass Pumping and/or Dewatering – Contractor shall provide such piping, pumping, connections, fittings, and other appurtenances as necessary to bypass flows (if any). There shall be no disruption of flow to the existing lines caused by the installation of this bypass, nor shall any sewage spills or overages be caused as a result of this action. The Contractor shall also remove standing water in the manhole as the result of a sewer surcharge or other overflow prior to beginning grouting procedures.

C. Post Installation Inspection and Documentation – After the preparation and grouting of the structure(s), the Contractor shall perform a thorough inspection to document the condition of the rehabilitated structures.

D. Traffic Control – The Contractor shall be solely responsible for all signage, flagging, cones, personnel and any other item or personnel required for traffic control.

E. Safety - The Contractor shall be trained in appropriate and satisfactory safety methods regarding the grouts used under this contract. These methods shall include handling, mixing, and transporting of chemical grouts.

1.03 RELATED SECTIONS **TO BE DETERMINED BY ENGINEER/OWNER (OR REMOVE)**

1.04 REFERENCE STANDARDS

1. American Society For Testing And Materials (ASTM):
2. ASTM F2304 (latest version) Standard Practice For Rehabilitation Of Sewers Using Chemical Grouting
3. ASTM F2414 (latest version) Standard Practice for Sealing Manholes Using Chemical Grouting.
4. National Association Of Sewer Service Companies (NASSCO)
5. National Association Of Sewer Service Companies (NASSCO) Manhole Assessment And Certification Program (MACP), form for inspection of manholes and structures,
6. NATIONAL ASSOCIATION OF SEWER SERVICE COMPANIES (NASSCO) Infiltration Control Grouting Association (ICGA) <http://www.sewergrouting.com>.

1.05 QUALIFICATIONS **TO BE DETERMINED BY ENGINEER/OWNER**

1.06 SUBMITTALS

A. Equipment and Procedures – The Contractor shall provide a complete list of equipment operating procedures and systems for the project.

1. Materials – The Contractor shall provide complete information concerning the chemical grout material(s) to be used, including the following:

1. Description of chemical grout materials to be used per sections 2.04 & 2.05; and

2. MSDS sheets for all materials to be used.

1. Reports - The Contractor shall submit to the Engineer a report showing the following data for each structure grouted or attempted to be grouted:
2. Identification of the structure,
3. Type of material, diameter and depth of pipe intrusions (if any) to the surface at manholes,
4. Type of material, diameter, and depth of the structure to the surface of the structure,
5. Volume of grout material used on each structure and/or pipe intrusion,
6. Gel set time used (cup test results from tanks), and
7. Grout mix record of the batches mixed including amount of grout and catalyst, additives and temperature of the grout solution in tanks.
8. Safety Plan –The Contractor shall provide a confined space entry plan and identify designated safety supervisory personnel to the Engineer. The plan shall include confined space entry training certification of each employee assigned to the project.
9. Bypass Plan – When requested by the Engineer, the Contractor shall provide and otherwise develop a plan for bypass pumping (if needed). The pump and bypass lines shall be of adequate capacity and size to handle the anticipated flow. This plan shall be approved by the Engineer or Owner before work begins on the section(s) requiring bypass.

1.07 QUALITY ASSURANCE **TO BE DETERMINED BY ENGINEER**

**PART 2 – PRODUCTS AND EQUIPMENT**

2.01 GROUTING EQUIPMENT

1. Equipment - Grouting equipment shall consist of appropriate pumping and hosing systems capable of supplying an uninterrupted flow of sealing materials to completely fill the voids. Grout pumping systems shall be sized to deliver a mixed volume of grout at a minimum of three gallons per minute (3 GPM) and thirty (30) gallons of uninterrupted flow within ten (10) minutes.
2. Volumes Recorded - The volume of mixed grout pumped must be measured and recorded for each grouted structure, pipe intrusion, etc.

2.02 GROUT(S) GENERAL REQUIREMENTS

1. Handling - Grouting materials shall be handled, mixed, and stored by the Contractor in accordance with the Manufacturers’ recommendations. The grouting materials shall be delivered to the site in unopened original Manufacturers’ containers.
2. Grout Specified - The Engineer shall specifically define the type of chemical grout that will be furnished for the project. Depending on the specific application either Acrylic or Acrylate-based grout or Urethane-based grout shall be furnished. The type of grout to be used shall be in accordance with the Manufacturer’s recommendation for the specific application area of the project.
3. Delivery and Storage - Contractor shall deliver materials to the job site in undamaged, unopened containers bearing Manufacturer's original labels. Materials used as chemical grout shall be transported, stored, mixed and applied in manner prescribed by the Manufacturer of the specified materials, as detailed in published data provided by Manufacturer.
	1. GROUT(S) CHARACTERISTICS
4. Component Parts - Contractor shall provide a chemical sealant solution containing principal chemical sealant constituent, initiator (trigger) and catalyst specifically recommended for the purpose of sealing leaks in manholes or structures. Chemical sealant constituent, initiator (trigger) and catalyst shall be compatible when mixed. Solution shall have the ability to tolerate dilution and react in moving water. After final reaction, it shall be a stiff, impermeable, yet flexible gel. The grout proportions shall be such that dilute aqueous solutions, and when properly catalyzed will form stiff gels.
5. Gel Time - Materials shall provide a gel in a predetermined time period when exposed to normal groundwater pH ranges, and be capable of formula adjustments to compensate for changing conditions. Final reaction shall produce a continuous, irreversible, impermeable stiff gel and shall not be rigid or brittle.
6. Properties - The grout shall exhibit the following properties:

	1. Controllable reaction times and shrinkage through the use of chemicals supplied by the same Manufacturer,
	2. The minimum set time shall be established so that adequate grout travel is achieved,
	3. Resistance to chemicals, to most organic solvents, mild acids and alkali, and
	4. The grout shall be non-toxic in its cured form.
7. References - The Contractor shall identify the type of grout and additives used on the contract and furnish references of successful use in similar applications. The Contractor shall select the choice of materials based on chemical and physical properties and expected performance for the requirements of the contract documents.
8. Adjustments - Grout conditions may be adjusted for catalyzing the reaction, inhibiting the reaction, lowering the freezing temperature of the grout solution, adding fillers, providing strength or for inhibiting root growth according to the instructions of the grout Manufacturer and in the specified quantities as recommended by the grout Manufacturer.

2.04 MIXING & HANDLING

1. Safe Handling - Mixing and handling of chemical grout, which may be toxic under certain conditions, shall be done in such a manner as to minimize any hazard to personnel and shall be in accordance with the Manufacturer’s recommendations. It is the responsibility of the Contractor to provide appropriate protective measures to ensure that chemicals are handled only by trained and authorized personnel. All equipment used to install the grout shall be as recommended by the Manufacturer and only personnel thoroughly familiar with all aspects of the grouting material and meeting the qualification requirements specified herein, shall perform the actual grouting operation.
2. Products Used - Unless otherwise specified by the Engineer, acrylic or acrylate- based grouts shall be utilized and have the following characteristics:
	1. A minimum of ten percent (10%) acrylamide base material by weight in the total grout mix. A higher concentration of acrylamide base material is recommended to increase strength or offset dilution during injection, and
	2. Approved Product(s) and Manufacturer(s) shall be:
	3. Avanti AV-100;
	4. Avanti AV-118; or
	5. Approved equal(s).

2.05 ADDITIVES

1. Field Adjustments - At the Contractors discretion according to field conditions, additives may be selected and used within the Manufacturers’ recommended quantities.
2. Strengthening - Strengthening agents may be added at the Contractor’s discretion according to field conditions or when specified by the Engineer, including:

	1. A latex or diatomaceous earth additive may be added to increase compressive and tensile strength, and
	2. The quantity of strengthening agent additive shall be as recommended by the Manufacturer and approved by the Engineer.
3. Product Manufacturer(s):
4. Avanti AV-257 Icoset;
5. Approved equal(s).
6. Root Inhibitor – An approved root inhibitor chemical shall be used as per the following:
7. When roots are present a root deterrent chemical shall be added to control root re-growth. The quantity of inhibitor shall be as recommended by the Manufacturer and approved by the Engineer.
8. Product Manufacturer(s) – Approved products shall include the following:
9. Avanti AC-50W; or
10. Approved equal(s).

F. Dye – Dye may be added under the following conditions:

1. A Manufacturer approved water soluble dye without trace metals may be added to the grout tank(s) for visual confirmation.

G. Gel Time Modifier – Agents may be added to the grout mix as follows:

1. A gel time extending agent may be used in accordance with the Manufacturer(s)’ recommendations to extend gel time as necessary.
2. Mechanical Mixing - When using non-soluble additives the grout tanks shall have mechanical mixing devices to keep the additives in suspension and maintain a uniform solution of grout and additive.

**PART 3 – EXECUTION**

3.01 CONTROL TESTS

1. Pump Tests - At the beginning of the contract, in the presence of the Engineer, and prior to application of grout, the Contractor shall perform a pump test. This test shall determine if proper ratios are being pumped from the grout component tanks at the proper rates and shall also measure pump rates. The Contractor shall use separate containers to capture the discharges from each of the grout component hoses to simulate the actual volumes of each component through the interconnect hoses, hose reel and length of grout hose, and to confirm accuracy of the grout pump totalizer. The Contractor shall take corrective action if ratios or rates are not within the Manufacturers’ recommended standards.
2. Grout Tests – The Contractor shall perform and record a grout gel test. This test shall include the recording of the grout tank solution temperature, catalyst tank solution temperature, ambient air temperature in truck, and gel time of the sample. The test shall be performed whenever the following conditions occur:
3. At the beginning of each day. The material in the hoses shall be recycled to the tanks and a sample shall be taken;
4. Whenever new batches of grout are mixed; and
5. Whenever the temperature in the tanks or ambient temperature have changed by more than plus or minus ten degrees Fahrenheit (+/- 10°F) from the previous gel test.

3.02 STRUCTURE PREPARATION

1. Dewatering Structures - Prior to the application of the chemical grouting materials, the Contractor shall dewater or drain the structure via means of a pumping or other system as indicated and necessary to provide a suitable environment for the application of the grouting material.
2. Bypass - Prior to the application of the chemical grouting materials, the Contractor shall set up a sewer bypass (if necessary and after consultation with the Engineer or Owner) to prevent flows from entering the structure during grouting operations.
3. Cleaning Structures - Prior to the application of the chemical grouting materials, the Contractor shall remove all loose debris and solids, root intrusions, mineral or other deposits, and any other matter which inhibits proper application of the grouting material.
4. Activated Oakum - Activated oakum may be used as needed to fill the void(s) (if any) between pre-cast sections of pipe within the inside face of the joint and form a fiber-reinforced primary seal. When using this technique as a prerequisite containment seal for chemical grout injection, Contractor shall attempt to keep the oakum seal in the first two inches (2”) of the joint(s) inside face. This will serve to contain the chemical grout resin during the injection process. During expansion the activated oakum can be worked by hand to be flush with the inside face of the pipe or can be ground flush after curing is complete. Steps in this process include:
5. Oakum rope material is unwound and cut into manageable lengths, three to four feet (3’ to 4’), and placed in a clean, dry, empty pail. The strands shall be untwisted so that the resin can easily absorb into the oakum. Also, the oakum shall be kept dry until it is soaked in the resin to avoid the oakum’s absorption of resin being diminished. A cardboard box of oakum shall not be left on a wet surface,
6. Hydrophilic chemical grout resin shall be poured into the pail to completely cover the oakum pieces. The Contractor shall dunk, prod, or squeeze the oakum in the resin to encourage full saturation,
7. Once the oakum is thoroughly saturated, the Contractor shall remove one piece at a time, pulling the strand through their gloved thumb and index finger to strip off excess resin,
8. Contractor shall dip the resin-soaked oakum into water and agitate briefly, five to ten (5-10) seconds, to activate the chemical grout resin,
9. As an alternate step, if more time is needed to place the oakum before it is activated, e.g. in a hard to reach place or when covering a large area, the Contractor shall wet the surface to be treated with a pressure sprayer of water, place the resin-soaked oakum, then thoroughly wet the oakum with the water-filled pressure sprayer to activate the resin. If applying multiple layers or an extremely thick layer, the Contractor shall wet each layer as applied to ensure good reaction of the grout,
10. The Contractor shall remove the activated oakum rope and fold or twist to a size appropriate for filling the gap in the joint. For tight joints or cracks it may be necessary to further separate the strands to a size that can be inserted with a screwdriver blade or utility knife. Contractor shall begin filling the joints at the lowest point and work its way up taking care to overlap each segment four to six inches (4”-6”) so that no gaps are left in the joint, and
11. As the chemical grout expands, the Contractor shall continue to work the activated oakum into the joint by hand to achieve a flush profile with the face of the joint.

3.03 CONDITIONS AND APPLICATIONS

1. Structural Integrity - Grouting should only be performed on a structurally sound manhole or structure unless the grouting material is used to prevent water from entering the manhole or structure during application of a lining or coating system. All structural repairs, adjustments to the frame and cover, and installation of grade rings shall be completed prior to beginning the grouting operation.
2. Working Temperatures - Normal grouting operations shall be performed at the temperatures as recommended by the Manufacturer.
3. Applications - Grouting applications may include sealing a manhole or structure from infiltration/Inflow prior to application of a coating or lining or other structural rehabilitation component or using the grout for sealing the entire manhole or structure. If the entire manhole or structure is to be sealed, grouting shall include corbel, wall, pipe seals, bench and invert as recommended by the Manufacturer of the grouting material.

3.04 EQUIPMENT

1. Basic Equipment - The basic equipment shall consist of chemical pumps, chemical containers, mixers, injection nozzles, hoses, valves, and all necessary equipment and tools required to seal manholes. The chemical injection pumps shall be equipped with pressure meters that will provide for monitoring pressure during the injection of the chemical sealants. When necessary, liquid bypass lines equipped with pressure-regulating bypass valves shall be incorporated into the pumping equipment.

3.05 GROUT PREPARATION AND ADJUSTMENTS

1. Preparation - The Contractor shall follow the Manufacturers’ recommendations for mixing and safety procedures.
2. Temperature Changes - Gel time shall be adjusted as necessary to compensate for changes in temperature in grout component tanks or hoses. The addition of dilution water to extend gel times is not acceptable unless the resulting base material exceeds ten percent (10%) by weight for solution grouts.
3. Other Adjustments - Gel times shall be within the Contractor’s experience and/or as field conditions dictate otherwise.

3.06 SEALING PROCEDURES

1. Injection Procedures - Grout shall be injected through the drilled holes using the recommended probe and applying pressures that will effectively inject the grout but, not cause damage to the manhole structure or the surrounding area. Grout typically shall be injected through the lowest holes first, working the grout higher until the manhole is externally sealed with grout.
2. Injection Holes - Drilling grout injection holes in the manhole in strategic locations to re-direct flow coming through cracks and other defects in the wall, or to seal the entire exterior surface of the manhole, shall be in accordance with the recommendations of the grout Manufacturer.
3. Sealing Leaks - At all visible leaks and areas with evidence of leaks within the manhole or structure, a hole shall be carefully drilled from within the manhole or structure and shall extend through the entire manhole wall. In cases where there are multiple leaks around the circumference of the manhole, fewer holes may be drilled, providing all leakage is stopped from these holes. Grout ports or sealant injection devices shall be placed in these previously drilled holes in such a way as to provide a watertight seal between the holes and the injection device. A hose, or hoses, shall be attached to the injection device from an injection pump. Chemical sealing materials, as specified, shall then be pumped through the hose until material refusal is recorded on the pressure gage mounted on the pumping unit or a predetermined quantity of sealant has been injected. Care shall be taken during the pumping operation to ensure that excessive pressures do not develop and cause damage to the manhole or structure.
4. Patching - Upon completion of the injection, the ports shall be removed and the remaining holes filled with quick-setting hydraulic mortar and troweled flush with the surface of the manhole walls or other surfaces. The mortar used shall be a non-shrink patching mortar approved by the Engineer.
5. Inspection - Visual inspection shall be completed after grouting to confirm that all leakage into the manhole has been eliminated.

3.07 DISPOSAL

1. Clean Up and Disposal - The Contractor shall collect and properly dispose of cleaning materials, storage bags, and other materials used in the cleaning of the grouting equipment and application of the grouting material.

3.08 FINAL ACCEPTANCE

1. Inspection - After the specified sealing work has been completed, the manholes or structures shall be visually inspected by the Contractor (as required) in the presence of the Owner/Engineer and found to be acceptable
2. Re-Inspection – When specified by the Engineer, all rehabilitated manholes or structures shall also be re-inspected for leaks two months after completion and resealed, if necessary, at no cost to the Owner.

**PART 4 – DELIVERABLES AND PAYABLES**

4.01 PAY ITEMS FOR STRUCTURAL GROUTING

1. Records - Complete records shall be kept of all repairs performed in each manhole section or structure. The records shall identify the manhole section or structure in which the repairs were made and the location of each repair. Two (2) neatly bound sets of these records shall be delivered to the Owner at project completion.
2. Pay Items - The quantity for this Item shall be determined based on the size and quantities of the structures to be grouted. Grouting prices shall be based on the following as determined by the Engineer:
3. Vertical footage and/or diameter of the structure,
4. Number of pipe intrusions,
5. Grouting allowance in gallons for each structure,
6. Excess grout pumped above allowances,
7. Combination of all/part of the above.
8. Payment - This payment shall only be made once for any given structure, regardless of the number of preparatory cleanings required to complete the various inspections and rehabilitation work. The unit price for this Item shall be full compensation for providing all labor, materials, equipment, tools, and incidentals for all aspects of preparatory sewer cleaning as specified and shown.

4.02 SUPPLEMENTAL GROUT UNIT PRICING

1. Measurement - The quantity for this Item shall be the number of gallons of grout used for sealing the structure(s), pipe intrusions, etc. This number shall be charged by the Contractor for grout used IN EXCESS of the allowance per structure as determined by the Engineer.
2. Payment - The unit price for this Item shall be full compensation for providing all labor, materials, equipment, tools, and incidentals. The payment per gallon of grout installed has been fixed by the Owner and is shown on the Schedule of Prices.

**END OF SECTION**

**Recommended Payment Schedule**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Item** | **Description** | **Qty.** | **U/M** | **Unit Price** | **Total** |
| 1 | Mobilization | 1 | Lump Sum |  |  |
| 2 | Traffic Control | 1 | Lump Sum |  |  |
| 3 | Grouting Price Per Pipe Intrusion (if applicable) | 1 | Per Each |  |  |
| 4 | Grouting Price Per Structure (TBD by Engineer) | 1 | Per Each |  |  |
| 5 | Supplemental Price for Excess Grout (TBDE by Engineer) |  |  |  |  |