

EXHIBIT A - 360-DEGREE MANHOLE INSPECTION

Contractor shall document the interior of the manhole structure using a 360-degree inspection camera. It is the intent of the scope of work to inspect the full height of each structure.

- A. Cameras shall be used for all manhole interior and connecting pipe photographs and video. The camera shall be operative in 100 percent humidity conditions and blowers shall be used, if necessary, to create a clear view of the manhole interior and pipe. Camera shall be operative in a hazardous and corrosive environment.
- B. The camera used for the interior inspection shall be one specifically designed and constructed for 360-degree inspections. Lighting for the camera shall be suitable to allow a clear still or video picture for the entire periphery of the manhole. The camera and other components shall be capable of producing a high-resolution video picture and should also have a still photo function. Picture quality and definition shall be to the satisfaction of the Owner and Engineer and if unsatisfactory, inspection shall be repeated with the appropriate changes made at no additional cost.
- C. The camera shall be suitable for manhole inspection. The camera shall have auto focus, auto exposure and manual override for focus and camera aperture.
- D. Camera shall be capable of being positioned a minimum of 45 feet below grade.
- E. The camera equipment/software shall be capable of producing digital images of all manhole defects, and pipe connections in .jpeg and .mpg formats. The digital photograph and video shall have a minimum resolution of at least 640x480. The digital photographs and video shall become the property of the Owner.
- F. Additional / Exterior lighting shall be provided to allow for a clear view of the structure's features, and entire circumference. Digital lighting enhancement is not sufficient.
- G. The camera shall be lowered and retrieved from the structure at a rate of no more than 1' per second.
- H. The deliverable shall be a .mp4 format for each manhole structure. Each video shall be individually linked to a spreadsheet that provides the following information for each manhole: Name/Number, Address/Location, Depth, Diameter, Structure Make, Inspection Date, Video Link (location). All videos and spreadsheet(s) shall be provided to owner on a single hard drive.
- I. All digital photos, videos, and spreadsheets will become the property of the Owner.
- J. Inspection pictures and videos shall be labeled with the manhole identification number.

EXHIBIT B - MAINLINE JOINT AND LATERAL CONNECTION TESTING AND SEALING SPECIFICATIONS

1. CHEMICAL GROUT

- a. The Contractor shall use Avanti International AV100 (or approved equal) chemical grout and related catalysts and additives.**
- b. Vendors submitting alternative products shall provide a copy of the manufacturer's technical manual with their bid submittal. Products with incomplete, inadequate or otherwise unacceptable technical manuals may be rejected.**
- c. Water based chemical grouts shall have the following characteristics:**
 - 1. A minimum of 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.**
 - 2. The ability to tolerate some dilution and react in moving water during injection.**
 - 3. A viscosity of approximately 2 centipoises, which can be increased with approved additives.**
 - 4. A controllable reaction time from 10 seconds to 1 hour.**
 - 5. A reaction (curing) that produces a homogenous, chemically stable, non-biodegradable, firm, flexible gel.**
 - 6. The ability to increase mix viscosity, density and gel strength by increased concentrations of the mix constituents or using approved additives.**
- d. At the Contractor's discretion and according to field conditions, additives may be selected and used within the manufacturers recommended quantities.**
- e. Strengthening Agents at Connection at Main**
 - 1. For joint grouting, a latex additive will be added to increase compressive and tensile strength. The quantity of strengthening agent additive shall be as recommended by the manufacturer and approved by the Owner.**
 - 2. Product Manufacturer:**
 - a. Avanti AV-257 or equal.**
- f. Dye - A manufacturer approved water soluble dye without trace metals may be added to the grout tank(s) for visual confirmation.**
- g. Gel Time Modifier - A gel time extending agent may be used in accordance with the manufacturer's recommendations to extend gel time as necessary.**

h. Freeze/Thaw - In those lines where the grouting material may be exposed to a freeze-thaw cycle, ethylene glycol or other additive approved by the Owner shall be used to prevent chemical grout cracking once set.

i. When using non-soluble additives, the grout tanks must have mechanical mixing devices to keep the additives in suspension and maintain a uniform solution of grout and additive.

2. GROUT PREPARATION

a. Transportation, storage, handling, mixing, and testing of all materials shall be in accordance with the Avanti International Technical Manual for AV-100 Grout and other applicable instructions and procedures as indicated by the manufacturer.

b. Prior to mixing grout, the operator shall make note of all factors affecting the work, and shall make appropriate adjustments for field conditions including, but not limited to air temperature, underground temperature, grout batch temperature, mix water characteristics, groundwater characteristics and pipe material.

c. All materials shall be fresh and free of contaminants and shall be in the manufacturer's original sealed packaging.

d. All mixing, heating, storage, and pumping equipment shall be clean and in proper working order.

e. The CONTRACTOR shall provide, at no additional charge, all additives necessary to achieve optimal results.

f. The Operator shall test each batch of grout above ground as per the Avanti International Guide to Successful Chemical Grouting and shall make appropriate adjustments to achieve optimal gel time as required by the field conditions. Any materials, either raw or mixed, that do not comply with the manufacturer's guidelines shall not be used and shall be disposed of in a lawful manner.

g. The Operator shall maintain a written record of each batch of grout, including the date, time, temperature, and location of mixing, quantities of all ingredients, times and results of all gel tests. Similar records shall be kept for grout that is disposed of, including the date, time, and quantity disposed of the method of disposal and the reason for disposal.

h. The CONTRACTOR shall adjust gel time as necessary to compensate for changes in temperature in grout component tanks or hoses.

i. The addition of dilution water to extend gel times is not acceptable unless resulting base grout tank material exceeds 20% by weight for solution grouts.

j. During the grouting process, the Grouting Technician shall monitor the grout component tanks to make sure that proper ratios are being pumped. If unequal levels are noted in the tanks, repeat the pump test as described and correct any defective equipment.

3. QUALITY CONTROL

- a. No change of material, design values, or procedures as developed before bidding the contract may be made during the course of the work without the prior written approval of the Owner.

4. PIPE PREPARATION

- a. Prior to application of the chemical grouting materials, the Contractor shall thoroughly clean the sewer designated to receive the chemical grouting. Cleaning shall constitute removal of all loose debris & solids which inhibit proper seating of the packer.
- b. The CONTRACTOR shall clean the sanitary sewer main and laterals as needed to facilitate the performance of all work specified in the contract. Gravity pipes shall be cleaned in accordance with ASTM 1216-16 and NASSCO Recommended Specifications for Sewer Collection System Rehabilitation. All internal debris, tree roots and other obstructions shall be removed from the original pipeline. The Contractor shall intercept all debris from the cleaning process at a point within the work zone so that no debris is allowed to travel downstream through the sewer system. Debris captured and removed from the sewer system shall be transported and disposed of in a lawful manner. The Owner shall provide a location for disposal of sewer system debris. Cleaning, including capture, removal, transportation and disposal of debris shall be included in the base unit price, and shall be performed at no additional cost to the Owner.

1. The designated disposal site shall be used only for debris removed from sewers, and for vegetation trimmed to facilitate access to sewers. Excess grout and chemicals from the grouting process shall be hauled off site for proper disposal
- c. If debris from pipeline cleaning is allowed to escape into the sewer system, the Contractor shall be held liable for the cost of correcting any sewer blockages and/or pump failures caused by the debris and shall also be held liable for restoration of any damages caused by sewer backups in customer premises.
- d. Copies of CCTV inspection recordings and related reports shall be made available to the Owner as soon as possible, at no additional charge, for review and approval prior to commencement of corrective work.
- e. If inspection reveals an obstruction or other defect that cannot be corrected by conventional sewer cleaning equipment, The Contractor shall submit a request to the City Representative to perform a point repair to enable grout installation. To the extent possible, approved point repairs shall be performed by the Owner within fourteen calendar days of submittal.
- f. The Owner shall have the right to make corrective repairs using in-house staff or a third-party contractor if it is deemed to be in the Owner's best interest to do so.
- g. If the Owner determines that the Contractor is best suited to perform corrective work, the Contractor shall submit a proposal for a contract change order and shall not commence corrective work until the Owner provides written approval of the change order.

5. TESTING AND SEALING OF LATERAL CONNECTIONS AND LATERALS

- a. The CONTRACTOR shall Test and Seal each lateral connection at the city main. This portion of the work shall test and seal the mainline connection and the first four feet of the service lateral.
- b. For service laterals where a cleanout exists, the Contractor shall access the service lateral from the cleanout and shall test and seal each service lateral downstream to the service lateral connection AND upstream to the foundation of the building.
- c. The Contractor shall adhere to the procedures outlined in the NASSCO Suggested Standard Specification for PRESSURE TESTING AND GROUTING OF SEWER JOINTS, LATERALS AND LATERAL CONNECTIONS USING THE PACKER METHOD WITH SOLUTION GROUTS. (Published October 2021)
- d. The basic equipment used for laterals connected to the mainline shall consist of a remotely operated color television camera capable of pan and tilt, joint testing device (referred to hereafter as a packer), and test monitoring equipment.
 1. The equipment shall be constructed in such a way as to provide means for introducing air under pressure into the void area created by the expanded ends of the packer against the host pipe and a means for continuously measuring, viewing and recording the actual static pressure of the test medium and grout within the void area only.
 2. The packer shall be of a size less than the diameter of the host pipe, with the cables at either end used to pull it through the line and may be constructed in such a manner as to allow a restricted amount of sewage to flow at all times.
 3. Packer shall be expanded by air pressure
 4. Packers shall be of low void space construction with void volume given by the packer manufacturer.
 5. The device for testing lateral connections shall consist of inflatable mainline end elements and a lateral grouting plug that creates a void area extending beyond the main connection.
 6. Whenever possible, use a lateral grouting plug sized to match the diameter of the lateral being grouted with an effective sealing length of at least four feet.
 7. The basic equipment for 4-inch and 6-inch laterals connected to manholes shall consist of a flexible push-type packer and mini-push camera. The device for testing lateral pipe connected to the manhole shall be capable of testing the joints, from the manhole toward the building, to the cleanout. If the lateral contains a transition, CONTRACTOR may change out diameters of push packer or grout lateral using only a 4- inch push packer.
 8. Void pressure data shall be transmitted from the void area to the monitoring equipment or video picture of a pressure gauge mounted on the packer and

connected to the void area. All test monitoring shall be above ground and, in a location, to allow for simultaneous and continuous observation of the televising monitor and test monitoring equipment.

9. Grouting equipment shall consist of the packer, appropriate pumping and hosing systems capable of supplying an uninterrupted flow of sealing materials to completely fill the voids. Grout pumping system shall be sized to deliver a mixed volume of grout at a minimum of 3 GPM and 30 gallons of uninterrupted flow within 10 minutes.

10. Volume of mixed grout pumped must be capable of being measured and recorded for each grouted joint/connection. Generally, the equipment shall be capable of performing the specified operations in sewers where flows do not exceed 25 percent of pipe diameter unless permitted by the City Representative.

11. Connection and lateral service sealing shall be accomplished using the lateral grouting plugs and push packers specified above. Provide back-up bladders for each packer on- site at all times during grouting procedures.

12. Equipment for cleaning lateral blockages shall be readily available while any lateral grouting work is being performed.

e. If any part of the NASSCO specification conflicts with this Bid Specification, this Bid Specification shall govern.

f. For all Pressure Testing and Grouting work, The Contractor shall submit daily work reports to the City Representative, using the Pressure Testing and Grouting Daily Report form that is attached to this bid. The Contractor may submit alternative report forms for the approval of the owner.

g. Payment for pressure testing shall be based on the unit cost per joint tested as submitted in the Bid Calculation Worksheet.

h. Payment for grouting joints that fail the pressure test shall be based on the unit cost per gallon of grout injected into joints. No payment shall be allowed for grout that is prepared but not injected into pipeline joints.

6. JOINT TESTING PROCEDURE

a. Testing of main line service connections and service laterals and associated pipe joints shall be performed in accordance with the Avanti International Guide to Successful Chemical Grouting. The equipment manufacturer's instructions shall also be followed, and any conflict shall be resolved by contacting Avanti International and the equipment manufacturer. If an operational conflict cannot be resolved, the equipment shall be replaced with equipment that is compatible with the Avanti grout.

b. Joint testing pressure shall be equal to 0.5 psi per vertical foot of pipe depth plus 2 psi; however, test pressure shall not exceed 10 psi without the approval of the Owner.

c. Individually test each sewer pipe joint at the above-specified pressure (and retest after sealing) in accordance with the following procedure:

1. The packer shall be positioned within the pipe in such a manner as to straddle the joint to be tested.
2. The packer ends shall be expanded to isolate the joint from the remainder of the pipe and create a void area between the packer and the pipe joint. The ends of the testing device shall be expanded against the pipe as per manufacturer's recommendations. If all attempts to isolate the joint fail, pump grout to seal the leak around the packer end elements. After the void pressure is observed to be equal to or greater than the required test pressure, the air flow shall be stopped. If the void pressure decays by more than 1.0 psi within 15 seconds, the joint will have failed the test and shall be sealed.

d. Upon completing the testing of each individual joint, the packer shall be deflated with the void pressure meter continuing to display void pressure. Should the void pressure meter fail to drop to 0.0 +/- 0.5 psi, clean the test equipment of residual grout material or make the necessary equipment repairs to provide for an accurate void pressure reading.

7. LATERAL CONNECTION TESTING PROCEDURE

a. Lateral connection joint testing pressure shall be equal to 0.5 psi per vertical foot of pipe depth plus 2 psi; however, test pressure shall not exceed 10 psi without approval of the Owner.

b. Air testing lateral connections shall be accomplished by isolating the area to be tested with the lateral connection packer and by applying positive pressure into the isolated void area. A pan and tilt camera shall be used to position the lateral packer for laterals directly connected to the mainline sewer. The lateral bladder shall be inverted from the mainline assembly into the lateral pipe and inflated. The mainline elements shall then be inflated to isolate the lateral connection and the portion of the lateral to be tested. A sensing unit shall monitor the pressure of the packer void and will accurately transmit a continuous readout of the void pressure to the control panel at the grouting truck or to a pressure gauge on the packer recorded by the CCTV camera.

c. The test procedure shall consist of applying a controlled air pressure into each isolated void area. Air shall then be slowly introduced into the void area until a pressure equal to or greater than the required test pressure, but in no case greater than 2 psi above the required test pressure, as observed on the pressure monitoring equipment. Once the designated pressure in the isolated void is displayed on the meter of the control panel, the application of air pressure shall be stopped, and a 15 second waiting period shall commence. The void pressure shall be observed during this period. If the void pressure drop is greater than 2.0 psi within 15 seconds, the lateral shall be considered to have failed the air test and shall be grouted and retested.

d. After completing the air test for each individual lateral specified herein, deflate the lateral packer, with the void pressure meter continuing to display void pressure. If the void pressure

does not drop to 0.0 +/- 0.5 psi, the equipment shall be adjusted to provide a zero void pressure reading at the monitor.

8. GROUTING - GENERAL

- a. Grout all joints and lateral connections that failed the pressure test by the injection method. This shall be accomplished by forcing grout through a system of pumps and hoses into and through the joints of the sewer from the packer within the sewer pipe.
- b. Remove excess grout from pipe and laterals. Excess grout shall be defined as a thickness of grout that given its location, size and geometry, could cause a blockage. Flush or push forward to the next downstream manhole, remove from the sewer system, and properly dispose of excess grout.

9. PIPE JOINT SEALING BY PACKER INJECTION GROUTING FOR LATERALS ACCESSED FROM CLEANOUT OR MANHOLE

- a. Position the push/pull packer over the joint or defect to be sealed by a means of visual observation, marked push rod, or where a cleanout is available, through a CCTV camera in the lateral.
- b. Pneumatically expand the packer sleeves such that they seal against the inside periphery of the pipe to form a void area at the joint now completely isolated from the remainder of the pipeline.
- c. Pump grout materials, in stages if needed, into this isolated area with the goal of applying 0.25 to 0.5 gallons of grout per inch-diameter per pipe joint. Record the amount of grout pumped.
- d. Upon completion of the injection, deflate the packer to break away from the ring of gel formed by the packer void. The packer shall then be re-inflated and the joint retested at a pressure equal to the initial test pressure. If the joint fails this air test, repeat the grouting procedure at no additional cost to the Owner, except for the cost of additional grout used. Repeat this sequence of air testing, grouting and subsequent air testing until either the joint is sealed, or it is determined that the grout consumption is too high. The final determination to stop subsequent attempts to seal a joint will be made jointly between the Owner and the Contractor. Should the void pressure meter not read zero 0.5 psi, clean the equipment of residual grout or make the necessary equipment repairs/adjustments to produce accurate void pressure readings.
- e. If lateral joints require more than 0.5 gallon of grout per inch-diameter per pipe joint, modify grouting procedure to perform stage grouting by pumping additional grout in up to 4-gallon increments, waiting 1 gel set cycle time or 1 full minute, whichever is greater between stages. Maximum number of stages shall not exceed two stages of 4 gallons each unless approved by the Owner.

10. LATERAL CONNECTION SEALING FROM THE MAINLINE BY PACKER INJECTION GROUTING

- a. Lateral connection sealing shall be performed if the lateral connection does not pass the air test, shows evidence of leakage, has been successfully cleaned to remove roots, or where Contractor has been directed by the Owner. The lateral packer shall remain in position during the pressure test, thus maintaining the isolated void. Pressure inject grout through the lateral packer into the annular space between the lateral grouting plug and the lateral pipe.
- b. When pumping grout, operate the pumps until the mixed grout has flowed through any joint failure, through any annular space, and into the surrounding soil; gelled or filled the available void space; formed a cohesive seal stopping further grout flow. If the grout pumped exceeds 1 gallon per foot of lateral bladder plus 3 gallons, it shall be assumed that there are significant voids on the outside of the pipe or that the packer is not properly sealed. Check that the packer is sealed properly. If it is, modify grouting procedure to stage grouting by pumping additional grout equivalent to 1 gallon plus 0.25 gallon per foot of lateral bladder, waiting 1 full minute, and retesting. The maximum number of stages shall not exceed two stages unless authorized by the Owner.
- c. Upon completion of the lateral connection sealing procedure, air test the lateral connection a second time to confirm the sealing of the connection in accordance with the air testing procedure. If the lateral connection fails this air test, repeat the grouting procedure at no additional cost to the Owner, except for the additional grout used.
- d. Confirm lateral flow after sealing of each lateral connection. If a grout blockage exists, the Contractor shall immediately clear the lateral at no additional cost to the Owner. Blockages in the lateral that are not the result of grouting operations shall not be the responsibility of the Contractor.
- e. After grouting lateral connections (with the appropriate size lateral bladder), a thin residual grout film may be present inside the lateral wall. The amount of residual grout film present is dependent on the lateral bladder used, geometry of the lateral and positioning of the packer. This thin layer of cured grout is normal and will eventually peel off the sidewall of the pipe. The residual chemical grout film is not “sandwiched” between two structures and will eventually peel off the sidewall of the pipe. This residual chemical grout film is not considered excess grout.

11. POINT/INJECTION GROUTING

In some sanitary service lateral there may be leaking joint that cannot be sealed with the lateral packer or push packer. In these situations, Point/Injection grouting may be performed. Only joints directed by the Owner's representative will be Point/Injection grouted.

- a. Probe(s) will be inserted in the ground just above the sanitary service lateral and as close to the leaking joint(s) as possible.
- b. The grout mixture will be pumped through the probes to seal the leaking joint(s).

- c. Grout set times made need to be adjusted depending on the depth of the service lateral and other factors.
- d. Grout mixing and testing for the Point/Injection grouting will the same process as the lateral grouting in this bid.
- e. Contractor can discuss with the Owner's representative other methods of Point/injection grouting.
- f. The lateral will always be televised to assure all leaking joints are sealed.
- g. The videos and CCTV reports for the Point/Injection grouting will follow the same process in this bid.

12. RESIDUAL GROUT REMOVAL

- a. Each service lateral connection that is grouted shall be inspected with a 360-degree pan and tilt color camera to ensure that it is not blocked with residual grout material. Residual sealing materials that extend into the pipe, reduce the pipe diameter, or restrict the flow shall be removed from the service lateral. Lateral flow shall be verified after the successful sealing of each lateral. With the lateral packer in position, the inversion tube shall be retracted, and air pressure injected into the lateral. Should pressure build in the lateral and not drop to approximately zero in a few seconds, the packer shall be moved off the connection and the connection viewed with a 360-degree pan and tilt color television camera. With the camera viewing the connection point, an attempt shall be made to obtain a water flush by the occupant. If no water is viewed during this procedure, it shall be assumed the building sewer is blocked with grout. Any service lateral that is blocked with grout shall be reopened by whatever means is necessary (with prior approval by the Owner's Representative) at no additional cost to the Owner. If excessive residual sealing materials accumulate in the service lateral or sanitary sewer main line the pipe segment shall be cleaned to remove the residual materials.

13. DISPOSAL

- a. Collect and properly dispose of cleaning materials used in the cleaning of the grouting equipment.

14. WARRANTY

All work performed under this contract shall be warranted free from defects in materials, workmanship, and leaks for a period of three years from the date of completion.

15. RECORDS

- a. All testing and sealing of lateral connections shall be video recorded during the air testing and sealing operation.
 - 1. The video recordings shall be submitted to the Owner for review and permanent record.

2. The video recording shall display the date, time, mainline segment ID number, footage to the lateral connection, street address of each lateral, void pressure and quantity of grout pumped.
- b. All service lateral pipelines accessed from cleanouts or manholes shall be video inspected and recorded before and after testing and sealing.
 1. The video recordings shall display the date, time, street address of lateral, distance from manhole or cleanout, void pressure and quantity of grout pumped.
- c. The Contractor shall maintain written records of:
 1. All set-up, adjustment, calibration and testing of equipment
 2. Mixing, testing and disposal of materials,
 3. Test pressures, times and results of all service lateral tests
 4. Quantities and packing pressure of all grout injected into leaking laterals
 5. Re-test pressures, times and results for verification of successful grouting
- d. Records shall be made available for field inspection by the Owner, and copies shall be submitted prior to payment for completed work.
- e. Prior to starting any work, the Contractor shall submit blank copies of all record forms proposed for use in documenting the performance of this contract and shall make any changes necessary to facilitate complete and accurate documentation, as determined by the Owner.

16. INSPECTION AND ACCEPTANCE

- a. The CONTRACTOR shall inspect each completed service lateral by closed circuit television (CCTV).
- b. Televised inspection of pipelines shall be performed by operators who hold NASSCO certification in LACP (Lateral Assessment Certification Program) and are experienced and trained in locating breaks, obstacles, and service connection via CCTV or man entry.
 1. Inspection documents submitted to the Owner shall include the certification ID number of the camera operator who performed the inspection.
- c. The CONTRACTOR shall clearly indicate the street address of each service on the post-grouting inspection reports, videos and other documentation.
- d. The CONTRACTOR shall provide the Owner with a color video and reports of all service laterals on an external hard drive with a USB 2.0 connection.
 1. Each service lateral address shall have a separate report and video and be titled according to the address of the service.
 2. Color videos of all televised service laterals should be provided in ".mpeg" format.

3. Written inspection reports shall be provided electronically in Adobe Acrobat Reader “.pdf” format.
- e. Inspection video submittals shall include written reports that document the findings of each video inspection:
 1. The service lateral inspection shall consist of identifying a location both within the pipe segment (physical location) and within the digital recording (video frame location) for each defect or observation.
 - a. The use of time codes for defect location shall NOT be deemed equivalent or acceptable.
 2. The digital recording and inspection data shall be cross-referenced for instant access to any point of interest within the digital recording.
 3. The inspection information shall include the digital recording of video and audio, segment identification information (starting manhole, date, time, etc.) including a pointer from each observation to the digital recording (video frame number), and any accompanying digital still images (JPEG or BMP).
 4. Any out of-focus video recordings, or portions thereof, shall be cause for rejection of the video recording and will necessitate re-televising at the Contractor’s expense. Televising shall be done one section at a time
 - a. The Contractor shall be responsible for correction of all defects in materials and workmanship at no cost to the Owner, including removal and replacement of the entire section of lining, if deemed necessary by the Owner.

EXHIBIT C - CURTAIN GROUT MANHOLE, GROUT WALL JOINTS & GROUT BOTTOM 18"

This work shall govern all work, materials and testing required for chemical pressure grouting of manhole defects. Manholes or sections of manholes with leaks are shown on the Manhole Rehabilitation Schedule. Manhole structure grouting includes the sealing or plugging of the manhole base, walls, cone/cone and chimney using chemical grout sealants to eliminate leakage. Chemical grout shall be injected into the soil surrounding the manhole as needed for complete sealing resulting in a grout curtain.

Curtain Grout Manhole.

The Contractor shall furnish all labor, supervision, materials, equipment and testing if required for the completion of chemical grout sealing of manhole defects in accordance with the Contract Documents. Manhole grouting shall not be performed until sealing of manhole frame and grade adjustments is complete.

1. Equipment: The basic equipment shall consist of chemical pumps, chemical containers, injection packers, hoses, valves, and all necessary equipment and tools required to seal manholes by chemical pressure grouting. 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 will be incorporated into the pumping station.
2. Chemical Sealing Materials: The chemical grout shall be Avanti AV-100 or approved equal which has a documented record of satisfactory performance in sewer usage. All grouting materials shall be delivered to the job site in the original, labeled, and unopened containers. The Contractor shall submit the brand name manufacturer of the chemical grout(s) he intends to use. The chemical grout(s) selected by the Contractor is subject to approval of the Owner.
3. Mixing and handling of chemical grout, which may be toxic under certain conditions, shall be in accordance with the recommendations of the manufacturer and in such manner to minimize hazard to personnel. It is the responsibility of the Contractor to provide appropriate protective measures to ensure that chemicals or gels are handled by authorized personnel in the proper manner. All equipment shall be subjected to the approval of the Engineer. Only personnel thoroughly familiar with the handling of the grout material and additives shall perform the grouting operations.
4. Preliminary repairs: All cracked or deteriorated material shall be removed from the manhole and the Contractor shall cut and trim all roots within the manhole. The Contractor shall seal all unsealed lifting holes, unsealed step holes, pre-cast manhole section joints, and voids larger than approximately $\frac{1}{2}$ " in thickness with a waterproof quick-setting mortar, Cemtec Rapid Cure or an approved equal in accordance with the manufacturer's specifications.
5. Drilling and Injection: Injection holes shall be drilled through the manhole at 120-degree angles from each other at the same plane of elevation. Rows shall be separated no more than

three vertical feet, and the holes shall be staggered with the holes in the rows above and below. Provide additional injection holes near observed defects, bench and trough and at pipe seals. At all visible leaks and areas with evidence of leaks within the manhole structure, a hole shall be carefully drilled from within the manhole and shall extend through the entire manhole wall. A minimum of 6 injection holes shall be provided in the walls/cone and three injection holes at each pipe seal and at the bench/trough.

6. Manholes shall be grouted completely from the pipe invert to the top of the cone/chimney or bottom of flattop. Grout shall be injected through the holes under pressure with a suitable probe. 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. Grouting from the ground surface shall not be allowed. Grout travel shall be verified by observation of grout to defects or adjacent injection holes. Provide additional injection holes, if necessary to ensure grout travel. Care shall be taken during the pumping operation to ensure that excessive pressures do not develop and cause damage to the manhole structure or surrounding surface features. Grout shall be injected through the lowest holes first. The procedure shall be completed until the manhole is externally sealed with grout, resulting in a chemical grout curtain.

7. Sealing after grouting: Upon completion of the injection, all chemical grout material shall be removed from interior surfaces of the manhole. After grouting is completed, the grout ports shall be removed, and the remaining holes shall be cleaned with a drill and 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 such as Cemtec Rapid Cure or an approved equal. In addition to filling the holes the interior surface of the manhole shall be patched with a $\frac{1}{2}$ " thick quick setting mortar such as Cemtec Rapid Cure or an approved equal. This coating shall cover at least 6" either side of the joint sealed or where injection holes were drilled.

Grout Wall Joints.

The procedures for Grout Wall Joint shall be the same as listed above, but shall be limited to wall joints and/or areas with evidence of infiltration for each manhole indicated on the plans. Holes shall be carefully drilled from within the manhole 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. Grout travel shall be verified by observation of grout to defects or adjacent injection holes. Provide additional injection holes, if necessary to ensure grout travel. Sealing after grouting wall joints shall be the same as above and shall include patching with a $\frac{1}{2}$ " thick quick setting mortar such as Cemtec Rapid Cure or an approved equal and shall cover at least 6" either side of the joint sealed or where injection holes were drilled.

Grout Bottom 18"

The procedures for Grout Bottom, 18" shall be the same as indicated above, but shall be limited to the bottom portion of the manhole. Pipe seal grouting shall include all pipe seals in the specified manhole and grouting of the bench/trough, wall/bench joint and walls to the maximum height of 18" from the crown of the pipe. Provide additional injection holes near observed defects, bench and trough and at pipe seals. At all visible leaks, a hole shall be carefully drilled from within the manhole and shall extend through the entire manhole wall. A minimum of three injection holes at each pipe seal and at the bench/trough shall be required. Sealing after grouting manhole bottoms shall be the same as above and shall include patching with a $\frac{1}{2}$ " thick quick setting mortar such as Cemtec Rapid Cure or an approved equal and shall cover at least 6" either side of each location sealed or where injection holes were drilled.

Grout Tests

The Contractor shall perform and record a grout gel test in the presence of the Owner. 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:

1. At the beginning of each day. The material in the hoses shall be recycled to the tanks and a sample shall be taken;
2. Whenever new batches of grout are mixed; and
3. 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.

Exhibit D - Multi-Sensor Inspection:

A. Work covered by this specification includes, the furnishing all equipment, materials, labor, supervision and any incidental items necessary to perform a detailed pipe condition assessment utilizing closed-circuit television inspection, sonar inspection, and LIDAR inspection. The specified equipment shall be capable of inspecting spans of sewer lines of up to 4,000 linear feet or greater between access points. The work shall include the processing of all collected data and the delivery of the data in usable formats such that no additional fees or services are required to review the data collected for this project.

CCTV Inspection:

A. CCTV inspection shall be conducted as a component of pipeline condition assessment to provide visual identification of defects above the water line in partial flow pipelines. Two hard copies of the digital images, video and reports generated by the CCTV inspection shall be provided as part of the overall Project Deliverables. Digital CCTV data must be annotated via a digital database using PACP compliant annotation software. (The Contractor should use inspection software Granite Net). This ensures digital images and data are easily shared, viewed, stored and retrieved.

B. CCTV inspection shall be conducted simultaneously with the other inspection technologies described herein. Each inspection record and recording shall be limited to a single sewer segment. Combining multiple sewer segment inspections in one recording shall not be permitted.

C. The purpose of a CCTV inspection component in a Multi-Sensor Inspection is to visualize pipeline defects and features. CCTV inspections gather digital images of the complete end-to-end and overhead arc of pipe coverage above the fluid level. The CCTV component must provide off-line viewing capabilities that can be imported into PACP / WRc compliant pipe annotation tools. This tool ensures that digital images are easily shared, viewed, stored and retrievable for comparative analyses, historical reference, and subsequent prediction of future pipe condition. The inspection is intended to identify operational or structural issues which require attention. The work shall include a CCTV inspection of the pipeline and the preparation of all video, digital, and written reports. If a blockage or obstruction is encountered and conditions allow, the survey shall be attempted from the opposite end of the pipeline and continued back towards the blockage or obstruction to ensure maximum data collection of the pipeline segment.

D. The CCTV video system must be capable of transmitting from the underground pipe environment to a surface control center with zero loss of clarity. It is therefore required that the CCTV service provider utilize a fiber optic cable for signal transmission. The cable must support multiplexing of numerous signals from numerous sensors over the one fiber. CCTV signal transmission must take into account and prevent or compensate for high frequency roll-off in order to maintain image detail.

E. At all times during the inspection, a certified CCTV operator shall be used to operate the inspection equipment and code the inspection. NASSCO/PACP or WRc certification is required to ensure inspection and defect coding is done in a consistent manner. A copy of the CCTV operator's

certificate stating certification or re- certification within the previous five years must be submitted prior to start of CCTV inspection operations.

F. Video capture equipment shall be capable of continuously capturing digital video from first generation recordings with no frame loss, regardless of the progression of the inspection. Software must be NASSCO or WRc certified and integrate seamlessly with other third-party NASSCO or WRc certified data management software.

Sonar Inspection:

A. The Sonar system shall be designed for pipeline condition assessment by scanning of submerged and semi-submerged pipelines utilizing high resolution, short range sonar technology. These scans shall allow for accurate determinations of conditions below the fluid level in partially or fully surcharged pipelines. The system must be capable of producing a usable image, displaying detailed measurements relative to size, corrosion, debris buildup and other conditions as well as generating a report of findings. The sonar scanner shall scan a full 360° profile of the surcharged pipe surface at one (1) slice per second.

B. A thorough understanding of pipe eccentricity, corrosion and debris build up shall be provided as a result of processed sonar cross sectional dwell images. Each dwell image shall contain multiple sonar scans at a particular location. The information from the multiple scans shall be combined to create a more complete picture of the pipe condition. Each dwell scan shall be viewable as an image. In each image, bright colors shall represent strong returns.

D. Sonar inspection shall be conducted simultaneously with other inspection technologies described herein. Each inspection record and recording shall be limited to a single sewer segment. Combining multiple sewer segment inspections in one recording shall not be permitted.

LIDAR Inspection:

A. The LIDAR shall provide for pipeline condition assessment of the pipe walls above the fluid level. The laser profile data shall be combined with sonar data to create a complete and accurate, forward-facing three-dimensional model of the pipeline interior above and below the fluid level. Contractor to follow LIDAR speciation below. The LIDAR equipment must be certified for calibration before use on the project. LIDAR scans shall be complete and continuous throughout the entire inspection length. The laser data must be logged in a digital format to enable extraction of any relevant information, such as internal pipe diameter, ovality, mortar loss, concrete loss, etc.

B. Corrosion/buildup graphs shall be used in conjunction with the integrated and detailed views generated to precisely quantify internal pipe wall material loss or gain at a given location and clocking angle. Pipe cross-sections obtained from precision high resolution scans shall be used to provide quantitative information of pipe inside diameter, including ovality and eccentricity.

C. LIDAR inspection shall be conducted simultaneously with other inspection technologies described herein. Each inspection record and recording shall be limited to a single sewer segment. Combining multiple sewer segment inspections in one recording shall not be permitted.

Equipment:

A. All equipment used shall be specifically designed and manufactured for the purpose intended under this Contract. The equipment utilized for the inspection shall be of the advanced multi-platform variety and shall be the CUES SoLID FX: LIDAR, SONAR, and Live CCTV system or an approved equal. The Contractor shall submit an equipment list to the City of Naperville for approval prior to the commencement of work and shall certify that back-up equipment is available and can be delivered to the worksite within 48 hours.

Profiling LIDAR Specification:

1. The Light Detection and Ranging (LIDAR) must be specifically configured as a pipe profiling LIDAR that uses time-of-light ranging principle. Specifically excluded is Structured Light (SL) ranging systems that use a camera and laser wand/light ring or other types of scanners with degrading z-axis accuracy as the pipe diameter increases. In addition, the pipe profiling LIDAR must have the following characteristics:

- a) The LIDAR unit (sensor that is placed within the pipeline) must be protected by a mechanical housing that is specifically designed to survive the rigors of the sewer environment
- b) The LIDAR housing shall have IP 67 or better.
- c) The LIDAR unit shall be “fog” resistance by providing at least 3 multi-echo distance measurements per step. (Note this is an essential feature for obtaining accurate LIDAR data in cold weather, hot condensing, or high humidity conditions where the tendency to induce fog into the pipeline or condensation on the sensor is the greatest)

2. The LIDAR system shall be capable of transmitting continuous, multi-echo range and bearing data from the LIDAR unit within the pipeline to topside viewing station.

- a) The transmission of the LIDAR data shall be digital.
- b) The transmission of the LIDAR data shall be continuous.
- c) The transmitted data shall be logged in digital format for subsequent viewing and analysis operations.

3. The LIDAR unit within the pipeline shall be capable of operation in pipes 24" to 240" (600 mm to 6,000 mm). Also, the LIDAR unit shall have the following properties:

- a) The range estimation mode of the LIDAR unit shall be time-of-flight.
- b) The LIDAR unit shall be capable of scanning at least 40 times per second.
- c) The Near Field Ranging Limit: shall not exceed 0.1 meters.
- d) The Far Field Ranging Limit shall be at least 30 meters.
- e) The LIDAR sensor Field of View shall be 270-degree arch.
- f) The Operating Wavelength shall be near infra-red range (not visible to the naked eye) with a nominal value of 905 nm.

g) The Angular Resolution shall be 0.25 degrees or better.

h) The Accuracy shall be at least +/- 30mm at 10 meters.

Profiling SONAR Specification:

1. The SONAR system must be specifically designed as a sewer pipe profiling system that uses high frequency sound waves to obtain profiles from the submerged section of the pipes. In addition, the pipe profiling sonar must have the following general characteristics:

a) The SONAR unit (sensor that is placed within the pipeline) must be protected by a mechanical housing that is specifically designed to survive the rigors of the sewer environment.

b) The SONAR unit shall be depth rated to at least 1000m.

c) The SONAR unit shall have integrated pitch and roll sensing

2. The SONAR system shall be capable of transmitting continuous SONAR data from the SONAR unit within the pipeline to topside viewing station.

a) The transmission of the SONAR data shall be digital.

b) The transmission of the SONAR data shall be continuous.

c) The transmitted data shall be logged in digital format for subsequent viewing and analysis operations.

3. The SONAR unit within the pipeline shall be capable of operation in pipes 24" to 240" (600 mm to 6,000 mm). In addition, the SONAR unit shall have the following properties:

a) The Near Field Ranging Limit shall be at least 0.125 meters.

b) The Far Field Ranging Limit shall be at least 6 meters.

c) The Min Detectable Range shall be at least 50 millimeters.

d) THE SONAR unit shall support the following Variable Range Scales:

a. 0.125 m, 0.25m, 0.5 m, 0.75 m, and

b. [1-6] m.

e) The SONAR unit Step Size shall be at least 0.9 degrees.

f) The SONAR unit shall support continuous Train Angles, e.g. Continuous Rotation.

g) The SONAR unit shall have an unobstructed Field of View: of 360 degrees.

h) The SONAR unit shall support a Scanning Speed no smaller than 360 degrees in 1.3 sec.

i) The SONAR unit Frequency shall be at least 2.25 Mhz. to ensure the highest possible resolution of resultant data.

j) The SONAR unit Transducer Beam Width shall not exceed 1.4 degree conical.

k) The SONAR unit Range Resolution shall be at least 1/250 (e.g. 1mm at 250 mm).

HD CCTV Camera Specification:

1. The CCTV camera system must be waterproof, corrosion resistant, and with a protective enclosure specifically designed to survive the rigors of the sewer environment.
2. The CCTV camera system must operate over the temperature range -10 C to 50 C.
3. The CCTV camera system shall contain an imaging sensor that has full resolution color.
 - a) The imaging sensor shall have selectable automatic or manual exposure.
 - b) The imaging sensor shall have a dynamic range of 55db.
 - c) The imaging sensor shall have sensitivity of 1.5 lux at F1.0.
 - d) The imaging sensor shall have selectable automatic or manual white balance.
4. The CCTV System shall be capable of transmitting live video from the CCTV camera within the pipeline to the topside viewing station.
 - a) The transmission of the video signal from the CCTV camera to the topside viewing station shall be digital.
 - b) The digital video signal must be capable of transporting full frame rate video at distances of at least 2000 linear feet (600 linear meters) without distortion of the topside video image.
5. The CCTV camera shall be high definition with a resolution of at least 2048 x 1536 pixels.
 - a) The frame rate at full resolution must be at least 10 frames/sec.
 - b) The frame rate at 1/2 (1280 x 1024) resolution must be at least 30 frames/sec.

Recording:

- A. The Contractor shall provide the City with a color video of all pipeline segments in ".mpeg- 1" format on an external hard drive with a USB 2.0 connection or flash drive in mpeg-1 format. Each video shall be named according to the "upstream manhole number – downstream number.mpg" format. For example, a pipe segment video with an upstream manhole of T02-004 and downstream manhole T02-003 would be named "T02-004_T02-003.mpg". Separate MPEG-1 files reports with still images shall be created for each manhole-to-manhole pipe segment inspected.
- B. Written inspection reports shall be provided electronically in inspection software format or Adobe Acrobat Reader ".pdf" format. The file naming format shall follow a similar format to the video naming format. Each inspection report shall be named according to the "upstream manhole number – downstream manhole number.pdf" format. For example, a pipe segment with an upstream manhole of T02-004 and downstream manhole T02-003 would be named "T02-004_T02-003.pdf".
- C. The pipeline inspection shall consist of identifying a location both within the pipe segment (physical location) and within the digital recording (video frame location) for each defect or

observation. The use of time codes for defect location shall NOT be deemed equivalent or acceptable. The digital recording and inspection data is to be cross-referenced for instant access to any point of interest within the digital recording. The inspection information shall include the digital recording of video and audio, segment identification information (starting manhole, date, time, etc.) including a pointer from each observation to the digital recording (video frame number), and any accompanying digital still images (JPEG or BMP).

D. Any out-of-focus video recordings, or portions thereof, shall be cause for rejection of the video recording and will necessitate re-televising at the Contractor's expense. Televising shall be done one section at a time.

E. Address of every service lateral or main and manhole shall be on all videos and reports.

F. CCTV inspections shall be performed, and report shall be prepared in accordance with NASSCO PACP Inspection and Defect Coding Program.

G. The contractor shall utilize the latest version of the NASSCO approved PACP software.

Sonar Inspection:

A. The sections below provide general specifications for the Sonar inspection of the interceptor. The Contractor shall warrant to the City and the Engineer any and all claims from infringement of patents and shall save harmless the City, the Engineer and their Representatives from loss on account thereof.

B. The purpose of the sonar inspection shall be to document pipe conditions below the water line in pipes which are partially or fully surcharged. Observations shall be recorded according to the procedures detailed in the NASSCO PACP CCTV Inspection and Defect Coding Program Manual. Sonar inspection results shall be used to determine the need for and limits of any cleaning which if required will be bid under a separate Contract.

C. This work shall include all material, labor, equipment, supplies and supervision required to perform Sonar inspection of the pipelines detailed in the Inspection Schedule, including processing of data, preparation of all digital recordings and hard copy reports.

Sonar Inspection Procedures:

A. Sonar inspection shall be performed according to the Sonar System manufacturer's recommendation as it pertains to survey rate in inches per second. The sonar inspection system shall operate in real time mode with continuous interior scanning over a full 360 degrees. Digital data shall be recorded at full resolution.

B. If an obstruction is encountered that prevents completion of the segment from the upstream manhole, the survey shall be restarted at the downstream manhole and continued back towards the blockage or obstruction to ensure maximum data collection of the pipeline segment. Work required to perform a "reverse setup" shall be considered incidental to the contract and no additional compensation shall be allowed.

Sonar Inspection Documentation:

A. SONAR INSPECTION LOGS: Location records of the sewer mains inspected shall be kept and maintained by the Contractor in a digital format. These location records shall clearly show the stationing location in relation to the upstream manhole. Observations shall be digitally recorded by the Contractor in the approved digital file format and submitted to the City of Naperville Representatives. Two hard copies of the inspection reports shall be bound and submitted to the City of Naperville Representatives along with all of the digital data. The digital information shall contain multiple video inspection records and files that store each line segment as a unique digital record. Combining multiple segments on one form or digital record is not permitted.

B. DIGITAL RECORDINGS: The purpose of digitally recording shall be to supply a visual record of all line segments that are inspected. The digital video playback speed shall be at the same speed that it was recorded.

C. Slow motion and stop motion playback features shall also be supplied as part of this Contract. The Contractor shall provide all digital video and necessary playback software or viewing applications to ensure data is readily accessible for review by the City of Naperville Representatives during and after the project. The digital video file shall be a deliverable and will be required for completion of the work for each segment inspected by sonar. The digital files (recorded on the approved digital storage media) shall be indexed with the line segment and labeled appropriately on the media. At a minimum, the digital file shall display manhole numbers and footage at all times.

D. Two digital files and report deliverables including dwell scans shall be turned in via bound hard copy and USB powered hard drive as indicated in the previously in the special provisions. Digital recordings shall be processed by Contractor and delivered to the Engineer after completion of sonar inspection for review. A line segment shall be considered complete for payment once the CCTV, Sonar and Laser inspection and report has been delivered to the Engineer, reviewed and accepted.

LIDAR Inspection

A. The sections below provide general specifications for the LIDAR inspection of the interceptor. The Contractor shall warrant to the City of Naperville Representatives any and all claims from infringement of patents and shall save harmless the City of Naperville Representatives. B) The purpose of the LIDAR Inspection is to reveal and document sewer line operational and structural conditions above the water line in pipes that are flowing partially full.

B. The work shall include all material, labor, equipment, supplies and supervision required to perform Laser inspection of the pipelines detailed in the Inspection Schedule, including processing of data, preparation of all digital recordings and hard copy reports.

LIDAR Inspection Procedures

A. LIDAR inspection shall be performed according to the LIDAR System manufacturer's recommendation as it pertains to survey rate in inches per second.

B. If an obstruction is encountered that prevents completion of the segment from the upstream manhole, the survey shall be restarted at the downstream manhole and continued back towards the blockage or obstruction to ensure maximum data collection of the pipeline segment. Work

required to perform a “reverse setup” shall be considered incidental to the contract and no additional compensation shall be allowed.

C. An integrated overview of Corrosion and Buildup data revealed from laser scanning is to be presented in a color-coded format as an unrolled illustration of the pipe condition above the spring line (9:00 to 3:00 clocking angles inclusive) over the length of the inspection segment. Measured pipe ID that coincides with expected values must be coded green. Material loss (corrosion), as measured by increasing pipe ID, must be colored on a yellow/red color scale, with red indicating advanced corrosion. Material gain (buildup), as measured by decreasing pipe ID, must be on a blue color scale. To support identified radial localization of defects, individual ID measurements, as computed from the axis of the inspected pipe, must be presented in an illustrated corrosion/buildup graph form for the 9:00, 10:30, 12:00, 1:30 and 3:00 clocking angle positions over the length of the inspection segment. Precision high resolution laser scan views identifying ovality and eccentricity shall be presented in a color-coded format as an unrolled illustration of the pipe condition to include the entire pipe circumference as well as a cross-section view where precision scans are taken during the pipe inspection survey. The color coding shall be identical to the aforementioned requirements. Where the presence of fluids in the pipe necessitates interpolation and estimation calculations to fill gaps and complete the full circumference view, the method and calculations used to support these assumptions must be presented. Sonar or as-built data, if used for these calculations, must be identified in the report. Areas revealing deflection greater than 2% must be identified in the report. Combining multiple segments on one form or digital record is not permitted.

Deliverables

A. All project data shall be delivered to the City of Naperville representatives in usable formats that do not require additional services, ongoing maintenance, or service contracts for data usage including the proper usage of video, reports, and software required to effectively view the data collected under this contract. All costs associated for delivering project data in usable formats shall be included in the Contract unit bid pricing.

B. Deliverables shall include:

- a. Two (2) color copies of the Final Reports in hard copy format
- b. Two (2) external hard drives containing digital .pdf copies of the Final Reports as well as all digital video recordings and PACP reports in .pdf format

C. The Final Report shall be structured so that gravity main segments inspected are in sequential order, starting with the most upstream segment and following that with the next downstream segment and so on.

D. All digital video recordings and hard copy reports generated under this contract shall become the exclusive property of the City.

E. Data generated by the CCTV, sonar, and lidar scans shall be processed by the Contractor and delivered to the City within the timeframe laid out in this contract. A line segment shall be

considered complete for payment once the CCTV, Sonar, and Lidar inspection and all associated reports and videos have been delivered to the City Representative, reviewed, and accepted.

Exhibit E - Vac-A-Tee Installation Specifications

1. Intent: It is the intent of this specification to provide a cost-effective installation of a sewer lateral clean out without conventional excavation.

2. General The VAC-A-TEE® product and process consists of locating a sewer lateral pipe by the most effective means available to the installer. The most common method utilized and associated with the VAC-A-TEE® process consists of inserting a video camera with an internal sonde into the lateral service line from the mainline pipe. Locating the lateral pipe is accomplished using a locating receiver. The located lateral pipe shall be marked by driving a steel pin in the soil when possible and marking the surface with marking paint and a marking flag. Next, a borehole approximately twenty inches (20") in diameter is created by vacuum excavation. A saddle is affixed to one end of a PVC riser pipe utilizing a solvent weld. A mastic adhesive/sealant is applied to the underside of the saddle. The pipe and saddle are inserted down into the hole with the saddle end first, to snap fit onto the exterior of the lateral pipe. The saddle is pressed down onto the lateral pipe whereby the saddle expands under the downward force until the bottom-most portion of the saddle has surrounded more than fifty percent (50%) of the pipe diameter.

Once the saddle has surrounded more than half of the pipe and passes the spring line of the pipe, the saddle retracts thus pulling downward until the saddle has snapped as it encompasses a majority of the pipe. Next, the annular space between the borehole and the riser pipe is filled with sand or pea-gravel to within six-inches (6") of the surface grade and an approved cleanout cap is installed, and the crown of the lateral pipe is cut open. The surface is then restored to its original condition.

3. Material: The material shall be a one-piece, molded PVC saddle and shall be compatible with the riser pipe. Solvent welding the riser pipe into the saddle boss. The saddle shall conform to the lateral pipe by a snap fit where the lateral pipe is either four (4") or six (6") in diameter. The riser pipe shall be SDR 35. The resin will be a one-part marine grade adhesive/sealant designed for the specific designed for the application of a VAC-A-TEE saddle adhered to the lateral pipe by a chemical bond.

4. Installation Procedure

4.1 In grass areas, the sod shall be neatly cut and removed. In pavement areas, the pavement shall be straight-line marked, cut and removed.

4.2 The vacuum excavated borehole shall be approximately twenty inches (20") in diameter and all spoils shall be deposited in a vacuum truck.

4.3 A riser pipe of an appropriate length is solvent welded to the saddle.

4.4 The adhesive/sealant shall be applied to the underside of the saddle at no less than a $\frac{1}{4}$ " thick layer.

4.5 The saddle and riser pipe shall be carefully inserted into the bore hole, setting the saddle onto the pipe, applying a downward force causing the saddle to expand and snap onto the lateral pipe.

4.6 Immediately after the saddle has been affixed to the lateral pipe, the riser pipe should be secured by backfilling the bore hole with sand or pea-gravel to within 6-inches of the original grade.

5. Testing & Cutting

5.1 An exfiltration test shall be performed by filling the riser pipe with a 6-foot column of water. The test shall be performed no less than 12-hours from the time of affixing the saddle to the pipe. The column of water shall be held for five minutes. The water level shall be measured from the top of the riser pipe. Zero leakage is allowed.

5.2 A diamond core saw shall be introduced into the riser pipe, the crown of the pipe is cut and the coupon is removed.

5.3 An approved cap or cover is installed at ground level or below ground level.

6. Deviations Should soil conditions reveal running sand or similar conditions that would prohibit the installation, the installation shall be terminated and the borehole filled with flowable grout. The surface area shall be restored to its original condition.

7. Clean-Up The site will always be left clean and the property restored to conditions equal to site conditions prior to the VAC-A-TEE® installation.

Exhibit F – Pricing - Hoerr Construction, Inc.

NO.	DESCRIPTION	QTY	UOM	PRICE
1	8"-12" MAINLINE JOINT TESTING	1	EA	\$180.00
2	8"-12" MAINLINE JOINT SEALING	1	EA	\$100.00
3	15"-18" MAINLINE JOINT TESTING	1	EA	\$200.00
4	15"-18" MAINLINE JOINT SEALING	1	EA	\$110.00
5	21"-24" MAINLINE JOINT SEALING	1	EA	\$350.00
6	21"-24" MAINLINE JOINT SEALING	1	EA	\$180.00
7	27"-30" MAINLINE JOINT TESTING	1	EA	\$600.00
8	27"-30" MAINLINE JOINT SEALING	1	EA	\$350.00
9	33"-36" MAINLINE JOINT TESTING	1	EA	\$650.00
10	33"-36" MAINLINE JOINT SEALING	1	EA	\$350.00
11	42"-48" MAINLINE JOINT TESTING	1	EA	\$1,000.00
12	42"-48" MAINLINE JOINT SEALING	1	EA	\$500.00
13	ACRYLAMIDE GROUT	1	GAL	\$40.00
14	GROUTING SET-UP - PIPE MORE THAN 100' FROM STREET	1	EA	\$1,500.00
15	TEST LATERAL CONNECTION AT MAIN 8"-12" - 4 FEET	1	EA	\$1,200.00
16	SEAL LATERAL CONNECTION AT MAIN 8"-12" - 4 FEET	1	EA	\$500.00
17	TEST LATERAL CONNECTION AT MAIN 8"-12" - 10 FEET	1	EA	\$1500.00
18	SEAL LATERAL CONNECTION AT MAIN - 8"-12" - 10 FEET	1	EA	\$800.00
19	TEST & SEAL LATERAL FROM CLEANOUT TO FOUNDATION	1	EA	\$2,800.00
20	TEST & SEAL LATERAL FROM CLEANOUT TO MAIN	1	EA	\$2,800.00
21	POINT GROUTING	1	HR	\$1,000.00
22	LATERAL CLEANING	1	LF	\$150.00
23	LATERAL TELEVISING	1	LF	\$75.00
24	LARGE DIAMETER GROUT MOBILIZATION (PER SIZE)	1	EA	\$22,000.00
25	MSI INSPECTION	1	LF	\$25.00
26	MH GROUTING – JOINT	1	EA	\$1,000.00
27	MH GROUTING – CURTAIN UP TO 10'	1	EA	\$5,000.00
28	VAC-A-TEE INSTALLATION	1	EA	\$3,000.00
29	360-DEGREE MANHOLE INSPECTION	1	EA	\$300.00