

Section VI – Technical Specifications

ITEM XI - FOLD AND FORMED PVC PIPE

11.01 SCOPE OF WORK

- A. This specification consists of the method and process for furnishing all labor, materials, tools, equipment and incidents necessary for the rehabilitation of sanitary sewer lines by the insertion of fold and formed poly-vinyl chloride (PVC) pipe that is heated, pressurized, and expanded to conform to the wall of the original pipe between manholes forming a new structural pipe-within-a-pipe.
- B. Sewers to be rehabilitated, tested and sealed under this process are shown on the plans.
- C. All necessary bypass pumping, including appurtenances necessary to maintain sewer service is also part of the work specified under this Section.
- D. Pre-qualification

1. Contractor

All work shall be performed by a pre-qualified contractor using fold and formed PVC piping from a pre-qualified manufacturer. The pre-qualified contractor shall be a licensed contractor of the pre-qualified manufacturer. In order to pre-qualify for the project, contractors shall have successfully installed a minimum of 50,000 lineal feet of similar sized fold and formed PVC pipe. Any contractors wishing to pre-qualify shall submit a pre-qualification submittal to the Engineer no later than _____. Submittals shall be sent to the following street address or if regular mail to P.O. Box:

City of Cayce
Attn: Judy Hall
1800 12th Street Extension
Cayce, SC 29033
Or
City of Cayce
Attn: Judy Hall
P.O. Box 2004
Cayce, SC 29171

or faxed to the City of Cayce, Attn: Judy Hall at (803) 739-5386.

The pre-qualification submittal shall include the Contractor's name with a contact person, license number, address, phone number, fax number, description of previous projects totaling a minimum of 50,000 lineal feet of similar sized pipe,

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and at least three (3) references who are familiar with the fold and formed PVC process and the quality of the Contractor’s work. A contact person and phone number shall be provided for each reference.

Prime Contractors that have been pre-qualified for prior City lining projects shall not be required to resubmit pre-qualification documentation for this project.

2. Manufacturer

Any manufacturer wishing to pre-qualify shall have successfully had 100,000 lineal feet of similar sized fold and formed PVC pipe installed. The manufacturer shall have a minimum of three (3) years experience in the installation of fold and formed PVC pipe. Any manufacturers wishing to pre-qualify shall submit a pre-qualification submittal to the Engineer no later than _____. Submittals shall be sent to the following street address or if regular mail to P.O. Box:

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Cayce, SC 29171

or faxed to the City of Cayce, Attn: Judy Hall at (803) 796-9020

The pre-qualification submittal shall include the Manufacturer’s name, address, phone number, fax number, description of previous projects totaling a minimum of 100,000 lineal feet of similar sized pipe, number of years with experience in the installation of fold and formed PVC pipe, and at least three (3) references who are familiar with the fold and formed PVC process and the quality of the Manufacturer’s product. A contact person and phone number shall be provided for each reference. The manufacturer shall also submit general information about the product, including documentation that the product meets applicable ASTM standards, and any other information that would help the Engineer determine the pre-qualification of the manufacturer.

Manufacturers that have been pre-qualified for prior City lining projects shall not be required to resubmit pre-qualification documentation for this project.

The Engineer shall issue an addendum listing the pre-qualified contractors and

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manufacturers prior to bid.

11.02 SYSTEM DESCRIPTION

- A. The fold and formed liner pipe shall be made from PVC compound, meeting or exceeding all requirements as referenced in ASTM F 1871 – 98.

11.03 QUALITY ASSURANCE

- A. The materials and the method of installation shall be in accordance with ASTM standards and in accordance with manufacturers recommendations.
- B. The Contractor shall test all sewers, service line connections and piping reconstructed under this Contract.
- C. All testing shall be done by the Contractor or an independent testing firm approved by the Engineer.

11.04 REFERENCES

- A. Codes, specifications, and standards, referred to by number or title, shall form a part of this specification to the extent required by the reference thereto. Latest revision shall apply in all cases.
 - 1. Following is a partial list of American Society of Testing & Materials which are applicable to this specification.
 - a. **ASTM-F 1867-98** Standard Practice for Installation of Folded/Formed Poly Vinyl Chloride (PVC) Pipe Type A for Existing Sewer and Conduit Rehabilitation
 - b. **ASTM-F 1871-98** Standard Specification for Folded/Formed PVC Pipe Type A for Existing Sewer and Conduit Rehabilitation
 - c. **ASTM-D-1784** Standard Specification for Rigid Poly Vinyl Chloride (PVC) Compounds and Chlorinated PVC (CPVC) Compounds

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11.05 SUBMITTALS

A. SHOP DRAWINGS

The Contractor shall submit at least five (5) copies of shop drawings to the Engineer for approval. The shop drawings shall include the items listed below:

1. Contractor's stamp verifying Contractor's approval on each shop drawing. Shop drawings shall not be approved without a Contractor's stamp.
2. Liner data showing liner meets all requirements of ASTM F 1871-98 and ASTM D 1784.
3. Complete catalog cuts and technical data and the manufacturer's recommendations as to method of installation.
4. Liner Design Calculations.
5. Curing process and recommended curing cycle.
6. Factory Quality Control Test Reports for each Liner Reel.

B. PRE-CONSTRUCTION VIDEO

1. Provide two (2) copies of tapes of the video inspection performed no longer than 24 hours prior to installation of the fold and formed pipe. Videotapes shall include voice description, as appropriate, with stationing of services indicated. Data and stationing to be on videotapes. Videotapes shall begin at Station 0.0 Ft. TV codes shall conform to the City of Cayce Sewer Condition Classification Manual, latest edition.

C. POST CONSTRUCTION SUBMITTALS

1. Provide two (2) copies of videotapes of sewer after installation of the fold and formed pipe. Videotapes shall include voice description as appropriate with stationing of services indicated. Data and stationing to be on videotapes. Videotapes shall begin at Station 0.0 Ft. TV codes shall conform to the City of Cayce Sewer Condition Classification Manual, latest edition.
2. Provide one (1) copy of multiple CD's containing one MPV file for each post TV inspection of the liner from manhole to manhole. The CD's may be filled to capacity with as many MPV files that will fit on a CD. Each MPV file will be labeled with corresponding manhole numbers of the line segment inspected. For example, a file containing TV information of a liner inspected from manhole 2800 to manhole 2801 would be labeled "2800-2801.MPV".

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11.06 PRODUCT HANDLING

- A. The Contractor shall use all means necessary to protect sewer line materials before, during, and after installation and to protect the installed work and materials of other trades. In the event of damage, the contractor shall immediately make all repairs and replacements necessary to the approval of the Engineer, at no additional cost to the Owner.

11.07 SITE CONDITIONS

- A. The Contractor shall satisfy himself of the condition of the sewer sections or pipeline to be lined. The Contractor shall be responsible for verifying the size and condition of the existing sewer and his ability to rehabilitate the sewer using fold and formed pipe, prior to ordering materials, by TV inspection and shall not receive compensation for excavations to remove obstructions due to conditions of which he could have informed himself.
- B. Prior to entering access areas such as manholes or inspection hatches and performing inspection or cleaning operation, an evaluation of the atmosphere to determine the presence of toxic, flammable vapors or lack of oxygen must be undertaken by the Contractor in accordance with local, state and federal OSHA safety regulations.
- C. TELEVISION INSPECTION
 - 1. No longer than 24 hours prior to installation, all sewer sections which are to be rehabilitated using fold and formed pipe are to be inspected by closed circuit television to confirm any changes that have occurred from the date of the original inspection. All sewer sections are to be cleaned as stated below prior to the television inspection.
 - 2. The television inspection shall be performed in order to supply a visual and audio record of the location of obstructions in the sewer that would interfere with or prohibit lining of the sewer and provide the location of service laterals that are to be reconnected to the new fold and formed pipe. A color television inspection camera with pan and tilt capability is required for all inspections.
 - 3. Videotapes, CD's, and hard copy reports shall be made for each line inspected. The quality of the tapes shall be such that obstructions and service lateral locations are clearly identified and can be located. The Contractor shall make the tapes, CD's, and reports available to the Owner for review. Areas in the pipe where camera is underwater shall be cleared of debris prior to or during inspection to allow complete survey of pipe.

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Post construction video with “camera underwater” conditions due to debris will not be accepted.

4. If there is an obstruction in the sewer line that will not allow the television camera to pass, then the camera shall be backed out of the line and an attempt shall be made to televise the line from the manhole at the other end. If the entire length of the sewer line cannot be televised because of two or more obstructions, then the Engineer shall be notified and a determination of how to proceed shall be made by the Engineer.
5. The Contractor shall provide a videotape and CD of the finished fold and formed pipe after accepted by the Owner.
6. The cost of the television inspection, videotapes, CD’s and reports shall be included in the unit cost of the fold and formed pipe.
7. The City of Cayce intends to perform an additional video inspection of the lines prior to the expiration of the one-year warranty.

11.08 WARRANTY

The manufacturer shall warrant all materials to be free from defects in workmanship and materials for a period of one (1) year after final acceptance.

11.09 PIPE LINING MATERIALS

A. POLY VINYL CHLORIDE LINER

1. The liner shall be fabricated to a size that, when installed, will neatly fit the internal circumference of the conduit specified by the Engineer. Allowance for circumference stretching during insertion shall be made. The liner material shall be made from a poly vinyl chloride (PVC) compound.
2. The minimum length shall be of a distance to span the distance from inlet to the outlet of the respective pipe to be lined. The Contractor shall verify the lengths in the field before forming.
3. The minimum thickness shall be SDR 32.5, which is verified by design calculations by a professional engineer. The existing host pipe shall be considered **fully deteriorated** for design calculations. Contractor shall confirm loadings on buried pipe based on depths, soil conditions and water table. The height of water table shall be the same as the depth of soil above the pipe. The design soil unit weight shall be 120 pounds per cubic

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foot. The pipe shall also be designed for an additional AASHTO HS-20 highway live load condition. All pipes shall have a minimum of 2% ovality in the circumference. Any deviation must be approved by the Engineer.

- 4. Unless otherwise specified, the Contractor shall furnish a Poly Vinyl Chloride compound liner pipe meeting all the requirements for cell classification 12111-C, as defined in Specification D 1784, and with minimum physical properties as listed below:

<u>Physical Characteristics</u>	<u>Test Procedure</u>	<u>Rating</u>
Tensile Strength	ASTM D-638	3,600 psi
Tensile Modulus	ASTM D-638	155,000 psi
Flexural Strength	ASTM D-790	4,100 psi
Flexural Modulus	ASTM D-790	145,000 psi

The Contractor shall furnish, prior to use of the materials, satisfactory written certification of this compliance with the manufacturer’s standards for all materials and conformance with the methods of the manufacturer.

11.10 SURFACE PREPARATION

- A. All sewer sections which are to receive the fold and formed pipe are to be thoroughly cleaned and all debris, roots and other obstructions removed. All material removed from the existing sewer sections shall be properly transported to an approved disposal site obtained by the Contractor on a daily basis. Under no circumstances will the Contractor be allowed to accumulate debris or to create a public nuisance.
- B. The method used to clean the sewer sections shall be at the option of the Contractor and may include high pressure water jet cleaning, brushes, balls, swabs, bucket machine or other methods. The Contractor shall be responsible for damage to the sewer sections due to improper cleaning methods.
- C. The cost of preparatory cleaning shall be included in the unit price of the folded/formed pipe.
- D. **REMOVAL OF OBSTRUCTIONS IN SEWER**
 - 1. Obstructions in the sewer sections which cannot be dislodged or cleared by cleaning, bucketing, dragging a mandrel, or other internal methods shall be cleared by excavation. The Contractor shall notify the Engineer prior to any excavation work that is performed that is not indicated on the plans.

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2. The excavation shall conform to requirements of Section VI-1, “Excavation,” and shall be located to minimize the obstruction of traffic where possible. The size of the excavation shall be kept to a minimum and shall be shored and sheeted as required.
3. The existing sewers shall be repaired, after the obstruction is removed, in accordance with the City of Cayce Standards.
4. If more than two obstructions require excavation in any one sewer section, the Contractor shall notify the Engineer and a determination of how to proceed shall be made by the Engineer.

11.11 FIELD MEASUREMENTS

The Contractor shall make all necessary measurements in the field to ensure precise fit of items in accordance with the drawings. In the event of a discrepancy, the Contractor shall immediately notify the Engineer. The Contractor shall not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

11.12 INSPECTION OF PIPE LINER

Each pipe liner shall be subject to inspection by the Engineer immediately before it is installed. Defective liner or undersized thickness liner will be rejected for use on the project.

11.13 INSTALLATION OF PIPE LINER

A. INSTALLATION PROCEDURES:

The following installation procedures shall be adhered to unless otherwise approved by Owner’s representative.

1. **SAFETY:** The Contractor shall carry out his operations in strict accordance with all OSHA and manufacturer’s safety requirements. Particular attention is drawn to those safety requirements involving working with hazardous/combustible materials, scaffolding, and entering confined spaces.
2. **CLEANING OF SEWER LINE:** It shall be the responsibility of the Contractor to remove all internal debris from the sewer line to the liner manufacturer’s requirements.
3. **INSPECTION OF PIPELINES:** Inspection of pipelines shall be performed by experienced personnel trained in locating breaks, obstacles and service

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connections by closed circuit television. The interior of the pipeline shall be carefully inspected to determine the location of any condition which may prevent proper installation of the liner into the pipelines and it shall be noted so that these conditions can be corrected. A video tape and suitable log shall be kept for later reference by the Owner. Pre-installation video shall be no older than 24 hours.

4. **BYPASSING FLOW:** The Contractor, when required, shall provide for the flow around the section of pipe designated for the liner. The bypass shall be made by plugging the line at an existing upstream manhole and pumping the flow into a downstream manhole or adjacent system. The pump and bypass line shall be of adequate capacity and size to handle the flow.
5. The Contractor shall make every effort to maintain service usage throughout the duration of the project. In the event that a service will be temporarily out of service, the maximum amount of time of no service shall be 8 hours for any property served by the sewer. The Contractor shall be required to notify the City and all affected properties whose service laterals will be out of commission and to advise against water usage until the sewer main is back in service. Such notifications shall be provided to the City at least one week prior to service disconnecting. Any costs incurred by overflowing in a home or business shall be the responsibility of the Contractor.
6. **LINE OBSTRUCTIONS:** It shall be the responsibility of the Contractor to clear the line of obstructions or collapsed pipe that cannot be removed by conventional sewer cleaning equipment, then the Contractor shall make a point repair excavation to uncover and remove or repair the obstruction. Such excavation shall be approved in writing by the Owner's representative prior to the commencement of the work and shall be considered as a separate pay item.

B. INSTALLATION OF PIPE LINER

The method of installation shall be compatible with the manufacturer's recommended practices and shall meet ASTM-F 1867-98. For the pipe liner, the installation shall be as follows:

1. The liner pipe shall be inserted into the existing sewer through existing manholes, without modification of manholes.
2. **FORMING:** After installation is completed, the Contractor shall supply suitable steam source equipment. The equipment shall be capable of

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delivering steam through the lining section to uniformly raise the temperature to effective forming of the PVC liner. This temperature shall be determined by the system employed.

3. The heat source shall be fitted with suitable monitors to gauge the pressure of the outgoing steam supply. Another such gauge shall be placed at the remote manhole to determine the pressure during forming. Monitoring methods and forming period shall be as recommended by the liner manufacturer.
4. The liner pipe shall be expanded until it is pressed tightly against the existing pipe walls.
5. If the liner fails to form, the Contractor shall remove the failed liner and replace it with a new liner. This work shall be performed without additional cost to Owner.
6. After the liner has been formed, the ends of the liner shall be cut away at both manholes, leaving 4" inside of manhole. No ponding upstream of drain hole invert or in manhole will be accepted. Existing invert may require chipping prior to pipe installation.
7. FINISH: The finished liner pipe shall be continuous over the entire length of run between two manholes and be as free as commercially practical from visual defects such as foreign inclusions and pin holes. It shall also meet the leakage requirements or pressure test specified below.
8. Any defects which will affect in the foreseeable future or warrant period, the integrity or strength of the liner pipe shall be repaired at the Contractor's expense. Allowance shall be given for excess pipe (rib) when the cross-sectional area has been reduced due to offset joints, out of round sections, etc.

C. SEALING AND BENCHES IN MANHOLE

1. The fold and formed pipe shall make a tight fitting seal with the existing pipe(s) in the manhole. 1/2" diameter activated oakum band soaked in Scotch Seal 5600 or equal, shall be applied circumferentially near the annular space touching the end of existing pipe and encased with a cementitious mortar. Top half of the pipe shall be neatly cut off and not broken or sheared off, at least 4" away from the walls and a pipe collar built over pipe. The channel in the manhole shall be smooth continuation of the pipe(s) and shall be merged with other lines or channels, if any. Channel cross-section shall be U-shaped with a minimum height of 6" for 8" pipe and full depth for greater sized pipes. The side of the channels shall be built up with mortar/concrete to provide benches at a maximum of

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1” in 12” pitch toward the channel. All grout work including invert bench and pipe collars are to have a steel trowel finish.

2. Payment for above work shall be incidental to sewer rehabilitation by the fold and formed method, since that payment is made from centerline to centerline of manhole(s), be that the end of the liner.

The fold and formed pipe and the existing pipe in the manhole must be sealed as above before proceeding on to the next manhole section, and all manholes shall be individually inspected for liner cut-offs, benches and sealing works.

D. SERVICE / OUTSIDE DROP RECONNECTIONS

1. After the pipe liner has been formed in place, the Contractor shall reconnect the existing active service connections as designated by the Engineer. This shall be done without excavation unless otherwise directed by the Engineer, from the interior of the pipeline by means of a television camera and a cutting device that re-establishes the service connections to not less than 90 percent capacity.
2. The exact location and number of service connections shall be determined from TV tapes and/or in the field. It shall be the Contractor’s responsibility to accurately field locate all existing service connections whether in service or not. *The Contractor shall reconnect all active service connections to the liner pipe, unless directed otherwise by the Engineer.* The Contractor shall be responsible for restoring/correcting without any delay, all missed or faulty reconnections, as well as for any damage caused to property owners for not reconnecting the services soon enough or for not giving notice to the Owners. All services which are reconnected to rehabilitated liner shall be shown on the “Record Drawings” with the exact distance from the nearest upstream/downstream manhole.
3. All existing service connections shall be reconnected by Remote TV Controlled Cutting Device method. In the event that the remote cut does not meet the Engineer’s approval with respect to quality and workmanship, the service connection shall be performed by excavation at no additional cost to the Owner.
4. The engineer may direct the Contractor to replace the service lateral from the main line to the clean-out assembly (See No. 6 in this Section).
5. Service Connection by Remote Cut

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- a. All service connections shall be done by TV controlled Remote Cutting Device unless otherwise directed by the engineer. These shall be made by experienced operators so that no blind attempt or holes are made in the liner pipe. Location shall be re-verified carefully with earlier tapes for accuracy, especially where dimples are not defined or clearly ascertained. The Engineer reserves the right to require service connection by excavation at certain or all locations at no additional cost to the Owner, if the quality, workmanship and approval rating for remote cut is poor and not satisfactory.
- b. The remote cut shall be smooth and circular in nature as seen by a 360° TV camera. The hole shall be a maximum of 100% and a minimum of 90% of the service pipe diameter. It shall be properly aligned and be concentric to the existing connection. The locations of all remote cuts shall be verified carefully to match with earlier tapes for their exact locations. Excess, wrong holes or trial cuts shall not be made and must be repaired at no cost to the Owner to the full satisfaction of the Engineer. The Engineer may check the completed remote connections for the minimum 90% requirement by excavating the site, in which case payment shall be made for the excavation at the location and for any special backfill, if necessary. Defective connections shall be repaired to the Engineer's satisfaction at no extra cost.
- c. Protruding taps that will obstruct or hinder the insertion of the liner, shall be removed to allow the liner to pass through. If these taps are to be reinstated at a later time by excavation, the initial removal will be incidental. If the camera equipment cannot pass, the trimming will be paid as a removal of protruding service by remote cut upon approval by Engineer.
- d. Outside drop pipes at drop manholes shall be reconnected by remote cut. Payment for this reconnection shall be the same as for a service connection by remote cut.

6. Service Connection by Excavation

- a. In the event of poor quality or workmanship of the remote cut, or if service lateral replacement is directed by the Engineer, the existing service connections may be done by Excavation method with the Engineer's approval. The existing sewer (now the carrier or host pipe for the liner) shall be carefully broken/removed to expose the liner to the extent necessary. The liner pipe shall not be damaged and shall be allowed to normalize to ambient temperature and cool down, before a 4" or 6" diameter hole is cored out with a hole saw.

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This coupon shall be retrieved and handed over to the Engineer for inspection of the liner thickness at that location, if so required. The size of new service shall match the existing service size.

- b. A three piece service connection shall be installed consisting of an IPS/Schedule 40 PVC hub, rubber sleeve and 301 stainless steel band. The service connection shall be a compression fitting such as INSERTA TEE as manufactured by Inserta Fittings Company or equal for 8" and larger mains. The rubber sleeve shall meet ASTM C443. The PVC hub gasket shall meet ASTM F477.
- c. The rubber sleeve shall be lubricated as recommended by the manufacturer. The rubber sleeve shall be inserted into the pipe liner such that the entry lip forms a complete seal between the inside of the pipe liner and the sleeve entry lip. The PVC hub shall be inserted into the rubber sleeve to the mark shown on the outside of the hub. The hub shall not protrude into the pipe liner such that a TV camera cannot pass.
- d. Place the stainless band around the top of the rubber sleeve and tighten down. Install lateral service pipe in the normal manner.
- e. If directed by the Engineer, the contractor shall replace the existing service line to the clean-out assembly.
- f. One or more homes discharging into a common connection shall be considered as one service connection. Damage repair to residences or properties due to delay or faulty connections shall be incidental.
- g. Compression fittings shall not be used on 6" main lines. Saddles shall be used for 6" lines as shown on the plans.

E. TESTING

Gravity sewers rehabilitated using fold and formed pipe shall be tested in accordance with Section VI-II of the Technical Specifications with the exceptions that tests relating to grade and alignment are not required.

All service line connections noted as leaking shall be repaired or replaced and then retested. The Contractor may be allowed to leave the service line connection exposed in one (1) manhole section at a time, to minimize inconvenience and hazard to the residents. If service line connection repair or replacement, testing or retesting, and backfilling of the excavation is not completed within the work day, the Contractor shall properly cover each excavation with steel plates, plywood, or

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some other approved material, to keep the area secure from accidents or hazard.

11.14 SERVICE LATERAL REHABILITATION

- A. For all service connections that do not currently have a clean-out assembly installed at the edge of the road right-of-way or prescriptive right-of-way, the Contractor shall install a clean-out assembly on the existing service lateral. Laterals to have clean-outs installed shall be approved by the Engineer's field representative prior to installation.

Clean-out assemblies shall be installed in accordance with the City's standard details and technical specifications.

- B. In addition to the television inspection that will be required prior to installation of the fold and formed PVC pipe, all service laterals shall be inspected. The method of televising service laterals may be chosen by the Contractor, but must be coordinated and approved by the Engineer prior to inspection of the laterals.

The Contractor shall coordinate each service lateral inspection with the Engineer's field representative. At the time of the inspection, the field representative shall make a decision whether to replace the lateral or not. The field representative may determine that replacement of the lateral is not required.

- C. If it is determined that the lateral needs to be replaced, the Contractor shall replace the existing service line from the clean-out to the main collection system line by means of open-cut excavation. Service laterals shall be constructed in accordance with the City's standard details, the Special Conditions (Section V), and Section VI – II of the Technical Specifications.

11.15 FIELD QUALITY CONTROL

- A. The manufacturer of the fold and formed material shall provide technical and installation advice to the Contractor work force when first installing the fold and formed pipe. The service of an experienced installation representative shall be provided for a minimum of two days at no additional cost to the Owner.
- B. Video tapes shall be required after the liner has been installed in the existing sewer pipe, at no additional cost to the Owner. The televising shall be done after all service connections have been made, unless required earlier by the Engineer.
- C. A smoke test shall be performed on all service line connections made by open excavation that are constructed due to poor quality or workmanship of the remote cut, at no extra cost to the Owner. No excavated taps shall be backfilled until completion of this test. The Contractor shall isolate the manhole section to be

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tested from the adjacent manhole sections to prevent smoke from migrating into lines not being tested, as well as to provide a concentration of smoke in the section being tested.

- D. All smoke testing shall be closely coordinated with and scheduled through the Owner. Before smoke testing, written notice(s) shall be given to the area residents not fewer than two (2) days, nor more than seven (7) days, prior to the proposed testing. Notice shall also be given to the local Police Department and local Fire Station, twenty-four (24) hours prior to actual smoke testing. This test shall be conducted by forcing smoke from smoke generators, through the newly rehabilitated sanitary sewer main. The smoke generators shall have a minimum duration of five (5) minutes with a capacity of 1500-2000 cfm.
- E. Smoke shall be introduced as per the Manufacturer's recommendations. The Engineer, accompanied by the Contractor, shall check each service line connection being tested. Sources of all leaks must be found and noted for correction.
- F. All service line connections noted as leaking shall be repaired or replaced and then retested. The Contractor may be allowed to leave the service line connection exposed in one (1) manhole section at a time, to minimize inconvenience and hazard to the residents. If service line connection repair or replacement, testing or retesting, and backfilling of the excavation is not completed within the work day, the Contractor shall properly cover each excavation with steel plates, plywood, or some other approved material, to keep the area secure from accidents or hazard.
- G. In houses where smoke does not issue from the plumbing vent stacks to confirm the reconnection of the sewer service to the newly installed liner, a dye test may be required to confirm the reconnection. Dye shall be introduced into all service lines and then each line shall be flooded with water. The Contractor and the Engineer shall look to the downstream manhole to detect the dye coming out of the sewer main. This shall confirm a reconnection. If any more than one service connection is dye tested at a time, these dye tests shall be done with enough time allowed between each test to allow the dye to be purged from the line. Otherwise, different colored dyes shall be used. Dye testing shall be performed by the Contractor at no additional cost to the Owner.

11.16 POST TELEVISION OF COMPLETED SECTIONS

- A. The Contractor will provide to the Owner a color video tape taken by a 360° radial view camera for close up view, showing the completed work, including the condition of the restored pipes prior to requesting payment.
- B. Television inspection, tapes, CD's and reports, etc., shall be as specified elsewhere

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in this section. Upon completion of the installation work and testing, the Contractor shall restore/clear the project area affected by his operations. No trash, rubbish etc., shall be stored at any site, be the work in progress or not.

11.17 CLEAN-UP

1. The contractor shall restore or replace all removed or damaged paving, curbing, sidewalks, gutters, shrubbery, fences, sod or other disturbed surfaces or structures in a condition equal to that before the work began, to the satisfaction of the Engineer, and shall furnish all labor and material incidental thereto.
2. Surplus liner material, tools and temporary structures shall be removed by the Contractor. All dirt, rubbish and excess earth from operation shall be legally disposed of by the Contractor, and the construction site shall be left clean, to the satisfaction of the Engineer.

11.18 PATENTS

The Contractor shall Warrant and save harmless the Owner against claims for patent infringement and any loss thereof.