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SECTION 600 – SANITARY SEWER

SECTION 600 – GENERAL REQUIREMENTS

600.01 – DESCRIPTION

This section covers general construction requirements of sanitary sewers and sewer appurtenances as described herein.

600.01.01 – DEFINITIONS

A) DIP – Ductile Iron Pipe
B) ENGINEER – The individual or firm responsible for the design associated materials needed for the completion of a project
C) Fitting – A part used to connect piping or tubing.
D) Inlet – The opening in a valve or fitting through which flow enters the valve or fitting.
E) N.P.T. – National Pipe Thread as specified in ANSI/ASME B1.20.1
F) OCWUT – Oklahoma City Water Utility Trust
G) Outlet – The opening in a valve or fitting through which flow from the waterline leaves the valve or fitting.
H) Owner – Oklahoma City Water Utility Trust and/or City of Oklahoma City
I) PVC – Polyvinyl Chloride

600.02 – PREQUALIFICATION

All Contractor's must be pre-qualified as to perform all Sewer Construction Work as required by the most recent ordinance, passed by the Council of the City of Oklahoma City. The Contractor must obtain all permits required by the City of Oklahoma City, State and Federal regulations and laws.

600.03 – CONSTRUCTION OUTSIDE CITY LIMITS

The Contractor performing work outside the corporate limits of Oklahoma City will comply with all ordinances, regulations, and policies of the county and city wherein the work is located. The Contractor must obtain any permits, provide barricades and lights, and make repairs as required by the responsible authorities. When performing work on any Oklahoma City assets, Contractors shall meet all requirements in Section 600.02 "General Requirements - Prequalification".

600.04 – TEST HOLES

Test hole information, when shown on the plans or included in the specifications, must only represent subsurface characteristics to the extent indicated, and only for the point location of the test hole. Each bidder must make their own interpretation of the character and condition of the materials that will be encountered between test hole locations. Each

prospective Bidder may, at their own expense, make additional surveys and investigations as may be deemed necessary to determine conditions which will affect performance of the work.

600.05 –CONSTRUCTION SEQUENCE AND CONSTRAINTS

A) The Contractor must start at enough different locations to complete the entire contract within the contract duration specified.

B) The construction of all sewers must begin at the low point in the line in every case working toward the high point.

C) When the construction involves the building of main or submain sewers having one or more lateral or tributary, the construction of tributary lines must not be started until the main or submain sewer has been completed to the point where the tributaries or laterals discharge into it, except as may be approved by the Engineer. Approval by the Engineer does not relieve the Contractor of any responsibility for meeting the specified connections.

D) Sewer appurtenances must be constructed as soon as the sewer that they serve is constructed to their locations. Postponing of the construction of appurtenances until the sewer line has been completed, or the building of appurtenances in advance of the construction of the sewer line, will not be permitted.

E) The construction of sewers eighteen inches (18-in) in diameter and smaller for more than six hundred feet (600-ft), and sewers twenty-one inches (21-in) in diameter and larger for more than three hundred feet (300-ft) in advance of appurtenances which are incomplete or the construction of which has not been started, will not be permitted.

F) Unless otherwise directed by the Engineer and/or Owner, the Contractor must leave no more than nine hundred feet (900-ft) between backfilling operations and the complete restoration of paving, paving repairs, fencing, sodding, etc.

G) When temporary surfacing is provided for in the contract documents, the Contractor must complete temporary paving repair as per Section 824, “Temporary Surfacing”, immediately before backfill is completed.

H) The Contractor must take proper precautions to avoid excavating earth or rock or shattering rock beyond the limits of excavation shown on the plans. All damages caused by excavating or blasting, either to surface or subsurface structures, must be repaired or replaced by the Contractor at their own cost and expense.

600.06 – DELIVERY OF MATERIALS

Construction materials cannot be delivered to the site of the work more than three (3) calendar days in advance of their anticipated use nor can the quantity of pipe or other materials on hand at the site of the work at any time be in excess of the amount required to complete Six hundred feet (600-ft) of sewer unless with special permission of the Engineer.

Unless otherwise specified, all concrete used in construction of sewers and their appurtenances must have a minimum twenty-eight (28) day compressive strength of three thousand five hundred pounds per square inch (3,500-psi) and must conform with the applicable requirements of Section 900. All steel reinforcement used must be grade sixty (60) with a minimum yield strength of sixty thousand pounds per square inch (60,000-psi) and meet the applicable material requirements of Section 900.

600.07 – SEWER GRADES

A) General – The grade line shown on the plans is the elevation of the invert or flow line of the sewer. The sewer grade must be established by use of laser beam, or other methods approved by the Engineer.

B) Laser Beams – When laser beams are used to establish line and grade, they must first be calibrated in accordance with the equipment manufacturers recommended procedures. The Contractor must establish horizontal and vertical controls (offset stakes) with a transit or theodolite, or any other equipment approved by the Engineer. The Contractor may then proceed to establish line and grade using the laser equipment. In conjunction with the laser beam, the Contractor may also be required to provide temporary benchmarks at intervals as specified by the Engineer.

600.08 – STOPPERS OR BULKHEADS

Dead ends of all sewers, wyes, tees, etc., must be closed with approved stoppers secured in place with concrete. When shown on the plans or required by the Engineer, such openings must be filled in with brick masonry or concrete. Tight fitting stoppers or bulkheads must be securely placed in or across the end of all sanitary sewer lines when construction is stopped at the end of each day's work or for any other cause. When work is stopped temporarily on sanitary sewers twenty-four inches (24-in) in diameter and smaller, the exposed end of the pipe must be closed to prevent trash or debris from entering the pipe. Such stoppers need not be watertight.

600.09 – SURFACE DRAINAGE STRUCTURES

When not called for on the plans or specified as separate bid item, all surface drainage structures and appurtenances must be removed and replaced in a condition equal to or better than the original installation when required. No additional compensation will be

made for this work, and the cost be included in the other pay items.

600.10 – TEMPORARY SEWER AND DRAIN CONNECTIONS

When existing sewers have to be taken up or removed, the Contractor at his own expense, must provide and maintain temporary outlets and connections for all private or public drains, sewers, or sewer inlets. They must also take care of all sewage and drainage which will be received from these drains, sewers, and sewer inlets; and for this purpose, they must provide and maintain at their own expense, adequate pumping facilities and temporary outlets or diversions. They must construct such trough, pipe, or other structures necessary and be prepared at all times to dispose of drainage and sewage received from these temporary connections until such time as the permanent connections are built and have service. The existing sewers and connections must be kept in service and maintained under the contract, save where specified or ordered to be abandoned by the Engineer. All water or sewage must be disposed of in a satisfactory manner so that no nuisance is created and that the work under construction will be adequately protected. Temporary Sewer and Drain Connections must be constructed, maintained, and managed within the guidelines established within the Storm Water Pollution Prevention Plan (SWPPP), the City of Oklahoma City Storm Water Management Plan (SWMP), and Oklahoma Department of Environmental Quality (ODEQ)..

600.11 – CLEANUP

After installation of each section of sewer line, the Contractor must remove all spoils resulting from work, debris, construction materials and equipment from the site of work, grade, and smooth over surfaces on both sides of the line, and leave the right-of-way and easement in a clean, neat, and serviceable condition prior to sodding , seeding, and/or sprigging.

SECTION 601 – PIPE INSTALLATION

601.01 – DESCRIPTION

This section covers installation of pipes in open-cut trenches, in conformity with the lines, grades, and dimensions and as provided in applicable sections of these specifications.

601.02 – PIPE MATERIALS

601.02.01 – PIPE

Acceptable pipe materials and fittings must meet the requirements of the appropriate sections listed below:

Pipe Type	Pipe Materials	Section
Rigid	Vitrified Clay Pipe (VCP)	630
Flexible	Ductile-Iron Pipe (DIP)	631
	High Density Polyethylene (HDPE) Pipe	632
	Polyvinyl Chloride (PVC) Pipe	633
	Reinforced Fiberglass Pipe (RFP)	634

601.02.02 – EMBEDMENT MATERIAL

A) General – Embedment material must meet the requirements of Section 215, “Embedment Material”. Prior to delivery, the Contractor must submit laboratory tests for materials to be used for embedment and backfill. The Engineer prior to placement must approve materials.

B) Invoices – The Contractor must submit invoices for the purpose of complying with the minimum quantities necessary to complete installation pursuant to the appropriate standard details and the minimum dimensions specified.

601.03 – CONSTRUCTION METHODS

601.03.01 – BEDDING AND HAUNCHING

A) Rigid Pipes – All rigid pipes must be embedded in accordance with ASCE Manual No. 60, "Gravity Sanitary Sewer Design and Construction", Class "B" Bedding and in accordance with the dimensions and lines shown on the Standard Detail on Construction and meeting the requirements of Section 215, “Embedment Material”.

B) Flexible Pipes – All flexible pipes must be embedded in accordance with ASTM D-2321, "Standard Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe", and in accordance with the dimensions and lines shown on the Standard Details of Construction and meeting the requirements of Section 215, “Embedment Material”.

601.03.02 – INSTALLATION REQUIREMENTS

A) Shipping, Handling and Storage – Pipe must be transported from the manufacturer, to the project site employing special methods of packaging to prevent damage to the pipe. After the pipe is received at the project site, it must be carefully inspected for any damage that may have occurred in transit. The pipe must be handled at all times with care using padded slings or hooks. The pipe must not be dropped, skidded or rolled against pipe already on the ground. If any damage occurs to pipe, the pipe will be rejected. All pipe and accessories must

be stored on flat, level ground with no rocks or other objects under the pipe. Gaskets for push-on joints and pipe must be stored in cool location out of direct sunlight in accordance with the manufacturer's recommendations.

B) Quality of Work – Watertight joints, first grade material and accurate construction will be required. Furthermore, utmost care must be exercised in laying pipe to line and grade, constructing inverts in manholes, transitions, and other joints as may be required during construction.

C) Pipe Foundation – No sewer will be laid unless the foundation is in a condition satisfactory to the Engineer. Where trenches are excavated in soft, unsuitable soil, or rock, trench bottom must be stabilized in accordance with Section 212, "Trench Excavation and Backfill", when directed by the Engineer.

D) Trench Dewatering – The Contractor must keep stormwater and stream water out of the trench. The Contractor must maintain groundwater level below pipe or rip-rap.

E) Laying Requirements – All pipes, specials, fittings and other appurtenances must be examined carefully for damage and other defects before installation. The Owner retains the right to reject damaged and defective materials.

The pipe ends must be free of all lumps, blisters and they must be wiped clean of foreign materials such as dirt and sand before installation.

Pipe laying must proceed upgrade, starting at the lower end of the grade and with the bells uphill, using laser beams or other methods approved by the Engineer pursuant to this section.

Bell holes for bell-and-spigot pipe must be excavated at proper intervals so that the barrel of the pipe will rest for its entire length upon the bottom of the trench. Bell holes must be large enough to permit proper installation of pipe. Bell holes must not be excavated more than ten (10) joints ahead of pipe laying. Filling and ramming earth or other material beneath the pipe to raise it to grade will not be permitted.

The Contractor must use every precaution at all times during construction of the pipeline. All pipe, specials, fittings, and other appurtenances must be lowered carefully into the trench with suitable equipment, to prevent damage to the sewer main materials. In rock trenches, plywood shields or other approved means must be used to prevent the cradled pipe from swinging against the sides of the trench.

All joint preparation and joining operations must comply with the instructions and recommendations of the pipe manufacturer and meet the joint requirements in the appropriate material section. Rubber gaskets must be positioned on the joint in accordance with the manufacturer's recommendations. Immediately before joints are pushed together, all joint surfaces must be coated with the lubricant furnished with the

pipe.

Any damage to the pipe and/or rubber gasket, from any cause during installation of the pipeline will be cause for replacement, as directed by the Engineer, and at the expense of the Contractor.

After a section of pipe is properly installed and approved for backfill, the trench must be backfilled and compacted as per Section 212, “Trench Excavation and Backfill”.

601.04 – METHOD OF MEASUREMENT

Payment for "Sanitary Sewer Pipe" must be made at the unit price bid per linear foot of pipe installed for each size. The price established must be full compensation for all materials including pipe, material, labor, tools, equipment and incidentals necessary to complete this item of work. Payment does not include the cost of trench excavation and backfill nor foundation material for soft and unsuitable soil conditions.

Measurement for "Sanitary Sewer Pipe" must be from station to station through manholes, junction boxes and other small structures.

601.05 – BASIS OF PAYMENT

Payment for embedment material is included in “Sanitary Sewer Pipe”, The items measured as provided above will be paid for at the contract unit price bid:

SANITARY SEWER PIPE (SIZE) L.F.

SECTION 602 – SEWER SERVICE CONNECTION

602.01 – DESCRIPTION

This section covers construction of sewer service connections when called for on the plans or as directed by the Engineer

602.02 – MATERIALS

602.02.01 – PIPE MATERIALS

Acceptable pipe materials and fittings must meet the requirements of the appropriate sections listed below:

Pipe Types	Pipe Material	Section
Rigid Flexible	Vitrified Clay Pipe (VCP)	630
	* Ductile-Iron Pipe (DIP)	631
	Polyvinyl Chloride (PVC) Pipe	633

* Not to be used for wye branches but for risers only.

602.02.02 – CONNECTION TYPES

The following connection types may be required to make sewer service connections: Connections for New Construction

A) Wye Branches – For new construction there must be installed wye branches of size and type shown on the plans with a minimum of four-inch (4-in) openings at locations shown on the plans or as designated by the Engineer.

B) External Connections to Existing Main – Connections to existing main may be accomplished as follows:

1) Saddles – Connections may be made by excavating to the existing main and cutting a hole using approved equipment and installing a saddle. When the existing main has been rehabilitated by a trenchless method of construction, the saddle connection must be made to the trenchless pipe and/or pipe liner specifications.

2) Tees – Connections may be made by removing a section of the existing pipe and installing a tee.

3) Wye Branches – Connections may be made by removing a section of the existing pipe and installing a wye branch.

4) Fittings, riser, and closure assembly must be used to make the connection and must be supplied in a nominal diameter a minimum of four inches (4-in). The external connections must be considered complete when backfilling and

subsequent surface restoration is completed.

C) Internal Connections (for Resin Impregnated Pipe Liner) – In the case where a resin impregnated pipe liner is installed an internal connection will be allowed along with the installation of a service liner extending to the limits of the right-of-way or easement, when it is included within the project. Otherwise, internal connections will not be allowed.

602.02.03 – RISER

A) General – Risers must be connected to sewer pipe using standard wyes, tees or saddles. No services may be connected to sewer pipe that is twenty-one inches (21-in) and larger in diameter unless directed by the Engineer.

B) Riser Construction – Particular care must be exercised in cutting the sewer pipe so that no damage is done to the pipe and its strength impaired by shattering or cracking of the pipe wall. The end of the fitting must not protrude beyond the inside surface of the sewer main. The annular space around the fitting must be completely filled and smoothly finished with Class "C" mortar with Type II cement.

The backfill must be thoroughly compacted under and above the pipe in the main sewer trench and up to at least the top of the concrete riser support. The backfill around the vertical pipe must be carefully placed and tamped avoiding disturbance of the alignment of the pipe and damage to the joints. The vertical pipe must be anchored to sewer trench wall with one-fourth inch (0.25-in) round hairpin bars.

The riser pipe must extend a minimum of twenty-four inches (24-in) above finish grade when not immediately being connected to a house service line. The riser pipe must be capped to protect from debris and/or water from entering.

A locator tape, green in color, and stating "CAUTION - SANITARY SEWER RISER PIPE BURIED BELOW' must be attached to the sanitary sewer riser and extend to a minimum of two feet (2-ft) above ground. The tape must be three inch (3-in) width unless otherwise specified by the Engineer.

602.02.04 – CONSTRUCTION METHODS

A) General – All work must be constructed in accordance with the Standard Details for Construction. Unless otherwise specified, sanitary sewer connections must be installed so that a plane through the center of the branch and the centerline of the main sewer must make an angle of forty-five degrees (45-degrees) with the horizontal. One cubic foot (1-cf) of concrete must be placed around each connection, the cost of which must be included in other items.

B) Wye & Tee-Wye Branches – Sewer Service Connections constructed with wye &

tee wye, also called combination wye, branches must include a twenty-two and half degree bend (22.5-degree) bend, elbow, and when required, a closure piece.

C) Tees – Sewer Service Connections constructed with tees must include a twenty-two and half degree bend (22.5-degree) bend, and when required, an elbow and a closure piece.

D) Saddles – Sewer Service Connections constructed with saddles must include straps, a twenty-two and half degree bend (22.5-degree) bend, and a closure piece.

E) Multiple Services - Multiple services or common service lines are not allowed. Each unit and/or dwelling must have a separate sewer service connection to the sewer main unless written approval from the Utilities Director is obtained.

602.03 – METHOD OF MEASUREMENT

Payment for "Sewer Service Connection" must be made at the unit price bid for each external connection. The price established must be full compensation for all material, labor, equipment, trench excavation, backfill, and incidentals necessary to complete this item of work.

When external sewer service connections are made in conjunction with installation of Formed-In-Placed Pipe (FIPP) per Section 607, “Formed-in-place Pipe (FIPP)”. Payment for external sewer connection must be made at the unit price bid for each "Point Repair" regardless of depth. External connection (reinstatement) of services must be considered incidental to the lining process and the cost must be included in other items. The price established for "Point Repair" must be full compensation for all material, labor, equipment, trench excavation, backfill, and incidentals necessary to complete this item of work.

Payment for "Riser Pipe" must be made at the unit price bid per linear foot of pipe for new sewer construction. The price established must be full compensation for materials, labor, tools, equipment and incidentals necessary to complete this item of work.

Payment for "Riser Pipe" for replacement and/or rehabilitative sewer construction must not be made directly but must be included in the cost for "Sewer Service Line" as described in Section 603, “ Sewer Service Line”.

602.04 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SEWER SERVICE CONNECTION	EA.
RISER PIPE	L.F.

SECTION 603 – SEWER SERVICE LINE

603.01 – DESCRIPTION

This section covers service lines for future or existing connections. The service line must be installed to a point where an acceptable connection can be made to the existing service if necessary. Pipe must be supplied in nominal diameter a minimum of four inches (4-in).

603.02 – MATERIALS

Acceptable pipe materials and fittings must meet the requirements of the appropriate sections listed below:

Pipe Type	Pipe Material	Section
Rigid	Vitrified Clay Pipe (VCP)	630
Flexible	Polyvinyl Chloride (PVC) Pipe	633

603.03 – CONSTRUCTION METHODS

The installation of a service line includes removing any cap or plug from existing riser, cutting and removing any existing service line, and reconnecting the riser and the existing service line if necessary.

603.04 – METHOD OF MEASUREMENT

Payment for "Sewer Service Line" must be made at the unit price bid per linear foot of pipe, including closure piece, and when required, adapters and other fittings. The price established must be full compensation for all material, labor, tools, equipment and incidentals necessary to complete this item of work.

603.05 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SEWER SERVICE LINE L.F.

SECTION 604 – ABANDONING SEWER

604.01 – DESCRIPTION

This section covers filling of abandoned sewer lines with grout or concrete.

604.02 – MATERIALS

The materials must meet the requirements of Section 218.02, “Embedment Plugs – Materials” for "Flowable Fill Plugs".

604.03 – METHOD OF MEASUREMENT

Payment for "Abandoning Sewer" must be made at the unit price bid per cubic yard. The price established must be full compensation for furnishing and placing all materials, labor, tools, equipment and incidentals necessary to complete this item of work.

604.04 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

ABANDONING SEWER	C.Y.

SECTION 605 – PIPE BURSTING

605.01 – DESCRIPTION

This section covers furnishing and installation of pipe by trenchless method of bursting existing pipes as shown on the plans and in conformity with these specifications. The operation must be conducted with a hydraulic pulling or pushing apparatus and a pipe expander (i.e. pig and swab). The pipe expander must be pushed or pulled through the existing pipe on grade, widening the existing pipe material for insertion of the new pipe material.

605.02 – MATERIALS

605.02.01 – SUBMITTALS

The Contractor must furnish for the Engineer's approval, a plan showing his proposed method of handling, including the design for the equipment, equipment support of backstop, arrangement and position of jacks, pipe guides, etc., complete in assembled position. The approval of this plan by the Engineer will not relieve the Contractor from his responsibility to obtain the specified results.

605.02.01 – PIPE MATERIALS

Acceptable pipe materials and fittings must meet the requirements of the appropriate sections listed below:

Pipe Type	Pipe Material	Section
Flexible	High Density Polyethylene (HDPE) Pipe	632
	Polyvinyl Chloride (PVC) Pipe	633

605.03 – CONSTRUCTION METHODS

605.03.01 – GENERAL

Where pipe is required to be installed under railroad embankments or under highways, streets, or other facilities by trenchless methods, construction must be made in such a manner that will not interfere with the operation of the railroad, street, highway, or other facility, and cannot weaken or damage any embankment or structure. During construction operations, barricades and lights to safeguard traffic and pedestrians must be furnished and maintained, as directed by the Engineer, until such time as the backfill has been completed and then must be removed from the site.

Suitable pit shafts, or trenches must be excavated for the purpose of conducting the trenchless operations and for placing end joints of the pipe. Wherever end trenches are cut in the sides of the embankment or beyond it, such work must be sheeted securely and braced in a manner satisfactory to the Engineer to prevent earth caving.

The removal of any obstruction that may be found to conflict with the placing of the pipe must not be measured for payment nor paid for as a separate contract pay item. The removal of any such obstruction must be included in the cost of other items.

Once the pipe installation has commenced it must be continued uninterrupted around the clock until the pipe has been installed between the specified limits.

Any pipe damaged during operations must be removed and replaced by the contractor at their expense.

The pits or trenches excavated to facilitate the operations must be backfilled immediately after the pipe has been installed.

605.03.02 – CLEANING SEWER LINES

Cleaning sewer lines must be accomplished in accordance with Section 609, “Cleaning Sewer Lines”.

605.03.03 – SEWER FLOW CONTROL

Sewer flow control must be accomplished in accordance with Section 608, “Sewer Flow

Control”.

605.03.04 – POINT REPAIR

Point repairs must be accomplished in accordance with Section 612, “Point Repairs”. Segments between two consecutive manholes that require more than five (5) point repairs for successful rehabilitation may be deleted, by the Engineer, from the specified work. At the discretion of the Engineer, these segments may be replaced by conventional excavation in accordance with Section 212, “Trench Excavation and Backfill”

605.03.05 – SEWER SERVICE CONNECTIONS

All sewer service connections must be accomplished and paid for in accordance with Section 602, “Sewer Service Connection”.

605.05 – METHOD OF MEASUREMENT

"Pipe Bursting" must be measured by the linear foot of pipe completed for each size. The price established must be full compensation for all materials, including pipe, labor, tools, equipment and incidentals necessary to complete this item of work.

605.06 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

PIPE BURSTING (SIZE)	L.F.

SECTION 606 – SLIPLINING

606.01 – DESCRIPTION

This section covers rehabilitation of deteriorated sewer lines by trenchless method of sliding a liner pipe of smaller diameter into an existing circular pipeline, then if required, re-establishing service connections to the new liner pipe.

606.02 – MATERIALS

606.02.01 – SUBMITTALS

Review and approval of the Contractor submittals, by the Engineer, must not be construed in any way as relieving the Contractor and the manufacturers of their responsibilities as specified in these specifications.

A) General – The Contractor must submit source of materials for the specified liner pipe, or proposed liner pipe when alternate materials are specified. No liner pipe must be shipped to job site until all submittals have been reviewed and approved by the Engineer.

B) Construction and Laying Schedule – The Contractor must submit an area map of the project designating the beginning and ending points as well as complete pipe laying and time schedule and detail drawings. The map must also indicate the access points, length, and pipes to be installed. Unless surveyed plans accompany project specifications, all elevations must be determined and included in the Schedule. This must include verification of all elevations on as-built drawings when such information is provided.

C) Submittals - No pipe, special sections and fittings must be manufactured until all submittals have been reviewed and approved by the Engineer. The drawings and data must include but not be limited to the following for each size and class of pipe.

    1) Details of the proposed pipe

    2) Properties, strengths, etc. of pipe

    3) Details of joints

D) Certification of Material Compliance – A signed letter from the manufacturer stating that all material satisfies claims made by the manufacturer and meets the requirements specified. Reports of the plant test including, but not limited to, liner thickness, flexural strength, and flexural modulus must be submitted. The submittal shall be signed and sealed by a Professional Engineer licensed in the State of Oklahoma.

E) Insertion or Access Pits – The location and number of insertion or access pits must be planned by the Contractor and submitted in writing for approval by the Engineer prior to excavation. The pits must be located such that their total number must be minimized, and the footage of liner pipe installed in a single pull must be maximized. Locations of damaged pipe must be used for insertion pits as directed by the Engineer.

F) Sealing Compound and Grout – Contractor must submit proposed sealing compounds to be used for sealing liner pipe at the manholes and type of grout and grouting equipment to be used.

G) Jacking Loads – The Contractor must submit a complete record of all jacking loads for the insertion of the pipe liner. This information must be submitted to the Engineer for review after each insertion operation.

H) Copies – The Contractor must provide a digital copy of all submittals, and if

requested by the Engineer, hardcopies of any submittal must be provided as well.

606.02.02 – LINER PIPE MATERIALS

Acceptable liner pipe materials are as follows and must meet the requirements of the appropriate sections indicated below:

Pipe Type	Pipe Material	Section
Rigid	Vitrified Clay Pipe (VCP)	630
Flexible	High Density Polyethylene (HDPE) Pipe	632
	Polyvinyl Chloride (PVC) Pipe	633
	Reinforced Fiberglass Pipe (RFP)	634

606.03 – CONSTRUCTION METHODS

606.03.01 – CLEANING SEWER LINES

Cleaning sewer lines must be accomplished in accordance with Section 609, “Cleaning Sewer Lines”.

606.03.02 – SEWER FLOW CONTROL

Sewer flow control must be accomplished in accordance with Section 608, “Sewer Flow Control”.

606.03.03 – POINT REPAIR

Point repairs must be accomplished in accordance with Section 612, “Point Repairs”. Segments between two consecutive manholes that require more than five (5) point repairs for successful rehabilitation may be deleted, by the Engineer, from the specified work. At the discretion of the Engineer, these segments may be replaced by conventional excavation in accordance with Section 212, “Trench Excavation and Backfill”.

606.03.04 – INSPECTION OR ACCESS PIT EXCAVATION & BACKFILL

Before excavation is begun, it must be the responsibility of the Contractor to check with the various utility companies and determine the location of the utilities in the vicinity of the work area. The Contractor at no cost to the City must arrange temporary construction easements and/or right-of-way areas.

A) All excavations must be properly sheeted and shored in accordance with relevant specifications for trench safety systems. Any damage resulting from improperly shored excavations must be corrected to the satisfaction of the Engineer with no compensation due to the Contractor.

B) All open excavations must be kept secure at all times by the use of barricades with

appropriate lights and signs, construction tape, covering with steel plates, etc., or as directed by the Engineer.

C) The cost for diversion pumping required around an insertion pit, from a manhole upstream to a manhole downstream, must be per applicable item of these specifications.

D) Excavations initially begun as Point Repairs that, for convenience, are later used as Insertion Pits, must be treated as incidental to sliplining. If the point repair excavation is used as an insertion pit, the Contractor must not be required to replace the carrier pipe.

Excavation and backfill of insertion or access pits must be accomplished pursuant to Section 212, “Trench Excavation and Backfill”.

606.03.05 – LINER PIPE INSERTION

The insertion and installation of the liner pipe must be in accordance with appropriate ASTM Standard Specifications and the Manufacturer's Recommendations.

The liner pipe must be aligned in contact with the invert of the existing sewer. If more than one-third (1/3) of the top profile of the existing sanitary sewer line is not intact and cavities exist above the pipe, the condition of the sewer line must be considered unsuitable and the sliplining operation cannot be performed.

The Contractor must maintain sewage flow at all times. This may be accomplished by allowing flows to pass through the liner pipe. By-pass pumping may also be allowed.

Liner pipe must not be installed prior to the Engineer's approval. The liner pipe must be jacked, pushed or pulled, in case of a butt-welded polyethylene liner pipe (with no exceptions), into the existing pipe. An aqueous solution of Bentonite may be used to minimize the jacking load. For each section to be lined, insertion must be one continuous operation until the planned termination point is reached. Precautionary measures must be taken to ensure against scarring the liner or breaking the joints. It may be necessary to use a nose-cone to guide the pipe end past minor obstructions and prevent entry of debris and to put guards over the edges of the existing pipe at the inlet end to prevent their gouging the pipe during the insertion procedure. Once the insertion is initiated, it must continue to completion without interruption.

Total jacking loads must not exceed the manufacturer's recommendations. The Contractor must provide a suitable means of measuring jacking loads and must monitor the load as the liner pipe is being installed. If at any time the load appears to rise non-uniformly, indicating possible obstruction of the pipe, jacking operations must be terminated and the obstruction or other impediment removed before continuing.

Permanent bends to accommodate line or grade changes must be limited to radii

equivalent to a longitudinal strain recommended by the pipe manufacturer. At no time must this minimum allowable radius of curvature be exceeded.

The Engineer must approve the products employed in the sliplining process. A hydraulic or cable operated winching pipe pushing device may be used. The machine operator must closely and continuously monitor and control the jacking load in uniformity and magnitude. A jacking ring or device must be used to distribute the jacking load evenly over the entire surface perimeter of the pipe end. The Contractor must also utilize a device that holds stable a nearly inserted joint preventing damage to it while the following joint is shoved home. All joint operations must be made in full view of the inspector. The maximum pulling length recommended by the manufacturer must not be exceeded.

After insertion, the pipe must be allowed to normalize for the number of hours suggested by the pipe manufacturer to the temperature of the ground as well as recover any imposed strain before cutting the pipe to length between manholes.

606.03.06 – LINER PIPE SEALING

The annular space between the liner and the existing sewer main must be sealed at each manhole with a chemical seal and non-shrink grout. Seals must be placed in a band to form an effective watertight gasket in the annular space between the liner and the existing pipes in the manholes. The width of the band must be a minimum of twelve inches (12-in) or one-half (1/2) the diameter of the pipe, whichever is greater. It must be finished off with a non-shrink grout placed around the annular space from inside the manhole and must not be less than six inches (6-in) wide. The Engineer must approve the chemicals and materials. The Contractor must cut the liner so that it extends four inches (4-in) into the manhole. The Contractor must make a smooth, vertical cut and slope the area over the top of the exposed liner using non-shrink grout. The Contractor must also use cementitious grout to form a smooth transition with a reshaped invert and a raised manhole bench such that neither the sharp edges of the liner pipe, nor the concrete bench, nor the channeled invert can exist to catch debris and create a stoppage. The invert of the manhole must also be reworked (smoothed and built-up) to match the flow line of the new liner.

The liner pipe must be allowed to normalize to ambient temperatures as well as recover from any imposed strain, in accordance with the manufacturer's recommendation before being cut to fit between manholes and proceeding with reshaping and/or smoothing the manhole invert.

606.03.07 – LINER PIPE GROUTING

The annular space between the liner pipe and the existing pipe must be sealed with a grout having good flow characteristics, minimum shrinkage, and permanence of support. A minimum twenty-eight (28) day compressive strength of the grout must be one thousand pounds per square inch (1,000-psi) or greater must be required to assure the structural integrity of the rehabilitated pip e. The safe grouting pressure

must conform to the type and the requirements of the pipe used. The maximum grouting pressure must be in accordance with the liner pipe manufacturer's recommendations.

The sealing compound must be suitable for underwater application and have elastomeric properties. The annular space must be one hundred percent (100%) filled, but particular attention must be paid to those areas just downstream of manholes to avoid air traps. Equipment for placement of grout must be used so as to prevent segregation of the grout components and to cause the grout to flow around the liner and completely fill the voids in the annular space. Under no circumstances must grout be dropped down the shafts onto the liner. Grout must not be permitted to rise in the vertical shafts more than two feet (2-ft) above the top of the existing pipe. The Contractor must have operable vibrators on the job to aid the flow of the grout. The Contractor must have operable pumps on the project site to remove water from the vertical shafts as it is displaced by grout to prevent an excessive hydrostatic head on the liner. Pumping pressures during the grouting process must not exceed the collapse pressure of the liner pipe.

The Contractor must install a vent pipe higher than the upper end of the pipe to ensure that the annulus is completely filled with grout.

606.03.08 – SEWER SERVICE CONNECTIONS

All sewer service connections must be accomplished and paid for in accordance with Section 602, " Sewer Service Connection".

606.04 – TESTING

604.05.01 – TELEVISION INSPECTION

Television inspection must be accomplished in accordance with Section 614, "Television Inspection".

604.05.02 – SMOKE TESTING

Smoke testing must be accomplished in accordance with Section 610, "Smoke Testing".

604.05.03 – DYE-WATER TESTING

Dye-water testing must be accomplished in accordance with Section 611, "Dye-Water testing".

606.04.04 – SEWER LEAKAGE TESTING

Leakage testing must be required after liner has been installed and prior to services being re-connected. Leakage testing must be conducted in accordance with Section 615, “Sewer Pipe Leakage Testing”.

606.04.05 – ACCEPTANCE OF SLIPLINING

Final acceptance of sliplining must be based on, but not be limited to, review of post-television inspection, leakage testing, and conformance with all provisions of these specifications as determined by the Engineer. The installed liner pipe must be watertight, smooth, and free from wrinkles, as well as defects, and improper house connections. Should any of these defects occur, the line must be excavated, repaired and/or replaced, and complete restoration must be made to the satisfaction of the Engineer at no additional cost to the City.

606.05 – METHOD OF MEASUREMENT

"Sliplining" must be measured along the pipe, through manholes, junction boxes, and other small structures. Payment for "Sliplining" must be made at the unit price bid per linear foot of line, for each size installed and must include liner pipe, grout for pipe sizes fifteen inches (15-in) and smaller, and buildup, shaping and reworking the manhole invert, and sealing the annular space, equipment, labor, tools, and incidentals necessary to complete this item of work. For larger pipes, "Grouting" must be paid for at the unit price bid per cubic yard. Addition of inverts/benches, if none already exist, will be considered incidental to the cost of "Sliplining".

606.06 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SLIPLINING (SIZE)	L.F.
GROUTING	C.Y.

SECTION 607 – FORMED-IN-PLACE PIPE (FIPP)

607.01 – DESCRIPTION

This section covers rehabilitation of existing deteriorated sewers by trenchless method of installing formed-in-place pipe (FIPP) as hereafter described.

607.02 – MATERIALS

607.02.01 – SUBMITTALS

Review and approval of the Contractor submittals, by the Engineer, must not be construed in any way as relieving the Contractor and the Manufacturers of their responsibilities as specified in these Specifications.

A) General – The Contractor must submit source of materials for the specified liner pipe, or proposed liner pipe when alternate materials are specified. No FIPP must be shipped to project site until all submittals have been reviewed and approved by the Engineer.

B) Construction Schedule – The Contractor must submit an area map of the project designating the beginning and ending points as well as the time frames for each inversion or insertion. The map must also indicate the access manholes, length, and FIPP thickness to be installed for said inversions and/or insertion runs. Unless surveyed Plans accompany project specifications, all elevations must be determined and included in the Construction Schedule. This must include verification of all elevations on as-built drawings when such information is provided.

C) Certification of Material Compliance – A signed letter from the manufacturer stating that FIPP meets the requirements of these specifications. The Contractor/manufacturer must submit Type "A" and "D" certifications for the material. See section 109.17.02 “Control of Work and Materials – Materials Certifications – Types of Certifications” for details on types of certifications.

D) Quality Control Reports – The manufacturer's results of quality control tests performed on the actual material used. The reports must contain all the raw data and intermediate calculations, as well as the testing procedures. Vendor Quality Control submittal must include performance testing from the following:

Standard	Standard name	Characteristic
ASTM D2990	Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics	Resin or resin-tube long term strength performance
ASTM D5813 Section 6.4.1 and 6.4.3	Standard Specification for Cured-In-Place Thermosetting Resin Sewer Piping Systems	Chemical corrosion performance
ASTM D5813 Section 6.4.2 and 6.4.3	Standard Specification for Cured-In-Place Thermosetting Resin Sewer Piping Systems	Strain corrosion performance

E) Installation Manual – The Contractor must submit installation manual describing

the method of installation.

F) Copies – The Contractor must provide a digital copy of all submittals, and if requested by the Engineer, hardcopies of any submittal must be provided as well.

607.02.02 – FIPP MATERIALS

Acceptable FIPP materials are as follows and must meet the requirements of the appropriate sections indicated below:

FIPP Material Type	Section
Deformed High Density Polyethylene (HDPE) Pipe	632
Folded Polyvinyl Chloride (PVC) Pipe	633
Resin Impregnated Tube (i.e. Cured-In-Place Pipe)	638

607.02.03 – FIPP DESIGN BASIS

The minimum installed formed-in-place pipe material thickness's specified are determined based on the buckling requirements (equation #3) established in ASTM F-1216, "Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube", Appendix X1. Design Consideration, Section X1.2.2 Fully Deteriorated Gravity Pipe Condition. The following design assumptions are used in determining the specified minimum thickness for the acceptable FIPP materials:

Design Parameter	Design Assumption
Mean inside diameter of original pipe, D	Same as pipe nominal diameter
Soil unit Weight, γ	120-lbpcf
Height of soil above top of pipe, H	Minimum 10-ft
Height of water above top of pipe, Hw	Same as height of soil above top of pipe
Live Load, WL	AASHTO H20
Water buoyancy Factor, Rw	0.67
Total external Load, %	Hydrostatic load+ (Rw) (earth prism load)+ Live load
Ovality of original Pipe, q	2%
Factor of Safety, N	2.00
Modulus of soil Reaction, E's	700-psi

607.03 – CONSTRUCTION METHODS

607.03.01 – GENERAL

The installation of formed-in-place pipe must be in accordance with appropriate ASTM Standard Specifications and the Manufacturer's recommendations. If no ASTM Standard exists for the installation, the licensor/Manufacturer must furnish, in detail, step-by-step procedures for review and approval by the Engineer.

Temperatures and pressures must be monitored and recorded throughout the installation process to ensure that each phase of the process is achieved at the approved manufacturers' recommended temperature and pressure levels. When requested by the Engineer, the Contractor must submit field records of temperatures, pressures, and other pertinent information regarding installation.

The minimum span for the FIPP must be the distance from inlet to outlet of the respective manholes unless approval to do otherwise is given by the Engineer. Individual runs can be made over one or more manhole sections but must not exceed Manufacturer's recommendations for maximum allowable tension during the pulling process. Care must also be taken to cut each end of the formed-in-place pipe as directed by the Manufacturer for extension into manholes before releasing tension.

The installed FIPP must form a waterproof seal with the manhole wall. If pipe fails to seal properly, a material compatible with the pipe and manhole must be used to provide a watertight seal.

607.03.02 – SEWER SERVICE CONNECTIONS

Prior to the installation of FIPP, the Engineer will review the pre-inspection videotapes and logs for each line to determine which services must be externally reconnected. Service connections that may be a source of I/I or root propagation must be externally replaced as directed by the Engineer. Such connections must include but not be limited to the following:

A) A cracked or collapsed connection.

B) Missing pipe segments around the connection

C) Presence of roots

D) Protruding or receding connections

External Connection of services must be executed as per Section 602, "Sewer Service Connection".
All sewer service connections must be accomplished and paid for in accordance with Section 602, "Sewer Service Connection".

607.03.03 – SEWER FLOW CONTROL

Sewer flow control must be accomplished in accordance with Section 606, "Sliplining".

607.03.04 – POINT REPAIR

Point repairs must be accomplished in accordance with Section 612, “Point Repair”. The Engineer, from the specified work may delete segments between two consecutive manholes that require more than five (5) point repairs or external connections to rehabilitate. At the discretion of the Engineer, these segments may be replaced by conventional excavation in accordance with Section 212, “Trench Excavation and Backfill”.

When performing an external connection, the Contractor may at his option perform a point repair prior to lining the pipe or to anchor a saddle to the liner after installation. Groups of services replaced within thirteen-foot (13-ft) span are accessed with one point repair using whichever method is used to make the connections.

607.03.05 – CLEANING SEWER LINES

Cleaning sewer lines must be accomplished in accordance with Section 609, “Cleaning Sewer Line”.

607.04 – FIPP MATERIAL TESTING

607.04.01 – GENERAL

Following the installation for each minimum design thickness, the Contractor must obtain one (1) sample from the formed-in-place pipe as follows:

A) Sample Locations – Sample locations must be determined by the Engineer. When necessary, a point repair must be done in order to obtain the sample, the cost of which must be paid for at the unit price bid per each point repair. The Contractor must cut each sample to a minimum of three feet (3-ft) in length and ship the samples to a laboratory designated by the Engineer for testing as described herein. The results of these tests must be forwarded to the Engineer directly from the approved laboratory for review.

B) Specimens – From each sample, five (5) specimens must be prepared to determine flexural bending properties, namely the initial flexural modulus and flexural strength and thicknesses. The results of each test must be used to determine average values.

C) Methods – Tests and measurements must be in accordance with ASTM Test Method D 790, “Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials”, and the calculated average values must meet the minimum material properties and thicknesses established in these Specifications.

D) Cost – The cost of each test, when the material passes, must be borne by the City. When average test results do not pass, the Contractor will be responsible for the cost.

E) Acceptance – When the average test meets the requirements of these Specifications, the testing will be considered accepted.

F) Penalty – In the event, the material fails to meet the requirements of these specifications, an actual factor of safety against buckling must be calculated and a penalty must be assessed in accordance with provisions specified in Section 607, “Formed-in-place Pipe (FIPP) ”. The actual factor of safety must be determined using the computed average values of test results and the assumed design parameters and equations specified in Section 607, “Formed-in-place Pipe (FIPP) ”.

607.04.02 – TELEVISION INSPECTION

Television inspection must be accomplished in accordance with Section 614, “Television Inspection” .

607.04.03 – SMOKE TESTING

Smoke testing must be accomplished in accordance with Section 610, “Smoke Testing”.

607.04.04 – DYE-WATER TESTING

Dye-water testing must be accomplished in accordance with Section 611, “Dye-Water Testing”.

607.04.05 – REDUCED VALUE DEDUCTION

Provided that the computed factor of safety is equal to or greater than the value specified, the penalty is not applicable. The penalty must be computed as a percentage of the bid unit price for the minimum design thickness represented by the test results, and applied to the total length of a run, in accordance with the following schedule:

Computed Factor of Safety	Penalty (%)
≥2.00	0
1.90 - 1.99	5
1.80 - 1.89	10
1.70 - 1.79	20
1.60 - 1.69	30
1.50 - 1.59	40
1.40 - 1.49	50
1.30 - 1.39	70
1.20 - 1.29	90
< 1.20	100

If the computed factor of safety for a specified design thickness fails to meet the required factor of safety, the following must apply:

On the run that the sample was taken from, the penalty applies to the entire run. A run must not be tested more than once.

The Contractor, at his option, may conduct additional tests on one (1) sample from other runs of the same design thickness. If so, the penalty for that run is determined from that test.

For runs not tested, the reduce valve deduction must be the highest from the other runs tested.

A run is defined as the full extent of an insertion beginning at a manhole or access point and extending continuously to a designated manhole or termination point. Sample locations for additional testing must be determined by the Engineer. The Contractor must be responsible for all costs in securing additional test samples (i.e., point repairs, etc.) and all laboratory costs whether the results are passing or failing. In lieu of the reduced value deduction, the Contractor may install additional formed-in-place pipe to meet the minimum factor of safety requirement.

607.04.06 – ACCEPTANCE OF THE FIPP

Final acceptance of the FIPP must be based on, but not limited to, review of closed circuit television inspection, the required material testing, and conformance with all provisions of these specifications as determined by the Engineer. Additionally, no groundwater must be observed, and all service entrances must be accounted for and unobstructed. The installed FIPP must be continuous over the entire length of a run between manholes and be smooth and free from substantial wrinkles, as well as flat spots, reverse curvature, defects, improper house connection cut-outs and installation over debris. Should any of these defects occur, the line must be excavated, repaired, and/or replaced, and complete restoration must be made to the satisfaction of the Engineer at no additional cost to the

City.

607.05 – METHOD OF MEASUREMENT

Payment for "Formed-In-Place Pipe" must be made at the unit price bid per linear foot of pipe for each size. External connections (reinstatements) of services must be considered incidental to the lining process and the cost for such must be included in this bid item. The price established must be full compensation for all labor and materials including FIPP material, installation, external connection of services, equipment, tools, testing, and incidentals necessary to complete this item of work. All lengths must be measured horizontally from centerline to centerline of manholes.

607.06 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

FORMED-IN-PLACE PIPE (SIZE) L.F.

SECTION 608 – SEWER FLOW CONTROL

608.01 – DESCRIPTION

This section covers necessary sewer flow control to the extent required for each operation, as specified and directed by the Engineer.

608.01.01 – SEWER FLOW CONTROL FOR TELEVISION INSPECTION AND SMOKE TESTING

When depth of flow at the upstream manhole of the section being worked is above the allowable for television inspection, the flow must be reduced to the level shown below by operation of pumps, plugging, or blocking of the flow, or by pumping and bypassing of the flow as specified. Depth of flow must not exceed that shown below for the respective pipe sizes as measured in the manhole when performing television inspection.

Pipe Nominal Size (inch)	Allowable Depth of Flow (% of pipe diameter)
≤ 10	20
12 - 24	25
≥ 27	30

608.01.02 – SEWER FLOW CONTROL FOR ALL OTHER OPERATIONS

A) General – The line must be completely blocked off and plugged and all flows must be by-passed to the extent necessary or as required by the Engineer.

B) Plugging or Blocking – A sewer line plug must be inserted into the line upstream of the section being worked. The plug must be so designed that all or any portion of the sewage can be released.

C) Pumping and Bypassing – When pumping and bypassing is required the Contractor must supply the pumps, conduits, and other equipment to divert the flow of sewage around the manhole section in which work is to be performed. The bypass system must be of sufficient capacity to handle existing flow plus additional flow that may occur during a rainstorm. The Contractor will be responsible for furnishing the necessary labor and supervision to set up and operate the pumping and bypassing system. If pumping is required engines must be equipped in a manner to keep noise to a minimum and must comply with noise limit codes for the City of Oklahoma City. Noise barrier device are required immediately when pumping operations begin.

D) Flow Control Precautions – When flow in a sewer line is plugged, blocked, or bypassed; sufficient precautions must be taken to protect the sewer lines from damage that might result from sewer surcharging. Further, precautions must be taken to ensure that sewer flow control operations do not cause flooding or damage to public or private property being served by the sewers involved. The Contractor will t be liable for damages resulting from sewer surcharge.

608.02 – METHOD OF MEASUREMENT

Payment for "Sewer Flow Control" must be made at the unit price bid per lump sum. The price established must include furnishing and operation of pumping and by-passing, labor, tools, and incidentals necessary to complete this item of work. Plugging or blocking of the sewer flow must be considered incidental to the work and must not be considered for payment.

608.03 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SEWER FLOW CONTROL	L.S.

SECTION 609 – CLEANING SEWER LINE

609.01 – DESCRIPTION

This section covers cleaning of existing sewer lines. The designated sewer manhole sections and the manholes themselves must be cleaned using mechanical, hydraulically propelled and/or high velocity sewer cleaning equipment. Selection of the equipment must be based on the condition of the sewer mains at the time the work commences. The equipment must be capable of removing dirt, roots, sand, rocks, grease, and other

materials from the sewer lines.

609.02 – EQUIPMENT

609.02.01 – APPROVAL OF CLEANING EQUIPMENT AND PROCEDURE

The Engineer must approve the cleaning system and plan for each manhole section. The Contractor must demonstrate the performance of the proposed cleaning equipment for use on the project. No work can begin until the Engineer gives such time approval.

609.02.02 – MECHANICALLY POWERED CLEANING EQUIPMENT

Bucket machines must be in pairs with sufficient power to perform the work in an efficient manner. Machines must be belt operated or have an overload device. Machines with direct drive that could cause damage to the pipe will not be allowed. A power rodding machine must be either a sectional or continuous rod type capable of holding a minimum of three hundred feet (300-ft) of rod. The rod must be heat-treated (tempered) steel. To ensure safe operation, the machine must be fully enclosed and have an automatic safety clutch or relief valve.

609.02.03 – HYDRAULICALLY PROPELLED CLEANING EQUIPMENT

Hydraulically propelled devices that require a head of water to operate must utilize a collapsible dam to obtain the head. The dam must be designed to easily collapse in the event of a sudden surcharge of the line to prevent damage to the sewer, property, etc. Sewer cleaning balls are acceptable for use only in sanitary sewers having a diameter of eighteen inches (18-in) or greater.

The movable dam must be of equal diameter as the pipe being cleaned and must provide a flexible scraper around the outer periphery to ensure effective operation.
Whenever possible, flows present in the sewer lines must be used to provide necessary fluid for hydraulic cleaning devices.

609.02.04 – HIGH-VELOCITY CLEANING EQUIPMENT

All high-velocity sewer cleaning equipment must be constructed for ease and safety of operation. The equipment must have a selection of two (2) or more high-velocity nozzles. The nozzles must be capable of producing a scouring action from fifteen degrees (15-degrees) to forty-five degrees (45-degrees) in all size lines designated to be cleaned. Equipment must also include a high-velocity gun for washing and scouring manhole walls and floor. The gun must be capable of producing flows from a fine spray to a solid stream. The equipment must carry its own water tank, auxiliary engines, pumps, and hydraulically driven hose reel. Filler piping on the tank must have an air cap to prevent backflow and contamination of water supply system.

609.03 – CONSTRUCTION METHODS

609.03.01 – CLEANING PRECAUTIONS

Satisfactory precautions must be taken to protect the sewer lines from damage that might be inflicted by the improper use of cleaning equipment. Whenever hydraulically propelled cleaning force or any tools which retard the flow of water in the sewer line are used, precautions must be taken to ensure that the water pressure created does not cause any damage or flooding to public or private property being served by the manhole section involved. Additionally, the Contractor must not allow the overflow from sanitary sewers to enter storm sewers.

The Contractor, at no additional cost to the City, and to the satisfaction of the Engineer, must repair any damage inflicted upon the sewer, regardless of the cleaning method used.

609.03.02 – ROOT AND DEBRIS REMOVAL

All roots must be removed. Special attention must be given during the cleaning operation to assure complete removal of roots from the joints. Procedures may include the use of mechanical equipment such as rodding machines, bucket machines and winches using root cutters and porcupines, and equipment such as high-velocity jet cleaners. Chemical root treatment may also be used.

A) When chemicals are used to aid in the removal of roots, the chemicals must be EPA registered and labeled for use in sewer lines and acceptable to all applicable State and City agencies.

B) All materials and mixing/application procedures for chemical root treatment must be consistent with the latest standards, requirements, and recommendations of the manufacturer of the chemical root treatment material used.

C) All sludge, dirt, sand, rocks, grease, and other solid or semi-solid material resulting from the cleaning operation must be removed at the downstream manhole of the section being cleaned. Passing of debris from manhole to manhole must not be permitted.

D) When hydraulic cleaning equipment is used, a suitable sand trap, weir, or dam must be constructed in the downstream manhole in such a manner that the solids must be trapped.

E) All solids or semi-solids resulting from the cleaning operations must be removed from the site and dispose at no additional cost to the City. The City will not provide a dumpsite for all debris removed from the sewers during the cleaning operation. The Contractor is responsible for coordination of disposal site and operations. Under no circumstances can sewage or solids removed therefrom be dumped onto

streets or into ditches, catch basins, storm drains, or sanitary sewer manholes.

609.04 – TESTING (CLEANING AND FINAL ACCEPTANCE

Acceptance of sewer line cleaning must be made upon the successful completion of the television inspection and must be to the satisfaction of the Engineer. If television inspection shows the cleaning to be unsatisfactory, the Contractor must be required to reclean and reinspect the sewer line until the cleaning is shown to be satisfactory.

609.05 – METHOD OF MEASUREMENT

Payment for "Cleaning Sewer Line" must be made at the unit price bid per linear foot of pipe regardless of size. The price established must be full compensation for furnishing and operation of all equipment, labor, tools, and incidentals necessary to complete this item of work. No deduction must be made for manholes.

609.06 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

CLEANING SEWER LINE	L.F.

SECTION 610 – SMOKE TESTING

610.01 – DESCRIPTION

This section covers testing of sewer lines with smoke where the origin of a connection as an inflow source is unknown. Common uses are to determine storm sewer cross connections, roof leaders, cellar, yard, fountain and area drains, abandoned building sewer and faulty service connections, and point source inflow due to leaks in drainage paths and pending areas.

610.02 – CONSTRUCTION METHODS

Smoke testing must not be used in sewer lines suspected of having sags or water traps or those that are flowing full.

Smoke testing must not be conducted to locate service connection when the soil surrounding and above the pipe is saturated, frozen or snow covered.

Smoke generated from bombs or canisters must be non-toxic, odorless, and non-staining. Air blowers must have a minimum capacity of 3,390 cubic feet/ minute.

610.03 – TESTING

Police, Dispatch UCS, and fire departments must be notified daily of the test locations. Contractor must inform residents individually on the day of testing by personnel displaying proper identification as well as knocking on doors and delivering a notice explaining the process.

Photographs must be taken of all leaks discovered during testing and must be numbered and direction orientated. They must be taken close enough to clearly mark the point where the smoke is escaping.

The Contractor must also submit a photograph and a sketch of each leak describing its extent, the area and type of surface drained by it, the location or address, and the photograph number. The leak must be marked at the site.

610.04 – METHOD OF MEASUREMENT

"Smoke Testing" must be measured by the linear foot of sewer line tested. Payment for "Smoke Testing" must be made at the unit price bid per foot regardless of pipe size. The price established must include all materials, labor, tools, equipment and incidentals necessary to complete this item of work.

610.05 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SMOKE TESTING	L.F.

SECTION 611 – DYE-WATER TESTING

611.01 – DESCRIPTION

This section covers dye-water testing used for detecting inflow such as storm sewer cross connections and point source inflow leaks in drainage paths or ponding areas, roof leaders, cellar, yard and area drains, fountain drains, abandoned building sewers, and faulty service connections. Dye-water testing must only be performed as directed by the Engineer where the origin of a connection is questionable.

611.02 – CONSTRUCTION METHODS

The equipment needed for dye-water testing must be limited to that required to carry the water to testing site and to block the sewers before testing. Sandbags or sewer pipe plugs may be used to block the sewer sections.

611.03 – TESTING

When inflow sources are located on private properties, property owners must be notified before tests to identify in-flow sources.

A field log sheet must be filled out for each dye-water test whether or not a positive transference is observed.

A sketch must be made. The sketch must indicate exactly what was flooded and the relationship between that and the sewer system. A photograph must be made to accompany the sketch. The photograph must include the set up or the point of ingress.

Dye must be safe to handle, visible in low concentrations, miscible in water, inert to the soils and debris in the sewers, and biodegradable.

611.04 – METHOD OF MEASUREMENT

The cost of dye-water testing must be considered incidental, and no additional compensation must be made for this work and the cost of same must be included in the other pay items.

SECTION 612 – POINT REPAIR

612.01 – DESCRIPTION

This section covers replacement of short segments of sections of the existing pipe as specified or directed by the Engineer.

The point repair is made by excavation to repair a line or remove an obstruction such as dropped joints, pipe sags or bellies one-half inch (1/2-in) or greater, protruding service connections, or crushed or collapsed pipe, which cannot be removed or repaired by remote devices. All point repair must be completed before trenchless construction.

612.02 – MATERIALS

Acceptable pipe materials and fittings must meet the requirements of Section 601, “Pipe Installation” and 602, “Sewer Service Connection”

612.03 – CONSTRUCTION METHODS

All point repairs require the method of repair prior approval of the Engineer. Pipe and fittings for point repairs must be installed according to the provisions set forth in Section 601, “Pipe Installation”. Trench excavation and backfill must be accomplished in accordance with Section 212, “Trench Excavation and Backfill”.

The length of any point repair must not exceed thirteen feet (13-ft).

Site cleanup and replacement of trees, shrubs, hedges, and sod must be in accordance with the appropriate sections of the specifications.

612.04 – METHOD OF MEASUREMENT

Payment for "Point Repair" must be made at the unit price bid per each regardless of depth. The price established must include all material, equipment and labor costs for excavation, pipe, replacement, embedment materials, cleanup, and incidentals necessary to complete a point repair.

All sod, trees, shrubs, hedges, if required foundation material, and paving must be replaced and paid for directly in accordance with the appropriate section.

Removal of obstructions by internal means must be considered incidental to work. Television inspection and cleaning of sanitary sewer in pursuit of repair must be considered incidental to work.

612.05 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

POINT REPAIR	EA.

SECTION 613 – DEFLECTION TEST

613.01 – DESCRIPTION

This section covers deflection tests intended to be performed on all flexible pipe installations.

613.02 – TESTING

All test results must be signed and sealed by a Professional Engineer licensed in the State of Oklahoma. The test must be performed not less than thirty (30) calendar days after backfill has been placed. The maximum allowable deflection must not exceed five percent (5-percent) of the pipe's base internal diameter (Base ID). Base ID for PVC pipes must be calculated from measurements taken in accordance with ASTM D 2122, “Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings”, and according to procedures outlined in Appendix XI of ASTM D 3034, “Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings”. For HDPE pipes Base ID must be calculated from measurements taken in accordance with ASTM D 2122, “Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings”, and according to procedures recommended by the Manufacturer and

approved by the Engineer. For other flexible pipes, Base ID must be calculated in accordance with the manufacturer's recommended procedures and approved by the Engineer.

A mandrel (go/no-go) device cylindrical in shape must be hand-pulled by the Contractor through all sewer lines. Any sections of pipe not passing the mandrel test must be uncovered and the Contractor, at no additional cost to the City, must replace the pipe to the satisfaction of the Engineer. The repaired sections must be re-tested. All tests for pipes twenty-four inch (24-in) and larger must be performed in the presence of the Engineer.

The Engineer must approve the mandrel and the testing procedures. Proving rings furnished by the Contractor must be used to verify the mandrel diameter.

In lieu of mechanical measurement of deflection by a mandrel, manual measurement can be performed using an internal micrometer or telescoping gage accurate to plus or minus (±) one-thousandth (0.001”) inch. The manual measurement of the vertical internal diameter must be taken at the centerline of the installed pipe

613.03 – METHOD OF MEASUREMENT

Payment for "Deflection Test" must be made at the unit price bid per lump sum for pipes smaller than twenty-four inches (24-in) and per linear foot for pipes twenty-four inches (24-in) and larger in diameter. The price established must be full compensation for all material, labor, tools, equipment and incidentals necessary to complete this item of work.

613.04 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

DEFLECTION TEST (< 24”)	L.S.
DEFLECTION TEST (≥ 24”)	L.F.

SECTION 614 – TELEVISION INSPECTION (CCTV)

614.01 – DESCRIPTION

This section covers closed-circuit television (CCTV) inspection of existing sewer lines and rehabilitated and newly constructed sewer lines.

The work must consist of furnishing all labor, materials, accessories, equipment, tools, transportation, services and technical competence for performing all operations required to professionally execute the internal inspection of sewers in strict accordance with these specifications.

Information concerning depths of flow, manhole depths, air quality in the sewers, accessibility of manholes, traffic conditions, and other safety considerations are to be the sole responsibility of the Contractor to obtain and to incorporate the necessary provisions into the overall contract price to complete the specified work under the conditions existing in the sewers to be inspected.

For large-diameter sewer inspections, the Contractor may be required to submit sample video recordings from recently completed projects demonstrating the picture quality obtained with each available inspection system for pipe diameters twenty-seven inches (27-in) and larger.

All television testing must be performed in accordance with guidelines published by the National Association of Sewer Service Companies (NASSCO) and as modified or specified in these specifications

614.02 – EQUIPMENT

All television cameras used for inspection must be color units specifically designed and constructed for the method of inspection performed. Camera(s) may be modified by mounting on conventional or floating skids, or rafts, for use in multiple-diameter, sewer line inspection work. Units must have either automatic or remote focus and iris controls, and the complete system(s) must be operable in conditions of one-hundred percent (100%) humidity.

Lighting must be suitable to allow a clear picture of the entire periphery of the main sewer pipe. For large-diameter twenty-seven inches (27-in) and larger pipe, the camera lens must have not less than a sixty-five degree (65-degree) viewing angle. A radial viewing camera with a three hundred and sixty degree (360-degree) vertical rotation and a two hundred and seventy degree (270-degree) horizontal rotation, or any combination of the two, may be required to properly evaluate the condition of the main sewer and laterals. Lighting must operate in a manner that allows the viewed object to be illuminated no matter what the angel of the lens. For a radial viewing camera, the lighting must be built into the unit so that the lamp(s) remains aligned with the lens. A minimum illumination of three (3) lux with a light color in the twenty-two hundred degree Kelvin (2,200-degree K) to thirty-two hundred degree (3,200-degree K) range must be provided. Auxiliary lighting acceptable to the Engineer must be provided for large diameter pipe. For diameters of sixty inches (60-in) and greater, a minimum of one million (1,000,000) candlepower lighting in the thirty-two hundred degree Kelvin (3,200-degree K) range must be made available.

The Contractor must be responsible for having the necessary camera skids, floats, and rafts available to allow for inspection of lines in a manner acceptable to the City under live flow conditions.

In all cases, the complete video system (camera, lens, lighting, cables, monitors and

recorders) must be capable of providing a picture quality acceptable to the Engineer, and if unsatisfactory, equipment must be removed, and no payment must be made for unsatisfactory inspections.

614.03 – CONSTRUCTION METHODS

614.03.01 – GENERAL

The Contractor must use one of the following methods individually or in combination, as approved by the Engineer:

A) Conventional color inspection cameras specifically designed for use in sewer line inspection work, mounted on conventional camera skids or tracks.

B) Conventional color inspection cameras specifically designed for use in sewer line inspection work, mounted on floating skids or rafts.

C) Special industrial grade, color-inspection cameras contained in waterproof housings, and mounted on floating skids or rafts.

D) Special industrial grade, color-inspection cameras, either handheld or contained in waterproof housings, and carried manually through the sewer during inspection work.

614.03.02 – PROCEDURE

A) Pre-work Submittals for Inspection of Large Diameter Pipes – For pipes twenty-seven inches (27-in) and larger, the Contractor must submit a listing of actual measured flow depths and times of measurement at a sufficient number of locations to indicate the flow depths that could be expected during inspection work. A minimum of one (1) flow depth measurement must be provided for each line section at no additional cost to the City. Additional off-peak flow measurements (i.e., night flow measurements) may be requested by the Engineer at various locations, also at no additional cost to the City.

   A prestart-up meeting must be scheduled prior to beginning any internal pipe inspection work to review the Contractor's proposed inspection methods for each of the line section groupings. At that time, the Contractor must have available the necessary flow depth date as well as the overall listing of proposed inspection methods in each area.

B) Remote Inspections – Remote pipe inspections must be permitted in cases where conditions are, as determined by the Engineer, to be unsafe or impractical for manual inspections, and where acceptable picture quality can be obtained by the Contractor.

   The main sewer must be cleaned as directed by the Engineer and in accordance with Section 609, “Cleaning Sewer Line”, of grease, roots and debris that may hinder movement of inspection equipment through the lines. Major line obstructions that

require point repairs are excluded.

The maximum flow depth for remote inspection work in pipes twenty-four inches (24-in) and less is twenty percent (20-percent) of the pipe diameter.

For large pipe diameters twenty-seven inches (27-in) and greater, the maximum flow must be thirty percent (30-percent) of the pipe diameter. The contractor may be required to perform inspections during off-peak hours (night inspections) when specifically requested by the Engineer to obtain this flow standard.

No inspections must be performed where flow depths exceed fifty percent (50-percent) of pipe diameter without prior approval of the Engineer.

Suspended moisture or fog in pipes must be cleared with blowers. Filming must commence only when the ambient temperature above ground is a minimum of forty degrees Fahrenheit (40-degree F).

CCTV inspection must be done one manhole section at a time and the flow in the section being inspected must be suitably controlled as specified in Section 614, “Television Inspection”. The inspection must proceed from one section to another starting either upstream or downstream and completing in that order for the entire line. When an obstruction prevents the camera from passing through the entire manhole section, the inspection must be continued from the opposite manhole before proceeding to the next section.

The camera must be moved through the line at a moderate rate, stopping when necessary to permit proper documentation of the sewer's condition. The maximum speed of the camera must not exceed thirty feet per minute (30-fpm). Caution must be taken to not linger in one spot allowing the heat generated from the unit to ignite roots, debris, etc.

The camera must be moved through the line by conventional means of manual winches, power winches, television cable, and powered rewinds or other devices, which do not obstruct camera view or interfere with proper documentation of the sewer conditions. In instances where manual or remote power winches are used to pull the camera through the sewer constant two-way communication must be set up between the two manholes of the line being inspected.

Accurate and continuous footage readings must be superimposed on the video recording for each line inspected by remote inspection methods. Also shown must be the date of inspection and a manhole number designation that corresponds to the field logs for each manhole on the line section inspected.

When specified, a lateral sewer camera must be employed to inspect up to twenty-five feet (25-ft) of the lateral. The lateral camera launcher must be brought into position by the main sewer television camera. Lateral sewers entering manholes must

be inspected with a mini push camera. Actual footage inspected must vary depending on the condition of the pipe. Videotapes of laterals may be in black and white and must show a view of the lateral connection by the main sewer camera before showing the internal view of the lateral by the launcher.

The Contractor must provide photographs developed from the television screen of problems revealed by the CCTV camera upon the request of the Engineer, as long as such photographing does not interfere with the Contractor's operations.

C) Manual (Walk Through) Inspections – Manual inspections must be required in lines where conditions will allow the Contractor's inspection crew to safely walk through the sewer. In general, lines sixty inch (60-in) in diameter and larger and having flow depths of less than twenty percent (20%) of the pipe diameter, must be manually inspected as directed by the Engineer.

Inspection crews must consist of two or more people. Blowers and exhaust fans must be available to provide ventilation for the sewer line being inspected.

Manual pipe inspections must be conducted in such a manner as to transmit the video signal to an aboveground viewing room to permit the Engineer to watch the inspection work live on a color monitor in the viewing facility. In addition, direct voice communication between the Engineer, the in-pipe inspection personnel, and the recording technician in the aboveground unit must be maintained at all times during the manual inspection work. Video recording equipment must also be located above ground in the inspection truck and accurate, continuous footage readings must be superimposed on the video recording for permanent record. Camcorders must not be permitted for use as the sole means of obtaining video records.

During manual inspections, the video camera must be used to look up sidelines and laterals, whenever practical. Conditions noted in these sidelines and laterals must be noted on the inspection logs and videotapes for the project. During manual inspections, digital color photographs must be obtained as instructed by the Engineer or as deemed necessary by the in-pipe technicians to document line conditions.

614.04 – DOCUMENTATION

A) Television Inspection Logs – Printed location records must be kept by the Contractor and will clearly show the location in relation to adjacent manhole of each infiltration point observed during inspection. In addition, other points of significance such as locations of building sewers, unusual conditions, roots, storm sewer connections, broken pipe, presence of scale and corrosion, and other discernible features will be recorded, and a copy of such records must be supplied to the Engineer. The video audio recording and written report of the condition of each lateral, if inspected, must be included along with an identification number corresponding to main sewer log and approximate locations of any pipe defects.

If preliminary inspection occurs in conjunction with a rehabilitation or replacement project, no construction activities must begin without prior review and subsequent approval by the Engineer of the work outlined in the submittals.

During large-diameter pipe inspections, the Contractor must document in writing observed conditions and comments given about each sewer line. These field logs must then be reviewed by the Contractor's technical staff, along with reviewing the associated video record, as a means of insuring that no defects or entries are omitted or incorrect, and as a means of gaining a second opinion as to the condition of each sewer line. Edited field logs must then be reprinted or typed for use in the final project reports. Detailed, one-page summaries must also be prepared for each line section inspected, during the data review, presenting the Engineer's synopsis of the general line condition and the relative severity of observed effects. These summaries must also be included in all field report copies immediately before each associated inspection report. Direct submittal of copies of the field technician's field logs, without this secondary review and summary pages, will not be acceptable.

Complete copies of the final project reports must be submitted to the City within fifteen (15) calendar days of completion of all field activities. The Contractor must provide a digital copy of all submittals, and if requested by the Engineer, hardcopies of any submittal must be provided as well.

An overall summary narrative must be provided in the final report describing the overall conditions found in each associated line section grouping and detailed summary tables must also be compiled showing those lines where major and significant defects were located.

Original recordings, along with the required submittals, must be forwarded to the Engineer upon completion of the inspection and will become the property of the City.

B) Video Audio Recordings – A forward introduction sequence stating the time and date, location or segment number, depth, diameter, and pipe material for each length between manholes must precede the recording of each line segment. The camera must progress through the pipe indicating the beginning manhole and destination manhole as it marks the footage continuously. Should there be a need to access the line from the other direction, a new introduction track must precede the setup, and the footage must begin at zero.

The camera must pause as it approaches a service so that the connection between pipe and service may be evaluated. The lens must then rotate to display the interior of the service. The service inspection should reveal any roots, cracks, or capped risers.

Audio description must accompany the visual. Operator's comments must contain verbal verification of footage and condition of each service, and any defects or unusual conditions noted in the main. When television inspection is performed as a part of

final examination for acceptance of project, it must be performed after all the lines have been constructed and within twenty-four hours (24-hr) of conducting deflection test on a line. It must be continuous and present each segment in the order laid out in the plans (e.g., Line A: station 0+00 to 4+00, station 4+00 to 8+00, Line 8: station 0+00 to 3+00, etc.).

All recordings must be digital format. Each deliverable should be accompanied by a Transmittal including the following: description of project and contents, showing the Owner's name, project number, project location, the date(s), lines recorded on the video, and name of the Contractor. If the quality of the recordings is not satisfactory to the Engineer, the lines must be rerecorded at the Contractor's expense.

C) Photographs – All photographs taken during manual, walk-through inspections must be properly documented.

Photographs taken from the monitor for remote television inspections must also be presented in the same manner as described above.

614.05 – METHOD OF MEASUREMENT

Payment must be made for pre-construction inspection, when required for construction, and post construction inspection only. Unless separately specified, all other recording and/or photographs requested by the Engineer must be considered incidental to the project and the cost included in the price for other items.

"Television Inspection" must be measured along the stations, through manholes, junction boxes and other small structures. Payment for "Television Inspection (CCTV)" must be made at the unit price bid per linear foot of pipe regardless of size. The price established must be full compensation for all equipment, labor, materials, mobilization, demobilization, reverse setups, recordings, reports, photographs, and incidentals necessary to complete these items of work.

614.06 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

TELEVISION INSPECTION (CCTV)	L.F.

SECTION 615 – SEWER PIPE LEAKAGE TESTING

615.01 – DESCRIPTION

After backfilling has been completed, the Contractor must conduct infiltration, exfiltration or air tests as directed by the Engineer and submit the results of all testing to the Engineer. All tests must be performed in the presence of the Engineer for pipes twenty-four inches (24-in) and larger.

Immediately prior to conducting a test, the ground water level must be determined by boring a vertical hole adjacent to the pipe and measuring the distance to the water level, or by the use of a one inch (1-in) diameter pipe installed horizontally through the upstream manhole wall with a clear plastic tube connected to the pipe and extending vertically.

615.02 – TESTING

615.02.01 – INFILTRATION TEST

Where sewers are laid under the groundwater, infiltration testing must be conducted. If at any time the infiltration between two adjacent manholes is observed and measured to exceed ten gallons per inch (10-gpi) of nominal pipe diameter per mile of sewer per day. The Contractor must locate the leakage and must make such repairs as are necessary to reduce the infiltration. The infiltration must be measured under the direction of the Engineer by use of a weir or other suitable flow rate-measuring device furnished and installed by the Contractor.

615.02.02 – EXFILTRATION TEST

Where sewers are laid above the groundwater table, exfiltration testing must be conducted. Exfiltration tests must be conducted by blocking off the other openings in the upper manhole and plugging the line where it enters the lower manhole of the reach to be tested, filling the line and the manhole with water at least five foot (5-ft) higher than the top of the pipe or five feet (5-ft) higher than the ground water elevation whichever is higher, and measuring the water required to keep the water level in the manhole at a constant elevation. The test section must be filled not less than twelve hours (12-hr) prior to testing. The total exfiltration must not exceed ten gallons per inch (10-gpi) of nominal pipe diameter per mile (idm) of pipe per day for each reach tested. For purposes of determining the maximum allowable leakage, manholes will be considered as sections of pipe having an I.D. equal to the diameter times depth of the manhole. The exfiltration test must be maintained on each reach for at least two hours (2-hr) or longer if, in the opinion of the Engineer, this is necessary to locate all leaks.

The Contractor must provide all necessary piping between the reach to be tested and the source of water supply, together with equipment and materials required for the tests. The methods used and the time of conducting the exfiltration tests must be subject to the approval of the Engineer.

If the leakage in any reach exceeds the allowable maximum, the Contractor must locate the leakage and must make such repairs as are necessary for the pipe to pass testing. The pipe reach must be retested after the leaks are repaired.

615.02.03 – AIR TEST

Air tests must be conducted on each manhole-to-manhole section of sewer. The air test

must be performed in accordance with the following specifications.

A) Equipment – Equipment used must meet the following requirements:

Pneumatic plugs must have a sealing length equal to or greater than the diameter of the pipe to be inspected.

Pneumatic plugs must resist internal test pressure without requiring external bracing or blocking.

All air used must pass through a single control panel.

Three (3) individual hoses must be used for the following connections:

1) From the control panel to pneumatic plugs for inflation

2) From the control panel to sealed line for introducing the low-pressure air

3) From sealed line to control panel for continually monitoring the air pressure rise in the sealed line.

B) Procedures – All pneumatic plugs must be seal-tested before being used in the actual test installation.

One length of pipe must be laid on the ground and sealed at both ends with the pneumatic plugs to be checked. Air must be introduced into the plugs to twenty-five pounds per square inch gauge (25-psig). The sealed pipe must be pressurized to five pounds per square inch gauge (5-psig). If a ground water level over the top of the pipe is present, the pressure in psig must be increased by the height of ground water level above top of pipe at upstream manhole divided by two and one third (2.33). The plugs must hold against this pressure without bracing and without movement of the plugs out of the pipe.

After a manhole reach of pipe has been backfilled and cleaned, and the pneumatic plugs are checked by the above procedures, the plugs must be placed in the line at each manhole and inflated to twenty-five pounds per square inch gauge (25-psig). Low-pressure air must be introduced into this sealed line until the internal air pressure reaches four pounds per square inch gauge (4-psig). At least two (2) minutes must be allowed for the air pressure to stabilize. After the stabilization period (three and one half pounds per square inch gauge (3.5-psig) minimum pressure in the pipe), the air hose from the control panel to the air supply must be disconnected. The portion of the line being tested must be termed "acceptable" if the time required in minutes for the pressure to decrease from three and one half (3.33-psig) to two and one half pounds per square inch gauge (2.5-psig) is not less than that shown in the following table:

Table 615.05.01 – Air Test Requirements

Pipe Nominal Size (In)	Minimum Test Time	Length for Min. Time (Ft)
6	2:50	751
8	3:47	564
10	4:43	450
12	5:40	376
15	7:05	302
18	8:30	250
21	9:55	215
24	11:20	188
27	12:45	167
30	14:10	150
33	15:35	138
36	17:00	125
42	19:50	107
48	22:40	94
54	25:30	83
60	28:20	75
66	31:10	68
72	34:00	63
78	36:50	58
84	39:40	54
90	42:35	51
96	45:20	47
>96	Per Engineer required time and length	

For lengths in excess of "Length for Minimum Time" given in table above, additional testing time to be added to the "Minimum Test Time" is determined from the following equation:

$$t = 0.011 (d2) (L)$$

where:

t = additional testing time, seconds
d = nominal pipe diameter, inches
L = additional length, feet

If the air leakage in any reach exceeds the allowable, it must be re-tested after the

leaks are repaired.

615.03 – METHOD OF MEASUREMENT

Payment for "Sewer Leakage Test" must be made at the unit price bid per lump sum for pipes smaller than twenty-four inches (24-in) and per linear foot for pipes twenty-four inches (24-in) and larger in diameter. The price established must be full compensation for all material, labor, tools, equipment and incidentals necessary to complete this item of work.

615.04 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SEWER LEAKAGE TEST (<24”)	L.S.
SEWER LEAKAGE TEST (≥24”)	L.F.

SECTION 616 – SANITARY SEWER MANHOLES

616.01 – DESCRIPTION

This section covers construction of sanitary sewer manholes. Manholes may be constructed of the following types at locations specified or directed by the Engineer:

A) Precast Reinforced Concrete

B) Cast-In-Place Non-Reinforced Concrete

616.02 – MATERIALS

616.02.01 – PRECAST REINFORCED CONCRETE MANHOLES

A) General – This specification covers construction of precast reinforced concrete manhole base sections, riser sections (walls) and appurtenances in accordance with ASTM C-478, “Standard Specification for Circular Precast Reinforced Concrete Manhole Sections”, and as modified herein.

B) Submittals – Review and approval of the Contractor submittals, by the Engineer, must not be construed in any way as relieving the Contractor and the manufacturers of their responsibilities as specified in these specifications. When requested by the Engineer, the Contractor must submit the following, but not limited to, for review and approval:

1) Concrete cylinder compressive test results as per ASTM C-478, “Standard Specification for Circular Precast Reinforced Concrete Manhole Sections”.

2) Amount and detail layout of steel reinforcement as per ASTM C-478, “Standard Specification for Circular Precast Reinforced Concrete Manhole Sections”.

3) Type "D" Certification for the specified protective coating, see section 109.17.02 "Control of Work and Materials - Materials Certifications - Types of Certifications" for details on types of certifications.

4) Daily log of applied protective coating per “Part 10 Protective Lining”, below.

C) Types – Components of manholes must be as follows:

1) Precast Risers and Grade Rings – Precast risers and grade rings must be cylindrical type.

2) Precast Tops – Precast tops must be of the following two types:

a) Concentric cone

b) Eccentric cone

3) Precast Base Sections – Base section types must be as follows:

a) Base riser section and separate base slab with Mastic sealer.

b) Base riser section with integral floor and preformed socket to accept a rubber ring.

D) Sizes – The standard internal diameter of a manhole must be four feet (4-ft). Non-standard internal diameters of five feet (5-ft), six feet (6-ft), and seven feet (7-ft) may be constructed when specified or called for on the plans.

E) Dimensions – The manholes must be constructed pursuant to the appropriate "Standard Details for Precast Reinforced Concrete Manholes", and/or as specified in ASTM C-478,“Standard Specification for Circular Precast Reinforced Concrete Manhole Sections”. The minimum wall thickness must be as specified in the following table or not less than one-twelfth (1/12) of the internal diameter of the largest cone or riser section or five inches (5-in), whichever is greater.

TABLE 616.02.01 - Manhole Diameter and Wall Thickness

Manhole Internal Diameter (feet)	Minimum Wall Thickness (inches)
4	5
5	5
6	6
7	7
8	8

F) Materials – All materials for construction of manholes must be in accordance with Section 6 of ASTM C-478,"Standard Specification for Circular Precast Reinforced Concrete Manhole Sections".

G) Design – Design including concrete properties, reinforcement type and grade, joints, manufacturing and physical requirements must be in accordance with Section 7 to 10 of ASTM C-478, "Standard Specification for Circular Precast Reinforced Concrete Manhole Sections".

Base slabs or floors must have a minimum riser thickness of six inches (6-in) for diameters up to and including forty-eight inches (48-in) and a thickness of eight inches (8-in) for larger diameters.

H) Manhole Steps and Ladders – Steps and ladders must not be constructed unless otherwise directed by the Engineer. If called for, they must conform to Section 13 of ASTM C-478, "Standard Specification for Circular Precast Reinforced Concrete Manhole Sections".

I) Handling – All lifting holes must be repaired with a mixture of cement and sand grout firmly packed.

J) Protective Lining– All inside surfaces (walls, bottom, and etc.) of pre-cast concrete manholes must be shop coated with a total dry film thickness of not less than 8 mils. The material Manufacturer must furnish an affidavit attesting to the successful use of their material as a lining for applications where sewage conditions are recognized as corrosive or otherwise detrimental to concrete. Coating materials must be stored, mixed, applied and cured in accordance with guidelines set by the Manufacturer. The applicator of the coating must be certified through the manufacturer.

For every manhole coated as required, a daily log must be kept indicating the date, weather conditions, size and identification numbers of manholes coated, and number of gallons of coating applied to each manhole. The average number of gallons applied per manhole must be equal to or exceed the Manufacturer's

recommended coverage rate for the coating.

K) Field Testing – When directed by the Engineer, a set of three cylinders, three inches (3-in) in diameter, must be cut from randomly selected manholes. Testing must be performed to verify compliance with the requirements of these specifications. Basis of acceptance for testing must be in accordance with the appropriate ASTM requirements.

L) Acceptance – Acceptance of manhole structure must be based on the conformance and performance of materials required in ASTM C-478, “Standard Specification for Circular Precast Reinforced Concrete Manhole Sections” and the Engineer's inspection of the installed product. The assessment must include, but not be limited to, the Engineer's random plant inspections during production, the quantity and the placement of reinforcement, surface fractures and roughness, and the test results of compressive strength performed on cores and cured cylinders in accordance with Section 7 of ASTM C-97, “Standard Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone”.

616.02.02 – CAST-IN-PLACE NON-REINFORCED CONCRETE MANHOLES

A) General – This specification covers construction of cast-in-place non-reinforced manholes consisting of plain concrete walls with brick masonry or precast grade rings at the surface. Rings and covers (castings) must be constructed in accordance with the dimensions and requirements of the standard details.

B) Types – Manholes may be constructed of the following three (3) types, when called for on the plans:

1) Concentric Manholes

2) Eccentric Manholes

3) Offset Manholes

C) Sizes – The standard manhole size must be four feet (4-ft) internal diameter. Non-standard sizes may be constructed when called for on the plans or specified. The wall thickness must be a minimum of eight inches (8-in).

D) Dimensions – The manholes must be constructed pursuant to the appropriate "Standard Details for Cast-In-Place Non-Reinforced Concrete Manholes".

E) Materials – All materials for the construction of cast-in-place manholes must be in accordance with the Material Specifications.

F) Protective Coating – Protective coating will be required unless otherwise called for

on the plans or as directed by the Engineer.

G) Acceptance – Ready-mix concrete may be accepted on the basis of Type "E" Certification, See section 109.17.02 “Control of Work and Materials – Materials Certifications – Types of Certifications” for details on types of certifications, provided that all applicable requirements are met, and that visual inspection at destination shows the workmanship and condition of the material to be satisfactory.

616.02.03 – MANHOLE INVERT AND BENCH

All loose materials must be removed prior to shaping the invert. The invert must be smooth, U-shaped, have a minimum depth of one half (1/2) pipe diameter and be channeled across the floor of the manhole using the materials specified herein to obtain the proper form and shape. The bench must also be formed and built up with concrete approved by the Engineer. Additionally, all work must comply with the appropriate "Standard Details for Precast Manhole Base Sections" and the "Standard Details for Cast-In-Place Non-Reinforced Concrete Manhole Base Section".

For precast manholes, inverts and benches must be formed and poured in place after manhole base and pipe sections are in place.

Materials used for invert or benches must not be allowed to enter the sewer line. Finished benches must be smooth and free of any defects that could cause the accumulation of debris.

616.02.04 – MANHOLE RING AND COVER

A) General – Cast iron rings, tops, covers, gratings and all cast iron fittings must be sound, true to form and thickness and neatly finished and must fit together in a satisfactory manner. Castings must be clean, uniform and whole, and without blow or sand holes, dorosit, hardspots, shrinkage, distortion or any other surface defects which would impair serviceability. Casting surfaces must be smooth and well cleaned by shot blasting or other approved cleaning method.

Plugging or filling of holes or other defects must not be permitted. Parting fins and pouring gates must be removed. Sharp edges resulting from fabrication must be dulled by any acceptable method to ensure safety in handling. Casting must conform to the requirements of the ASTM A-48, “Standard Specification for Gray Iron Castings”, Class "30 B" for rings and "35 B" for covers and the appropriate "Standard Details for Manhole Ring and Cover".

All rings and covers must be accurately and carefully placed. All rings must be bedded in a substantial layer of mortar, or a flexible ring seal, must have a full bearing, and must be set to the exact grade. Unless otherwise shown, the top of covers must be flush with, or slightly above, the surrounding surface. When each

cover is placed in any position on the ring, the side play must not exceed one eighth inch (0.125-in) in any direction. Wording and markings on covers must be in accordance with the Standard Details.

B) Rings – Rings must be manufactured in accordance with the "Standard Detail for Reversible Manhole Ring".

C) Covers –

1) General – Manhole covers must be manufactured in accordance with the appropriate Standard Details for Construction Unless otherwise specified or directed by the Engineer, non-vented manhole covers must not be used in the streets or paved areas.

2) Coating – When called for on the plans or specified, the underside of all manhole covers must be given one (1) coat of asphalt varnish after visual inspection and approval on the job site.

3) Hinged Ring and Covers – When hinge type covers are used they must include a drain and incorporate a ninety degree (90-degree) blocking system to prevent accidental closure. The cover also must be able to be open to 120 degree and be removed from the ring. Hinged covers must incorporate a spring bar locking system that automatically activates when closed. The cover must also comply to weight requirements of manhole covers and provide a watertight seal with replaceable gasketing per the standard details.

616.03 – CONSTRUCTION METHODS

A) Foundation – Manholes must be constructed in a dry excavation. A crushed rock foundation mat must be constructed under the manhole. The mat must be a minimum of six inches (6-in) thick. Placement of material and material properties must comply with all applicable requirements of this section.

B) Backfilling – Backfilling for all manholes must conform to the requirements of Section 212, “Trench Excavation and Backfill”.

C) Manhole to Pipe Connection at Inverts – Manhole to pipe connections must be made pursuant to Manufacturer's recommendations and Standard Details for Construction. In addition, flexible gasket pipe seals must be required where each pipe enters the wall of manholes. Where possible, the opening for each connecting sewer pipe must be circular and match the diameter of the pipe. For manholes built, over existing lines or for special conditions, horseshoe shaped openings must be accepted. The Engineer prior to construction must approve the method and materials used for grouting any remaining annular space. Flexible pipe seals must have a Type "D" Certification, See section 109.17.02 “Control of Work and

Materials – Materials Certifications – Types of Certifications" for details on types of certifications. The flexible pipe seals must be approved by the Engineer. The Engineer may request a visual inspection and a sample of the materials used at any time. All material furnished under certification must be tagged, stenciled, stamped or otherwise marked with a lot number, heat number, order number, or other appropriate identification which can be readily recognized and checked against the certification.

D) Above Invert Manhole to Pipe Connection – Above invert manhole to pipe connection must be constructed in accordance with the Standard Details.

E) Finishing Manhole to Grade – The manhole ring and cover must be adjusted to grade with concrete grade rings or steel risers and installed per manufactures instructions. Steel risers can be expandable and sloped to meet finished grade. The manhole ring and cover must be adjusted to grade with concrete grade rings or course(s) of brick masonry. All brick masonry must meet the requirements of the Material Specifications. Mortar must be Class D, to which has been added an approved admixture unless otherwise shown on the plans or provided in the bidding documents. All brick must be laid in a full bed of mortar and all joints must be shoved joints completely filled with mortar. The joints on the inside face or exposed face of the masonry must be rubbed full and cut as the brickwork is built up. The masonry must be built up in level courses, true to line, grade and dimension. Bats must be used only when necessary to close joints. All brick must be thoroughly wet down immediately before being placed unless otherwise permitted by the Engineer. All work must be completed and finished in a careful, professional manner. Old brick masonry must be thoroughly cleaned and wetted before joining new masonry thereto. Where a mortar coating is required it must have the minimum thickness shown on the plans, must be troweled and re-troweled until a uniform, smooth and impervious surface is obtained.

   All pipes that extend through masonry walls must be tightly sealed in the wall with mortar throughout the circumference of the pipe. The mortar must be pressed in and troweled off flush with the face of the wall.

F) Outside Waterproofing – When called for on the plans or specified, waterproofing must be required on the outside of manholes. The coating must have a minimum dry thickness of four mils (4-mils). Coatings must be environmentally non-hazardous. Spray applications must be shop applied, and field applications are limited to brush and roller. Acceptance of material used for Waterproofing must be on the basis of Type "D" Certification, see section 109.17.02 "Control of Work and Materials - Materials Certifications - Types of Certifications" for details on types of certifications, provided that all applicable requirements are met.

G) Extra Depth Manhole Wall – Where required to construct manholes beyond a depth of six feet (6-ft), manhole walls must be constructed to the depth called for on the plans or as directed by the Engineer. The construction requirements for

Extra Depth Manhole Wall are the same as for "Sanitary Sewer Manhole".

616.04 – TESTING

616.04.01 – MANHOLE INSPECTION

After manhole construction has been completed, the manhole must be visually inspected by the Engineer for acceptability. Visual inspection must be done to check for leaks, thin spots, honeycombs, voids, pinholes and conformance with these specifications.

616.04.02 – MANHOLE TESTING

Manhole testing must be accomplished in accordance with Section 617, “Manhole Testing”.

616.05 – METHOD OF MEASUREMENT

Payment for "Sanitary Sewer Manhole" must be made at the unit price bid per each size for a depth of zero feet (0-ft) to six feet (6-ft). The price established must be full compensation for excavation, backfill, crushed rock foundation, inverts and benches, walls and cones, manhole inserts when specified, ring and cover, protective coating, outside waterproofing when specified, removal of existing manhole when necessary or specified or called for on the plans, brick masonry or precast grade ring and all labor, materials, tools, equipment and incidentals necessary to complete this item of work.

Payment for "Extra Depth Manhole Wall" must be made at the unit price bid per vertical foot for each size. The price established must be full compensation for excavation, backfill, protective coating, outside waterproofing when specified, removal of existing manhole, brick masonry, and all labor, materials, tools, equipment and incidentals necessary to complete this item of work. Extra depth must be measured from the invert to within six feet (6-ft) below top of cover.

616.06 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(SIZE) SANITARY SEWER MANHOLE (0-6 FT)	EA.
EXTRA DEPTH MANHOLE WALL (SIZE)	V.F.

SECTION 617 – MANHOLE TESTING

617.01 – DESCRIPTION

This section covers testing of manholes when called for on the plans or specified. Manholes must be tested, before acceptance, by either performing exfiltration or vacuum test. The Engineer must determine which test must be performed.

617.01.01 – EXFILTRATION TEST

All incoming and outgoing lines (including services) must be plugged, and the manhole filled with water up to the bottom of the manhole ring. If the water loss exceeds the maximum allowable as shown, the manhole must be considered to have failed the test. The Contractor must drain, perform the necessary repairs as directed by the Engineer, and then retest the manhole until it passes, all at no additional cost to the City.

Manhole Depth (feet)	Maximum Allowable Water Loss
< 8-ft	One-inch (1-in) over Five (5) minutes
> 8-ft	One-eighth inch (0.125-in) per vertical Foot of depth over five minutes (5-min)

617.01.02 – VACUUM TESTING

All incoming and outgoing sewer and service lines must be plugged, the plugs restrained, and the vacuum tester head placed on the manhole ring and sealed. A vacuum of ten inches Hg (10-in HG) must then be drawn on the manhole and the time measured for the vacuum to drop to nine inches Hg (9-in HG). The time measured must be not less than that shown on the following table.

TABLE 617.01.01 – Manhole Diameter and Time Measured

Manhole Internal Diameter (feet)	Time Measured (seconds)
4	60
5	60
6	60
7	70

617.02 – METHOD OF MEASUREMENT

Payment for "Manhole Testing" must be made at the contract unit price of lump sum for manholes on lines less than twenty-four inches (<24-in) and each for manholes on lines twenty-four inches and greater (≥24-in). The price established must be full compensation for all material, labor, tools, equipment and incidentals necessary to complete this item of work.

617.03 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

MANHOLE TESTING	LS. (< 24”)
MANHOLE TESTING	EA. (≥ 24”)

SECTION 618 – SANITARY SEWER MANHOLE REHABILITATION

628.01 – DESCRIPTION

This section covers rehabilitation of existing manholes. This section is to provide for all aspects of manhole rehabilitation and waterproofing using various procedures either singularly or in combination.

Sewer manhole rehabilitation must include the following work:

A) Plugging, patching, and waterproofing of the manhole structure, (including manhole chimney, corbel/cone, wall, and base with mortars), coatings and sealants to improve the surface condition, eliminate infiltration, and provide corrosion protection.

B) Lining or coating of manholes

C) Cleaning manholes

D) Reconstruction of benches and inverts

E) Repair or rebuilding of the manhole chimney and corbel to improve structural condition when excavation is required.

F) Removal of steps or ladder

G) Reinstallation or replacement of manhole rings and covers for grade adjustment, ring alignment, or inflow elimination

H) Elimination of infiltration/inflow under manhole rings

I) Elimination of inflow through and around manhole covers

618.02 – CONSTRUCTION METHODS

618.02.01 – SEWER FLOW CONTROL

Manhole sewer flow control must be accomplished in accordance with Section 608, “Sewer Flow Control”.

618.02.02 – CLEANING MANHOLES

Prior to any rehabilitation work on manholes, all concrete and masonry surfaces must be cleaned to the satisfaction of the Engineer. Grease, laitance, loose bricks, mortar, unsound concrete, and other materials must be completely removed. Water blasting with a minimum of five thousand pounds per square inch (5,000-psi) pressure at the nozzles must be the primary method of cleaning, however, other methods such as wet or dry sandblasting, acid wash, concrete cleaners, degreasers or mechanical means may be required to properly clean the surface. Surfaces on which these other methods are used must be thoroughly rinsed, scrubbed, and neutralized to remove cleaning agents and their reactant products. All existing steps and ladders must be cut and disposed of properly. Install all products in accordance with manufacturer’s instructions regarding surface preparation, product application and curing.

618.02.03 – MANHOLE WATERPROOFING

Waterproofing of manholes must be accomplished in accordance with the requirements of Section 619 through 623.

618.02.04 – PATCHING

A) General – Work includes patching, reworking, and reforming of invert and bench. Dry voids, cracks, and spalls must be patched in concrete manholes. Brick manholes must be re-pointed and filled.

B) Material – Manhole waterproofing must comply to the following specifications.

1) Patching material must be formulated for use in high sulfide environments.

2) Patching material must be a premixed non-shrink cement-based patching material consisting of hydraulic cement, graded silica aggregates, special plasticizing and accelerating agents, which has been formulated for vertical or overhead use.

3) It must not contain chlorides, gypsums, plasters, iron particles, aluminum powder, or gas-forming agents or promote the corrosion of steel with which it

may come into contact.

4) Set time must be less than thirty minutes (30-min) per ASTM C-191, “Standard Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle” and designed to resist freeze-thaw environments.

5) One-hour compressive strength must be a minimum of two hundred pounds per square inch (200-psi) ASTM C-109, “Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens) with a maximum volume change of 0.02-percent per ASTM C-596, “Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement”, and the ultimate compressive strengths must be a minimum of five thousand pounds per square inch (5,000-psi) per ASTM C109, “Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens)”. Bond strength must be a minimum of one hundred and forty-five pounds per square inch (145-psi).

6) If patching material is used in combination with a liner material, the products must be deemed compatible as determined by the Manufacturer.

C) Method – Loose material must be removed from the area to be patched or pointed exposing a sound subbase. Holes or voids around steps, joints or pipes, spalled areas and cavities caused by missing or broken brick must be patched and missing mortar repointed using a non-shrink patching mortar.

Cracks not subject to movement and greater than one sixteenth inch (0.0625-in) in width must be grouted out to a minimum width and depth of one-half inch (0.5-in) and patched with non-shrink patching mortar.

Epoxy grouts may be used for filling cracks and voids less than two inches (2-in) in any dimension when preparing surface for application of an epoxy resin lining. Install all materials in accordance with Manufacturer’s instructions regarding surface preparation, product application and curing.

618.02.05 – INVERT AND BENCH RECONSTRUCTION

This section covers the reconstruction of invert and bench of manholes. When called for on the Plans or bidding documents or as directed by the Engineer, manhole benches and inverts shall be reconstructed in accordance with applicable requirements of Section 616, “Sanitary Sewer Manholes”. Hydraulic cement shall meet the requirements of Section 618.04.04, “Sanitary Sewer Manhole Rehabilitation”.

618.02.06 – RAISING MANHOLE

Raising manhole must be accomplished in accordance with Section 457, “Raising

Manhole”.

618.02.07 – LOWERING MANHOLE

Lowering manhole must be accomplished in accordance with Section 458, “Lowering Manhole”.

618.04.08 – RESETTING EXISTING MANHOLE RING AND COVER

Resetting existing manhole ring and cover must be accomplished in accordance with Section 459, “Resetting Existing Manhole Ring and Cover”.

618.04.09 – SETTING NEW MANHOLE RING AND COVER

Setting new manhole ring and cover must be accomplished in accordance with Section 460, “Setting New Manhole Ring and Cover”.

618.04.10 – REHABILITATION METHOD

Manhole may be rehabilitated using one of the following methods as called for on the plans or as directed by the Engineer. Liner must not be applied until all other repairs have been completed.

Rehabilitation Methods	Section
Cast-In-Place Concrete Manhole Liner	624
Cementitious Manhole Liner (Spray Applied)	625
Cured-In-Place Manhole Liner	626
Composite Manhole Liner (Grouted)	627
* Elastomeric Manhole Coatings	628

* Note: This rehabilitation method may be used only on manholes that do not have exposed rebar or missing bricks.

618.04.11 – SERVICE CONNECTIONS

All services connections must be reinstated.

618.05 – TESTING

618.05.01 – MANHOLE TESTING

When called for on the plans or specified in the bidding documents, manhole testing must be accomplished in accordance with Section 617, “Manhole Testing”.

618.06 – METHOD OF MEASUREMENT

Payment for “Sanitary Sewer Manhole Rehabilitation” must be made at the unit price bid per vertical foot for each internal diameter. The price established must be full compensation for all materials and labor required to clean, patch, line, tools, equipment and incidentals necessary to complete this item of work.

Payment for this item must not be made until all rehabilitation on the manhole has been completed. Measurement must be made from the bottom of invert to the finished grade.

Payment for “Invert and Bench Reconstruction” must be made at the unit price bid per each. The price established must be full compensation for all materials and labor required to clean, patch, line, tools, equipment and incidentals necessary to complete this item of work.

618.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SANITARY SEWER MANHOLE REHABILITATION	V.F.
INVERT AND BENCH RECONSTRUCTION	EA.

SECTION 619 – MANHOLE WATERPROOFING

619.01 – DESCRIPTION

This section covers the requirements for the elimination of infiltration/inflow into manholes that are otherwise structurally sound. The waterproofing of the manhole must include base, walls, corbel/cone, and chimney of brick, block or pre-cast manholes.

619.02 – MATERIALS

619.02.01 – GENERAL

The materials used must be designed, manufactured, and intended for sewer manhole rehabilitation and the specific application in which they are used. The materials must have a proven history of performance in sewer manhole rehabilitation. The materials must be delivered to the project site in original unopened packages and clearly labeled with the Manufacturer's identification and printed instructions. All materials must be stored and handled in accordance with recommendations of the Manufacturer.

619.02.02 – MANHOLE WATERPROOFING MATERIALS

A) General – After cleaning and preparing surface in accordance with Section 618, “Sanitary Sewer Manhole Rehabilitation” and when necessary, prior to the application of coatings and linings, active leaks must either be stopped by

application of the materials specified herein or an approved equal. When applying a liner or coating, plugging or channeling infiltration through “bleed” pipes installed at the bottom of the manhole may also be done.

Manhole structure waterproofing includes the waterproofing of the manhole base, walls, corbel/cone and chimney. Waterproofing must be done during high groundwater conditions, unless done in conjunction with application of a liner or coating installed in accordance with Section 620, “Manhole Waterproofing”.

B) Cementitious Grout Materials – A premixed fast-setting, volume-stable waterproof cement plug consisting of hydraulic cement, graded silica aggregates, special plasticizing and accelerated agents not containing chlorides, gas-forming agents, or promote the corrosion of steel it may come in contact with, may be used. Set time must be approximately one minute (1-min). Ten minute (10-min) compressive strength must be approximately five hundred pounds per square inch (500-psi).

C) Chemical Grout Materials

1) General – All chemical grout or sealant must comply with EPA requirements for performance attributes for a sewer sealant. In addition, they must have the following characteristics:

a) While being injected, the chemical sealant must be able to react/perform in the presence of water (groundwater).

b) The cured material must withstand submergence in water without degradation.

c) The resultant sealant (grout) formation must prevent the passage of water (infiltration) through the sewer joint.

d) The sealant material, after curing, must be flexible as opposed to brittle.

e) In place, the sealant formation should be able to withstand freeze/thaw and wet/dry cycles without adversely affecting the seal.

f) The sealant formation must not be biodegradable.

g) The cured sealant must be chemically stable and resistant to the mild concentrations of acids, alkalis, and organics found in normal sewage.

h) Packaging of component materials must be compatible with field storage and handling requirements. Packaging must provide for worker safety and minimize spillage during handling.

i) Mixing of the component materials must be compatible with field operations

and not require precise measurements of the ingredients by field personnel.

j) Cleanup must be done without inordinate use of flammable or hazardous chemicals.

k) Residual sealing materials must be easily removable from the sewer line to prevent reduction or blockage of the sewage flow.

2) Types – The Contractor may use one of the following chemical waterproofing materials, or an approved equal:
   a) Acrylamide and Acrylic Base Gels – Acrylamide and Acrylic Base Gels must meet the following requirements:

      i) A minimum of ten percent (10-percent) acrylamide or acrylic base material by volume in the total sealant mixes. A higher concentration percentage of acrylic base material may be used to increase strength or offset dilution during injection.

      ii) The ability to tolerate dilution and react in moving water during injection.

      iii) A viscosity of approximately two (2) centipoise which can be increased with additives.

      iv) A constant viscosity during the reaction period

      v) A controllable reaction time from ten seconds (10-sec) to one hour (1-hr) for acrylamide base gels and from five seconds (5-sec) to six hours (6-hr) for acrylic base gels

      vi) A reaction (curing) which produces a homogeneous, chemically stable, non-biodegradable, flexible gel

      vii) The ability to increase mix viscosity, density, and gel strength, by the use of additives

   b) Polyacrylamide Base Gel – Polyacrylamide Base Gel must meet the following requirements:

      i) A minimum of ten percent (10-percent) polyacrylamide base material by volume in the total sealant mix. A higher concentration percentage of polyacrylamide base material may be used to increase strength or offset dilution during injection

      ii) The ability to tolerate some dilution and react in moving water during injection

iii) A viscosity of thirty to thirty-five (30-35) centipoise at ten percent (10-percent) solids as applied. The ability to increase mix viscosity, density and gel strength by use of additives

iv) A controllable reaction time from ten seconds (10-sec) to five minutes (5-min)

v) A reaction (curing) which produces a homogeneous, chemically stable, non-biodegradable, firm, flexible gel

vi) A resistance to degradation over a pH range of two (2) to ten (10)

vii) A non-hazardous viscous liquid having ACUTE ORAURAT and Desnai/Rabbit LD60 greater than thirty-two g/kg (32-gpkg) and sixteen g/kg (16-gpkg), respectively

viii) The ability to use water to clean packers and pumps

c) Urethane Base Gel – Urethane Base Gel must meet the following requirements:

i) One (1) part urethane pre-polymer thoroughly mixed with between five (5) and ten (10) parts of water by weight.

ii) A liquid pre-polymer having a solids content of seventy seven percent (77-percent) to eighty three percent (83-percent), specific gravity of 1.04 (8.65-ppg), and a flash point of twenty degrees F (20-degree F)

iii) A liquid pre-polymer having a viscosity of six hundred (600) to twelve hundred (1,200) centipoise at seventy degrees Fahrenheit (70-degrees F) that can be pumped through five hundred feet (500-ft) of one-half inch (0.5-in) hose with a one thousand pounds per square inch (1,000-psi) head at a flow rate of one ounce per second (1-ozps)

iv) The water used to react the pre-polymer should have a pH of five (5) to nine (9)

v) A cure time of eighty seconds (80-sec) at forty degrees Fahrenheit (40-degrees F), fifty-five seconds (55-sec) at sixty degrees Fahrenheit (60-degrees F), and thirty seconds (30-sec) at eighty degrees Fahrenheit (80-degree F) when one (1) part pre-polymer is reacted with eight (8) parts of water only

vi) A cure time that can be reduced to ten seconds (10-sec) for water

temperatures of forty degrees Fahrenheit (40-degree F) to eighty degrees F (80-degree F) when one (1) part pre-polymer is reacted with eight (8) parts of water containing a sufficient amount of gel control agent additive

vii) A relatively rapid viscosity increases of the pre-polymer/water mix. Viscosity increases from about ten (10) to sixty (60) centipoise in the first minute for one (1) to eight (8) pre-polymer/water ratio at fifty degrees F (50-degree F)

viii) A reaction (curing) which produces a chemically stable and non-biodegradable, tough, flexible gel

ix) The ability to increase mix viscosity, density, gel strength and resistance to shrinkage by the use of additives to the water

d) Cementitious Coating Material – A liquid polymer modified hydraulic waterproof coating, which must provide a secure (mechanical and chemical) bond per ASTM C-1072, "Standard Test Methods for Measurement of Masonry Flexural Bond Strength".

i) The material must be available in contrasting colors. When fully cured, the two (2) coat or three (3) coat system must be able to withstand a hydrostatic pressure of seven pounds per square inch (7-psi) or thirty pounds per square inch (30-psi), respectively, without any visible leaks.

ii) Install all products in accordance with manufacturer's instructions regarding surface preparation, product application and curing.

619.03 – CONSTRUCTION METHODS

619.03.01 – Grout Waterproofing Method

A) Equipment – The basic equipment must consist of pumps, containers, injection packers, hoses, valves, and all necessary equipment and tools required to seal manholes. The chemical injection pumps must be equipped with pressure meters that will provide for monitoring pressure during the injection of the grout sealants. When necessary, liquid bypass lines equipped with pressure-regulating bypass valves will be incorporated into the pumping system.

B) Plugging Procedure – At each point of leakage within the manhole structure a hole must be carefully drilled from within the manhole and must 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 devises must 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, must be attached to the injection device from· an injection pump. Chemical sealing materials as specified must then be pumped through the hose until material refusal is recorded on the pressure gauge mounted on the pumping unit or a predetermined quantity of sealant has been injected. Care must be taken during the pumping operation to ensure that excessive pressures do not develop and cause damage to the manhole structure. Upon completion of the injection, the ports must be removed, and the remaining holes filled with mortar and finished flush by trowel with the surface of the manhole wall or other surface. The mortar used must be a non-shrink patching mortar meeting the requirements of Section 618, “Sanitary Sewer Manhole Rehabilitation”. Small leaks may be sealed without drilling and with grout delivered directly into the site with a caulking applicator.

C) Packing Procedure – Dry twisted jute oakum is soaked in polyurethane resin and then manually packed into cavity at site of active flow. Cementitious grouts may be mixed into a thick slurry and then packed directly into gravity. Both procedures require holding the product in place until material sets and the leak is stopped.

D) Cementitious Waterproof Coating Method – A waterproof, cementitious coating as specified herein must be applied to all surfaces, from and including the manhole bench to the bottom of the frame. The material must be applied to surfaces that are free of cracks or voids wider than one-sixteenth inch (0.0625-in). Coating may be applied over minor leaks and weeping around bricks, but major leaks will need to be plugged with cementitious or chemical grout before coating. A minimum of two (2) coats (of contrasting colors) must be applied to manholes zero feet (0-ft) to fifteen feet (15-ft), and three (3) coats applied to depths greater than fifteen feet (15-ft). When completed, the coating must be free of any cracks or holes.

After proper curing of the applied materials, any "bleed" pipes that were used must be removed, and the holes plugged and coated with the specified materials.

619.04 – TESTING & INSPECTION OF WATER PROOFING

After the specified waterproofing work has been completed, the manholes must be visually inspected and tested by the Contractor (as required) in the presence of the Engineer and found to be acceptable.

Manhole structure waterproofing must be visually inspected for water tightness against leakage of water into the manhole. All visible leaks and defects observed during inspection must be repaired to the Engineer's satisfaction.

619.05 – METHOD OF MEASUREMENT

Payment for "Manhole Waterproofing" must be made at the unit price bid per each. The price established must be full compensation for all materials, tools, labor, equipment and incidentals necessary to complete this item of work.

619.06 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

MANHOLE WATERPROOFING EA.

SECTION 620 – MANHOLE JOINT WATERPROOFING

620.01 – DESCRIPTION

This section covers waterproofing of joints in pre-cast concrete manholes. The work includes the sealing of barrel joints when general structural sealing is not required.

620.02 – CONSTRUCTION METHODS

Chemical Grout Sealing – Chemical grout sealing must be accomplished in accordance with Section 620, “Manhole Waterproofing”.

Cementitious Sealing – Cementitious sealing must be accomplished in accordance with Section 619, “Manhole Waterproofing”.

Expanded Gasket – Elastomeric polyurethane resin-soaked oakum method, using dry twisted jute oakum or resin rod with polyurethane resin (water activated) may be used.

Manufactured Seal **–** Manufactured manhole joint seal that generally conforms to the requirements of Section 621, “Manhole Ring Waterproofing”, with a stainless steel restraining hoop may be used. Detailed installation procedures must be in accordance with the manufacturer's instructions. Internal Joint Seals meet or exceed the physical requirements of ASTM C-923, “Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals”. The stainless steel expansion band meets or exceeds ASTM A-240, Type 304 standards, “Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications”.

620.03 – TESTING

Inspection and testing of waterproofing must be accomplished in accordance with Section 619 “Manhole Waterproofing”.

620.04 – METHOD OF MEASUREMENT

Payment for "Manhole Joint Waterproofing" must be made at the unit price bid per each joint. The price established must be full compensation for all materials, tools, labor, equipment and incidentals necessary to complete this item of work.

620.05 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

MANHOLE JOINT WATERPROOFING EA.

SECTION 621 – MANHOLE RING WATERPROOFING

621.01 – DESCRIPTION

This section covers manhole ring waterproofing.

621.01.01 – GENERAL

Manhole ring waterproofing includes the sealing of the ring joint area and the chimney above the cone of the manhole with either a manufactured or applied internal or external flexible seal. The seal must be designed to prevent leakage of water into the manhole through these areas throughout a twenty-year (20-yr) design life. The seal must remain flexible, allowing repeated vertical movements of the frame due to frost lift, ground movement, or other causes of up to two inches (2-in) and/or repeated horizontal movement of the frame due to thermal movement of pavement or other causes of up to one-half inch (0.5-in).

621.02 – CONSTRUCTION METHODS

621.02.01 – GENERAL

Manhole ring waterproofing must be accomplished by the following methods as directed by the Engineer.

A) Manufactured Chimney Seal

1) General – This product cannot be used on cones or where chimneys are "out of round" by more than two inches (2-in). If the flexible portion of the seal is made of a rubber type product, it must have a minimum thickness of three-sixteenth inch (0.1875-in), a minimum unexpanded width of eight inches (8-in) and be fabricated from a high-grade rubber compound conforming to the applicable requirements of ASTM C-923, “Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals”. The internal seal must have a double pleated and the external seal have a corrugated, expandable center section. Any extension used in conjunction with the sleeve to increase coverage must be made of the same material and have the same minimum thickness as the sleeve and be designed to be mechanically attached to the sleeve. The bands used for compressing the sleeve and extension against the

manhole must be fabricated from minimum sixteen (16) gauge sheet, if channeled, or five-sixteenth inch (0.3125-in) diameter, if round, stainless steel conforming to ASTM A240, “Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications”, Type 304, for sheet and ASTM A479, “Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels”, Type 304, for rods. Any screws, bolts or nuts used on these bands must be stainless steel conforming to ASTM F-593, “Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs”, and 594, “Standard Specification for Stainless Steel Nuts”, Type 304. The internal seal or its appurtenances must not extend into the manhole opening to prevent or unduly restrict manhole entry. If the seal is constructed of another flexible material, it must have both tensile and tear strength equal to or greater than that of the rubber when tested in accordance with the applicable ASTM procedures.

2) Installation – The contact surfaces for the sleeve and extensions must be clean, reasonably smooth and circular, and free of excessive voids. If the masonry surface is rough or irregular and will not provide an effective seal, it must be smoothed with mortar. A bead of butyl rubber caulk must be applied to the bottom-sealing surface of the seal or extension to fill minor irregularities in the masonry surface. After the rubber sleeve has been placed in the proper position, the bands are positioned and individually tightened or expanded as required to provide a watertight seal.

B) Extension – When an extension is used, its top must be positioned in the bottom band recess prior to installing the bottom band. The bands are then positioned in the extension and tightened or expanded as required to provide a watertight seal. Installation procedures must be in accordance with the manufacturer's instructions.

C) Applied Ring Seal – An applied seal is one that is achieved by applying a product, approved by the Engineer, either between the precast adjusting rings of the chimney and under the ring or to either the inside or outside surface of the chimney and ring to provide a seal that meets the performance criteria contained in this section. If the applied sealing product is a butyl compound, all of the surfaces that are to be sealed must be clean, dry and dust free.

D) Flexible Ring Seal – For application of flexible ring seal between joints, the waterproofing seal must be applied only when setting the manhole ring to brick or cast-in-place manholes. For precast manholes, the waterproofing seal must be applied between all adjustment ring joints including adjustment ring/cone joint, and to set the manhole ring.

E) Elastomeric Polyurethane Resin-Soaked Oakum Method – If the applied seal utilizes the elastomeric polyurethane resin-soaked oakum method, each joint must consist of two (2) concentric rings of two inch (2-in) oakum. The outer ring must be saturated with the urethane-base foam chemical-sealing material. The inner ring, saturated with

water, must be placed to prevent urethane foam from entering the manhole. The oakum saturated with urethane must be sprayed with water. When foaming begins, the frame must be set in place.

F) If the applied sealing product is a type of material that is applied to either the inside or outside surfaces of the ring and chimney and/or corbel/cone, the surface against which it is applied must be clean, and free of rust, dust, oil, loose material and other contaminants. The product must be applied by trowel, roller, or by spraying to achieve a thickness of not less than one hundred mils (100-mils). The sealing material must extend far enough onto the ring to ensure bonding and cover enough of the chimney to ensure sealing. Application procedures must be in accordance with the manufacturer's instructions.

621.02.02 – SETTING EXISTING OR NEW MANHOLE RING AND COVER

Setting of the manhole ring and cover must be in accordance with ring seal manufacturer's instructions.

621.03 – TESTING

Inspection and testing of waterproofing must be accomplished in accordance with Section 621, “Manhole Ring Waterproofing”.

621.04 – METHOD OF MEASUREMENT

Payment for "Manhole Ring Waterproofing" must be made at the unit price bid per each manhole. The price established must be full compensation for all materials, tools, labor, including resetting of existing manhole ring and cover, equipment and incidentals necessary to complete this item of work.

When waterproofing manhole ring requires installation of a new manhole ring and cover, a separate payment for the new manhole ring and cover must be made in accordance with Section 616 “Sanitary Sewer Manholes”.

621.05 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

MANHOLE RING WATERPROOFING	EA.

SECTION 622 – MANHOLE COVER WATERPROOFING

622.01 – DESCRIPTION

This section covers the waterproofing of manhole covers.

622.01.01 – GENERAL

Manhole cover sealing includes either the replacement of or sealing of existing manhole covers. All of the methods described, herein, require the thorough cleaning of the ring surface by wire brushing. Detailed installation procedures must be in accordance with the manufacturer's instructions.

622.02 – CONSTRUCTION METHODS

A) Cover Conversion – Reuse the existing cover by making it watertight. This is accomplished by installing a gasket between the cover and the cover-bearing surface of the ring and plugging the vent and pick holes. One of the plugs must be removable to facilitate removal of the cover.

   Manhole cover gaskets and plugs must be molded from a high-quality rubber compound such as Nitrile, EPDM or a blend thereof. The rubber product must have a minimum tensile strength of two thousand pounds per square inch (2,000-psi) with a hardness durometer of sixty (60) ± five (5). The cover gasket must be provided with an outside rib and have a minimum thickness of three-thirty seconds inch (0.09375-in).

B) Manhole Insert – Use the existing cover in conjunction with a watertight insert that is installed under the cover and prevents entry of water into the manhole. The manhole insert must be designed to prevent inflow through and around manhole covers and manufactured to fit the manhole ring upon which the manhole cover rests.

   The manhole insert must be manufactured from a corrosion-resistant material able to withstand the environment of a sanitary sewer system, road salts, oils and fuel that it may come in contact with. The material must be freeze-thaw resistant and withstand a temperature range of minus fifty degrees Fahrenheit (-50-degrees F) to two hundred forty-five degrees Fahrenheit (245-degrees F). The manhole insert must have a minimum thickness of one-eighth inch (0.125-in).

   The insert must have an approved system of relieving gas and vacuum pressure and must be complete with a closed-cell neoprene or polyethylene gasket with adhesive backing installed on the underside of the insert rim by the manufacturer. The insert must have a corrosion-resistant strap installed within the bowl for ease of installation and removal. The manhole insert must be fully seated upon the manhole ring and cover replaced to complete the installation.

622.03 – TESTING

Inspection and testing of waterproofing must be accomplished in accordance with Section 619 “Manhole Waterproofing”.

622.04 – METHOD OF MEASUREMENT

Payment for "Manhole Cover Waterproofing" must be made at the unit price bid per each manhole. The price established must be full compensation for all materials, tools, labor, equipment and incidentals necessary to complete this item of work.

622.05- BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

MANHOLE COVER WATERPROOFING	EA.

SECTION 623 – GROUT CURTAIN WATERPROOFING METHOD

623.01 – DESCRIPTION

This section covers waterproofing manholes by installing a grout curtain.

623.01.01 – GENERAL

When specified or called for on plans, a chemical grout curtain may be installed to prevent infiltration. Ports must be drilled in a checkerboard fashion in the manhole chimney, corbel, and wall, and a chemical grout is pumped into the surrounding soil through the ports surrounding the manhole to create an impermeable "curtain". For brick and block manholes, the procedure may involve the use of a two coat cementitious liner as described in Section 625, “Cementitious Manhole Liner”, in combination with the grout curtain.

623.02 – CONSTRUCTION METHODS

623.02.01 – SURFACE PREPARATION

The manhole surface must be cleaned, patched, and infiltration stopped in accordance with Section 618, “Sanitary Sewer Manhole Rehabilitation”.

623.02.02 – GROUT PORTS OR INJECTORS

Holes must be drilled and grout ports or chemical grout injection devices installed to

ensure proper grouting of the soil outside of the manhole. Some additional ports may be placed after the application of the cementitious liner.

623.02.03 – WATERPROOF COATING

Two (2) or three (3) coats, as required, of a cementitious liner must be applied as required after any chemical grout is pumped. The liner must provide a dam to optimize the grout sealing application and must extend from the manhole base to the bottom of the ring seal.

623.02.04 – CHEMICAL SEALING

Chemical grout gel must be injected into the soil surrounding the manhole as needed for complete sealing, using the same equipment and procedures as required earlier in this section. Grouts injected into near-surface and chimney-corbel areas must be modified with shrink control agents, gel reinforcing agents and accelerators as needed for the type of chemical gel used.

623.03 – METHOD OF MEASUREMENT

Payment for "Grout Curtain" must be made at the unit price bid per vertical foot of manhole. The price established must be full compensation for all materials and labor including waterproofing grout, liner materials, surface preparation, application, tools, equipment and incidentals necessary to complete this item of work.

623.04 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

GROUT CURTAIN	V.F.

SECTION 624 – CAST-IN-PLACE CONCRETE MANHOLE LINER

624.01 – DESCRIPTION

This section covers utilization of an internal forming system for casting a structurally independent three inch (3-in) concrete wall within the existing manhole. The liner is constructed of high-strength concrete in one pour without seams and without disrupting sewer flows.

624.02 – MATERIALS

624.02.01 – SUBMITTALS

Review and approval of the Contractor submittals, by the Engineer, must not be construed in any way as relieving the Contractor and the manufacturers of their responsibilities as

specified in these specifications. When requested by the Engineer, the Contractor must submit the following, but not limited to, for review and approval:

A) The Contractor must submit test reports of the concrete mix design meeting the requirements the following sub sections.

624.02.02 – GENERAL

Unless otherwise specified, the concrete must be a standard (Type 1/Type II) Portland cement mix, ASTM C-150, "Standard Specification for Portland Cement", with three-fourth inch (0.75-in) minus coarse aggregate, ASTM C-33, "Standard Specification for Concrete Aggregates", Size No. 67, producing a minimum twenty-eight day (28-day) compressive strength of four thousand pounds per square inch (4,000-psi) at full cure. When directed by the Engineer, a high-strength, quick-setting cement grout must be used for positioning and sealing the form at the manhole base.

624.02.03 – FORMS

Segmented stackable steel forms having cylindrical and conical sections with either eccentric or concentric cones are employed. The assembled internal manhole form must have sufficient stiffness and strength to preclude shifting and/or collapse during concrete placement and to ensure safe entry during the procedure. The assembled form must have appropriate cross section size to provide an annular space with a three inch (3-in) average and a one and one-half inch (1.5-in) minimum thickness.

624.03 – CONSTRUCTION METHODS

624.03.01 – SURFACE PREPARATION

The Contractor must use cleaning methods that are adequate to remove loose material from the manhole in accordance with Section 618, "Sanitary Sewer Manhole Rehabilitation". All existing manhole steps or ladders are to be removed. The Contractor must take all necessary precautions to prevent falling debris from damaging the manhole trough and/or entering the sewer. Install all products in accordance with manufacturer's instructions regarding surface preparation, product application and curing. If there is no product being installed, you must submit to the Engineer the method of Surface preparation. This submittal must include any method references ISO 8501 cleanliness levels and or SSP surface cleanliness number. Infiltration through existing manhole walls that would adversely affect the material used in the annular space must be eliminated or reduced to an acceptable level in accordance with Section 619 to 623.

624.03.02 – GENERAL

The Contractor must place block-outs as needed to provide pipe inlets and outlets of the same diameter through the new concrete wall. All flows through the manhole must remain active unless otherwise directed by the Engineer.

The internal form must be sized, erected and braced as necessary to assure that the new interior wall has an average thickness of three inches (3-in) with a one and one-half inch (1.5-in) minimum, extending from the manhole base to the bottom of the corbel/cone. The wall thickness may decrease to a minimum of one and one-half inches (1.5-in) at the top of the corbel/cone and through the chimney portion of the manhole. The finished opening must have a minimum diameter of twenty inches (20-in) unless otherwise specified.

The form must be positioned, sealed and finished at the manhole base using cement grout to assure that concrete does not enter the sewer during the procedure. As the concrete is placed, it must be consolidated to assure that it makes contact with the form and fills all pockets, seams and cracks within the annular space. The Contractor must use adequate but not excessive vibration that might cause segregation of the concrete components. The top of the new concrete interior must not extend into the manhole ring.

When the concrete has sufficiently cured to preclude slump or damage, the form must be removed. The resultant concrete manhole wall must be smooth and free of honeycomb and areas of segregated aggregate.

624.04 – TESTING

A set of nine (9) concrete cylinders, three inch (3-in) by six inch (6-in), must be made from each day's work with the date, location and job recorded on each. Testing must be in accordance with ASTM C-39, "Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens". A laboratory must make the cylinders for testing. A seven (7) day and a twenty-eight (28) day compression test will be made and recorded using three (3) of the samples for each test. Three (3) samples will be held for further instructions by the Engineer should the twenty-eight (28) day compression test results fail to meet the specifications.

624.05 – METHOD OF MEASUREMENT

Payment for "Cast-In-Place Concrete Manhole Liner" must not be made separately but is included in the unit price bid for "Manhole Rehabilitation" per Section 618, "Sanitary Sewer Manhole Rehabilitation".

SECTION 625 – CEMENTITIOUS MANHOLE LINER

625.01 – DESCRIPTION

This section covers the application of a premixed cementitious blend of binders, materials, aggregates, glass fiber and other additives. After mixing with water, the material is spray applied directly to all interior surfaces of manhole in an even application consisting of multiple passes. Install all products in accordance with manufacturer's instructions regarding surface preparation, product application and curing. If spray method is not used, the proposed method must be submitted and receive approval from the Engineer. Once

applied, material to be troweled and sponge finish which must restore structural integrity and provide corrosion protection. The material should be capable of persisting in environments having pH levels down to 1.0. Materials that cannot meet this requirement will not be considered due to the conditions of the manholes.

625.02 – MATERIALS

All additions to cementitious manhole liners must conform to the requirements of ASTM C-94, “Standard Specification for Ready-Mixed Concrete”. The material may be the following proprietary pre-blended product or approved equal:

A) Calcium Aluminates– CAC mix must be made with one hundred percent (100-percent) pure fused calcium aluminate clinker and calcium aluminate cement (minimum alumina content of both the cement portion as well as aggregates must be thirty eight percent (38-percent) and used per manufacturer’s recommendations in applications where there is moderate to severe evidence of hydrogen sulfide (biogenic) corrosion.

B) Portland Cement - A mixture of cementitious and pozzolanic materials, micro-silica one hundred percent (100-percent) virgin polypropylene fibers, and other additives. This can also consist of a mixture of Portland cement, especially graded aggregates, synthetic fibers, and admixtures. This can also consist cementitious material enhanced with Donna Fill, a fine-graded granite aggregate.

C) Geopolymer Lining Material - must be a factory blended, one-component (just add water), eco-friendly (low carbon footprint), fiber reinforced, ultra-dense geopolymer mortar synthesized from reactive SiO_2 and Al_2O from industrial byproducts, enhanced with monocrystalline quartz aggregate. This material must be designed to restore structural integrity while eliminating the infiltration of groundwater, provide enhanced corrosion resistance and must be specifically formulated for ease of mechanical pumping, spraying and spin casting.

   A process to rule out cementitious products and to quantitatively classify a Geopolymer must include oxide composition testing using X-Ray Fluorescence (XRF). Prior to testing, the geopolymer precursor must be isolated by screening the original untreated, unground product through a 200# mesh screen, to remove aggregate and fibers. Once isolated, the precursor must be analyzed by X-Ray Fluorescence (XRF) and must result in the % weight of Calcium Oxide (CaO) being less than 25% of the total oxides.

D) Physical Properties – The cementitious liner must have the following minimum properties at twenty-eight (28) days:

Physical Properties	Test Method	Minimum Value

Compressive Strength	ASTM C-495, ASTM C39/ C109	Minimum 8,000
Tensile Strength	ASTM C-496	300 psi
Flexural Strength	ASTM C-293	600 psi
Shrinkage	ASTM C-596	0%
Bond		130 psi
Density, when applied		105 pcf

625.03 – EQUIPMENT

The equipment must be of a type necessary for the application of the proprietary product used as recommended by the manufacturer and approved by the Engineer.

625.04 – CONSTRUCTION METHODS

625.04.01 – SURFACE PREPARATION

Surface preparation must comply with Section 636.04.01, “Cast-in -Place Concrete Manhole Liner – Construction Methods – Surface Preparation”. Install all products in accordance with manufacturer’s instructions regarding surface preparation, product application and curing.

625.04.02 – APPLICATION

The materials must be mixed and applied in accordance with the manufacturer's written instructions using approved equipment. The material must be spray applied directly to the prepared manhole surface. The material must be troweled and then sponge finished after each coat. All cementitious liner materials, approved herein, must completely cover the interior surface of the manhole with a minimum thickness of one-half inch (0.5-in).

625.05 – TESTING

Testing must be done in accordance with Section 624, “Cast-in-Place Concrete Manhole Liner”.

625.06 – METHOD OF MEASUREMENT

Payment for "Cementitious Manhole Liner" must not be made separately but is included in the unit price bid for "Manhole Rehabilitation" as per Section 618, “Sanitary Sewer Manhole Rehabilitation”.

SECTION 626 – CURED-IN-PLACE MANHOLE LINER

626.01 – DESCRIPTION

This section covers reconstruction and rehabilitation of sanitary sewer manholes by the installation of a resin impregnated flexible felt tube, inverted into the existing manhole. Cured-In-Place Liner and its minimum thickness must conform to the requirements of ASTM F-1216, “Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube”.

626.02 – MATERIALS

A) Tube – The tube must be compatible with the resin system and must consist of one or more layers of flexible felt or an equivalent woven or nonwoven material. The material must be able to stretch to fit irregular manhole sections. Allowance must be made in the fabrication of the tube so that the installed, formed-in-place-pipe fits snugly to the interior circumference of the existing manhole, while allowing for stretching during inversion.

B) Resin – The resin must conform to the requirements of Section 657.02, “Resin Impregnated Tube – Materials”.

C) Minimum Physical Properties – The cured resin impregnated tube must conform to the requirements of Section 638, “Resin Impregnated Tube”.

D) Chemical Resistance – The resin impregnated tube must conform to the requirements established in Section 638, “Resin Impregnated Tube.

E) Minimum Thickness – The installed liner must have a minimum SDR of 60 and must meet the following minimum thicknesses for various manhole internal diameters. All manholes must be lined with a minimum one inch (1-in) liner regardless of the internal depth. To ensure a fully structural, all manholes are required to be lined with a minimum one inch (1-in) thickness.

Internal Diameter (feet)	Minimum Thickness (inch)
4	1.00
5	1.00
6	1.20
7	1.40
8	Per Engineer’s requirement

F) Submittals – The Contractor must provide appropriate submittals in accordance with Section 607 “Formed in Place Pipe (FIPP)”.

626.03 – CONSTRUCTION METHODS

The Contractor must designate a location where the tube will be vacuum impregnated prior to installation. The Engineer must inspect the materials and the "wet-out" procedure and approve the location.

The wet-out tube must be installed in the manhole using a top inversion. The inversion ring must be built above the top of the manhole to an elevation required to create the standpipe section.

The tube must be banded to the inversion ring with the impermeable plastic membrane side out and inverted through the ring with a minimal amount of water. The inversion must be continued with a minimal amount of water until the tube reaches the bottom of the manhole.

After the inversion is completed, the water must be pumped out if required, and personnel should enter the manhole to manually adjust the tube to fit smoothly against the manhole wall. The tube must then be filled with water to the predetermined level and the curing process must begin.

The Contractor must then supply a suitable heat source and water recirculation equipment. The equipment must be capable of uniformly raising the water temperature to a level required to effectively cure the resin.

The heat source must be fitted with suitable monitors to gauge the temperature of the incoming and outgoing water supply. Another such gauge must be placed between the tube and the manhole at or near the bottom to determine the temperature during cure. Water temperature in the manhole during the cure period must be as recommended by the resin manufacturer.

Initial cure must be deemed to be completed when inspection of the exposed portions of the tube appear to be hard and sound and the temperature sensor indicates that the temperature is of a magnitude to realize an exotherm. The cure period must be of a duration recommended by the resin manufacturer and may require continuous recirculation of the water to maintain the temperature.

The Contractor must cool the hardened tube to a temperature below one hundred degrees Fahrenheit (100-degrees F) before relieving the hydrostatic head in the inversion standpipe. Cool down may be accomplished by the introduction of cool water into the inversion standpipe to replace water being pumped out of the manhole.

The liner must be cut off below the manhole cover and sealed as specified. The finished product must be continuous over the entire manhole and be free from dry spots, delamination and lifts. It must also meet the leakage requirements or pressure test specified. During the warranty period, any defects must be repaired at the Contractor's

expense.

After the liner has been cured in place, the Contractor must reconnect the existing pipes entering the manhole as designated by the Engineer. This must be done from the interior of the manhole by cutting the tube at the pipe openings.

If due to broken or misaligned pipe at the manhole wall the tube fails to make a tight seal, the Contractor must apply a seal at that point in accordance with Section 607, “Formed-in-Place Pipe (FIPP)”.

626.04 – METHOD OF MEASUREMENT

Payment for “Cured-In-Place Manhole Liner” must not be made separately but is included in the unit price bid for "Manhole Rehabilitation" as per Section 618, “Sanitary Sewer Manhole Rehabilitation”.

SECTION 627 – COMPOSITE MANHOLE LINER

627.01 – DESCRIPTION

This section covers rehabilitation of sanitary sewer manholes by the installation of a flexible plastic liner with profiled cross section cast into a structurally independent concrete wall three inch (3-in) thick or as directed by the Engineer.

627.02 – MATERIALS

627.02.01 – SUBMITTALS

Proposed grouting procedure including type of formwork used and/or measures taken to prevent buckling of liner, and cone entry assembly must be submitted to the Engineer for review and approval. The Contractor must submit a certificate that the PVC liner furnished under this specification is in conformance with the material and mechanical requirements in the appropriate ASTM and as specified herein. Submittals for concrete mix design must be in accordance with Section 624,“Cast-in-Place Concrete Manhole Liner”.

627.02.02 – GENERAL

A) Grout or Concrete – Grout components must be clean, fresh, and stored in suitable dry condition. Premixed grout and grout admixtures must be used in accordance with the manufacturer's instructions and approved by the Engineer. The grout or concrete must conform to the requirements of Section 624, “Cast-in-Place Concrete Manhole Liner”.

B) PVC Liner – The liner must be of the following types or approved equal:

1) PVC Panels or Coils – The PVC materials must be made from compounds specified for PVC pipe extrusion suitable for potable water and sanitary sewer, and DWV (Drain/WasteNent) with less than ten (10%) percent fillers and must conform to ASTM D-1784, “Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds” cell classifications 12454-B, or 13364-A, or 13364-B. The minimum panel base thickness and minimum panel "tee" profile height of the PVC panels must be as follows, unless otherwise specified by the Engineer:

Dimensions	Minimum Size (inches)
Base Thickness	0.06
"Tee" Profile Height	0.40

2) PVC Sheeting **–** The plastic liner must be a white, high-polymer, vinyl chloride sheeting capable of being cast into the concrete and made an integral part of the structure. It must have a minimum thickness of sixty-five mils (65-mils), and must be capable of resisting strong acid, alkaline and salt solutions.

C) HDPE Liner **–** HDPE manhole liner system must be fabricated from polyethylene pipe manufactured in accordance with ASTM F-894, “Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe”. The liner must have a minimum ring stiffness constant (RSC) of 63, and meet the material requirements of Section 632, “High Density Polyethylene (HDPE) Pipe”.

627.03 – CONSTRUCTION METHODS

627.03.01 – PVC PANELS OR COILS

A) Liner Installation (Panels) – If the Contractor chooses to use the PVC liner in the form of panels, the panels must be cut and trimmed to fit as near as practical to the internal circumference of the structure. The panels must be placed commencing at the bottom of the manhole with the male locking edge of the panel to the bottom of the manhole. The bottom edge of the first panel must be set in a bed of fast-setting grout. The panels must be kept square with the vertical wall. A bead of selected sealant/adhesive, approved by the Engineer, and of sufficient width to seal the joint must be applied to the female locking edge and the end-joining piece prior to the locks being engaged. The locks must be snapped together. End joints must be made with a manufacturer supplied/approved plasticized end-joining material which must under-lap the panels by not less than three inches (3-in). The end joints must be staggered so the joints are not aligned. A bead of the approved sealant/adhesive must be placed over the end joint after panel installation. If necessary, the panels may be shimmed off the wall to avoid

discontinuities on the surface, or to achieve a more circular interior wall than the original as may be approved by the Engineer.

B) Liner Installation (Coils) – If the Contractor chooses to use the PVC liner in the form of a one hundred fifty foot (150-ft) to two hundred foot (200-ft) coil of continuous strip, the liner must be placed commencing at the bottom of the manhole. The ribbed profile of the strip must be kept offset from the wall by vertical studs/spacers to maintain annular gap to grout (concrete) thickness specified. The strip is manually spirally wound around the interior of the manhole to a height that will exceed a scribe line on the liner that matches the bottom contour of the manhole by two revolutions. The bottom contour of the manhole is then scribed onto the liner. The liner is then cut along the scribe line so as to fit the interface of the bottom of the manhole and the wall. The liner is then positioned down into a bed of hydraulic cement. Winding then proceeds upward with the ribbed profile of the strip spaced from the wall as required. If necessary, the strip may be shimmed off the wall to avoid discontinuities of the wall surface. A bead of selected sealant approved by the Engineer, of sufficient width to seal the joint must be applied to the male locking edge prior to the locks being engaged. The locks must be snapped together with a rubber mallet or other means approved by the manufacturer. Additional coils of PVC strip may be introduced by joining the ends of the strip by means of a manufacturer supplied joiner pad inserted on the ribbed side of the strip. The joint must be sealed on both sides of the strip with the approved sealant and pinned with a nylon fastener if required. Alternatively, the ends of successive coils may be joined in a simple lap joint by grinding off the "T's" on one end and overlapping the other end piece by three inches (3-in) to four inches (4-in) and joining the two with PVC solvent cement. The edge locks on the lapped piece must be removed also and these locks must be aligned on both edges at the mating ends. This process must be done above ground with adequate ventilation. The strip must be wound just past the designated liner height. After grouting and grout set, the liner must be trimmed to the designated height.

C) Grouting – Once the liner is in place, the hydraulic cement bed at the bottom of the manhole is checked to determine if additional sealing is required. At the top and around the liner must be placed a series of tubes that act as grout injection tubes. Alternatively, or in addition, grout holes may be drilled in the PVC lining at appropriate points and grout pumped into them until satisfactory fill is obtained. When grouting holes are used, the holes must be sealed with PVC plugs upon grout completion. The grouting plan must be reviewed and approved by the Engineer in advance of the work. Care must be taken not to allow the hydrostatic pressure of the fluid grout to buckle with the PVC liner. When required, temporary rigid vertical supports must be placed on the inner perimeter of the PVC liner while the grout is being placed.

D) Lining of Cone/Corbel – The materials used in cone/corbel lining must consist of truncated pie sections made by diagonally cutting two strips of material and inserting these, along the diagonal cut, into a center joiner strip supplied by the

manufacturer. After trimming the ends to approximate the circular radiuses of the top and bottom of the cone and sealing all joints with approved sealant, the truncated pie sections must be fitted together by interlocking the edges to form the cone lining. The cone lining must then be braced and grouted after appropriate sealing at the bottom.

627.03.02 – INSTALLATION OF PVC SHEETING

Forms must be sized, erected, and braced as necessary to assure that the new interior wall must have a minimum thickness of one and one half inches (1.5-in) extending from the manhole base to the top of the cone section conforming generally to the interior dimensions of the existing structure. When casting a structurally independent wall three inches (3-in) in thickness or greater, an internal diameter of forty-two inches (42-in) must be maintained in the existing manhole.

The form must be positioned, sealed, and finished at the manhole base to ensure that concrete does not enter the sewer. The PVC liner must be fitted securely to the exterior of the steel forms during erection. When the forms are removed, any joints in the liner must be cleaned and fusion or extrusion welded. When directed by the Engineer, the interior surface including welded joints must be spark-tested with a holiday detector at fifteen thousand volts (15,000-V) to twenty thousand volts (20,000-V). Any holidays or defects in the liner must be repaired and retested.

The concrete must be carefully placed in such a manner as to prevent segregation of the cement and aggregate. The concrete must be consolidated to fill all pockets, seams, and cracks within the existing wall. When the concrete has sufficiently cured to preclude slump or damage, the form must be disassembled and removed.

Jointing seams in the plastic liner will be fusion welded by qualified personnel using only factory- approved methods and techniques. The welding operation of any joint must be continuous until that joint has been completed. The welding strip must be centered over the cleaned surfaces to be joined and fused across its entire width using a hot air welding gun producing temperatures ranging between five hundred degrees Fahrenheit (500-degrees F) and six hundred degrees Fahrenheit (600-degrees F).

627.03.03 – HDPE LINER

The surrounding roadway material or soil must be excavated, and the existing chimney and cone sections must be removed. Undamaged precast sections may be salvaged and reused as directed by the Engineer. All debris must be properly disposed of off-site at the contractor's expense.

The outer diameter of the liner must not exceed ninety-seven percent (97%) of the internal diameter of the existing manhole. The liner must be installed spigot end up and accurately trimmed around the bottom to conform to existing benches and sewer lines. The HDPE liner must be centered in the manhole and the bottom edge set using a seal between liner

and bench and crown of pipes at bottom of manhole. Pipe stubs must be installed through the liner wall matching inverts and flow lines and sealed with an approved mastic before grouting annulus. The pipe material must be a diameter equal to or slightly larger than the existing pipe.

Sound construction practice must be taken in the placement of grout to ensure that the annulus is free of voids and the liner is not buckled during the grouting operation. The annulus must be filled to the bottom of the top rib on the polyethylene liner.

A polyethylene flat top or cone with bell assembly must be installed on spigot end of liner and sealed with closure gasket or mastic as directed by the Engineer. The precast cone or slab and ring sections must be placed so that they are fully supported by the existing concrete walls leaving an approximately one fourth inch (0.25-in) space between the polyethylene and precast top sections. The ring or cone section of the liner must be trimmed so that the frame and lid will be fully supported by the concrete walls. The space between the entry sections must be grouted. All remaining concrete grout exposed to the sanitary sewer environment must be coated in accordance with Section 628, “Elastomeric Manhole Coating”.

627.04 – TESTING

Testing must be done in accordance with Section 624, “Cast-in-Place Concrete Manhole Liner”.

627.05 – METHOD OF MEASUREMENT

Payment for "Composite Manhole Liner" must not be made separately but is included in the unit price bid for "Sanitary Sewer Manhole Rehabilitation" as per Section 618, “Sanitary Sewer Manhole Rehabilitation”.

SECTION 628 – ELASTOMERIC MANHOLE COATING

628.01 – DESCRIPTION

This section covers application of elastomeric coatings to the interior surfaces of a manhole to provide a high level of corrosive protection. The coatings may be sprayed, rolled, brushed or applied by trowel as required by the manufacturer. The material must be suitable for overhead, vertical and horizontal surfaces.

628.02 – MATERIALS

628.02.01 – SUBMITTALS

Review and approval of the Contractor submittals, by the Engineer, must not be construed in any way as relieving the Contractor and the Manufacturers of their responsibilities as

specified in these specifications. When requested by the Engineer, the Contractor must submit the following, but not limited to, for review and approval:

A) a certificate that the coating furnished under this specification is in conformance with the material and mechanical requirements in the appropriate ASTM and as specified herein.

B) The ambient temperatures at time of application must be recorded by the Contractor and submitted by the Contractor to the Engineer.

628.02.02 – GENERAL

The coating systems may be one of the following types:

A) High-Build Epoxy Coatings – The coating material must be a two (2) part, one hundred percent (100%) solids epoxy-resin with fibrous and flake fillers specifically designed for sanitary sewer applications. The coating material must have the following minimum properties as listed in the following table:

	Test Method	Minimum Value
* Tensile Strength	ASTM D-638	8,000-psi
*Tensile Elongation	ASTM D-638	20-percent
* Compressive Strength	ASTM D-2240	80 ShoreD
+ 25% Sulfuric Acid	ASTM C-267	o28 days
* Solids by Volume		100%

* System cured for 7 days at 25-degrees C
\+ Topping cured for 3 weeks at 25-degrees C
o Days without deterioration after continuous contact with fresh chemical at 25-degrees C

B) Polyurea Coating Systems – The coating material must be urethane-based one hundred percent (100%) solids resin with chemically resistant fillers specifically designed for sanitary sewer applications. The coating material, tested at 25-degrees C, must have the following minimum properties as listed below:

	Test Method	Minimum Value
* Tensile Strength	ASTM D-412	1,800 psi
* Recoverable Elongation	ASTM D-412	300%
* Surface Hardness	ASTM D-2240	80 Shore A
+ 20% Sulfuric Acid	ASTM C-267	28 days
* Solids by Volume		100%

* System cured for 7 days at 25-degrees C

+ Topping cured for 3 weeks at 25-degrees C
- Days without deterioration after continuous contact with fresh chemical at 25-degrees C

628.03 – CONSTRUCTION METHODS

628.03.01 – SURFACE PREPARATION

Infiltration must be stopped, and surface preparation must be accomplished in accordance with Section 624, “Cast-in-Place Concrete Manhole Liner”. Install all products in accordance with manufacturer’s instructions regarding surface preparation, product application and curing. Mechanical cleaning must be done to provide a good bond between the epoxy coating or the Polyurea coating and the substrate. Water blasting with a minimum of five thousand pounds per square inch (5,000-psi) must be done to remove oil, grease and foreign materials from all surfaces to be coated. For brick manholes, use a minimum of six thousand pounds per square inch (6,000-psi) of water pressure. In areas where the concrete has become softened due to chemical attack, several millimeters of the wall surface must be removed using water pressures of twenty-five thousand pounds per square inch (25,000-psi) to thirty-five thousand pounds per square inch (35,000-psi), or as recommended by the coating manufacturer, to ensure that a sound substrate is exposed. Surfaces must be made damp or dry as required by the Manufacturer before application of coating system begins.

628.03.02 – APPLICATION

The material must be mixed and applied, in two (2) or three (3) coats, in accordance with the Manufacturer's written instructions, using approved equipment. When applying a Polyurea coating, all surfaces to be coated must be primed as required by the manufacturer. The material must be applied to all interior surfaces of the manhole with a minimum thickness of one hundred mils (100-mils).

The Contractor must allow a minimum of two hours (2-hrs) cure time before returning the manhole to active flow conditions or as recommended by the manufacturer. After seven day (7-day) cure, the liner's surface must be free of runs, sags, and other irregularities that indicate improper application practice. When directed by the Engineer, liner must be repaired following the Manufacturer's recommendation and to the Engineer's satisfaction.

628.04 – METHOD OF MEASUREMENT

Payment for "Elastomeric Manhole Coating" must not be made separately but is included in the unit price bid for "Sanitary Sewer Manhole Rehabilitation" as per Section 618, “Sanitary Sewer Manhole Rehabilitation”.

SECTION 629 – ABANDONING/REMOVING MANHOLE

629.01 – DESCRIPTION

This section covers abandoning or removing existing manholes when called for on the plans or specified. This work must be accomplished following abandoning and plugging existing sewer lines.

629.02 – CONSTRUCTION REQUIREMENTS

A) Abandoning Manhole – This work must be accomplished in accordance with the Standard Detail for Abandoning Manholes. The manhole must be broken down to a point three feet (3-ft) below proposed or existing grade and filled with sand and/or concrete.

B) Removing Manhole – This work must be accomplished in accordance with the Standard Details for Construction except the manhole must be broken down to a point two feet (2-ft) below any proposed construction or totally removed when directed by the Engineer.

C) Construction – Manhole must be filled with sand backfill and must be compacted in accordance with the requirements of Section 212, “Trench Excavation and Backfill”.

Salvaged materials, including ring and cover must be disposed of by the Contractor.

629.03 – METHOD OF MEASUREMENT

Payment for "Abandoning or Removing Manholes" must be made at the unit price bid per each manhole. The price established must be full compensation for all materials and labor including materials, surface preparation, application, tools, equipment, site cleanup and incidentals necessary to complete this item of work.

629.04 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

ABANDONING MANHOLE	EA.
REMOVING MANHOLE	EA.

SECTION 630 – VITRIFIED CLAY SEWER PIPE (VCP)

630.01 – DESCRIPTION

This section covers vitrified clay pipe and fittings intended to be used for the conveyance of sewage and industrial waste. Pipe may be supplied in sizes ranging from four inches (4-in) to forty-two inches (42-in).

630.02 – MATERIALS

630.02.01 – SUBMITTALS

Review and approval of the Contractor submittals, by the Engineer, must not be construed in any way as relieving the Contractor and the Manufacturers of their responsibilities as specified in these Specifications. When requested by the Engineer, the Contractor must submit the following, but not limited to, for review and approval:

A) Type "A" Certification for pipes and Type "D" Certification for fittings, See section 109.17.02 “Control of Work and Materials – Materials Certifications – Types of Certifications” for details on types of certifications. These certifications must be prepared by the manufacturer and must consist of a certified copy of a report covering tests conducted by an approved laboratory. Tests performed must be sufficient to determine the conformance of the material to the Standard Specifications. Such tests must have been conducted on samples obtained from the lot or lots of material in the shipment.

B) Tests results for Three-Edge Bearing Tests, Hydrostatic Tests, Joint Tests, Joint Leakage, Absorption, and Compressive Strength Tests.

C) The Contractor must provide a digital copy of all submittals, and if requested by the Engineer, hardcopies of any submittal must be provided as well.

630.03 – CONSTRUCTION METHODS

630.03.01 – OPEN-CUT CONSTRUCTION

A) General – All vitrified clay pipes and fittings must be extra strength and conform to the requirements of the appropriate ASTM listed below or as modified herein

1) ASTM C-700, Standard Specification for "Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
2) ASTM C-425, Standard Specification for “Compression Joints for Vitrified Clay Pipe and Fittings”
3) ASTM C-12, Standard practice for “Installing Vitrified Clay Pipelines”

Minimum laying lengths must not be less than five and one-half feet (5.5-ft) for pipes twelve inches (12-in) and smaller, and seven find one-half feet (7.5-ft) for pipes fifteen inches (15-in) and larger in diameter.

Pre-fabricated joints must be of a type where the same resilient material is used both on the spigot end and the bell end of the pipe. Other type joints may be approved by the Engineer in writing and must similarly conform to the requirements of said ASTM C-425, “Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings”.

B) Maximum Depth of Cover – The maximum depth of cover above top of the pipe must not exceed the value shown in the table below. The maximum depth of cover for each pipe size is based on AASHTO HS-20 live loading, ordinary clay backfill with kμ' of 0.130 and a unit weight of one hundred twenty pounds per cubic foot(120-pcf), a design load safety factor of 1.30, Class "B" Bedding Installation, the maximum trench width specified in Section 212, "Trench Excavation and Backfill", and the minimum required three-edge bearing strength, for each pipe size as specified in ASTM C-700, "Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated".

TABLE 630.03.01 - Maximum Depth of Cover

Nominal Size (inches)	Minimum Three-Edge Bearing Strength (lb./ft)	Maximum Depth of Cover (feet)
4	2000	25
6	2000	25
8	2200	20
10	2400	18
12	2600	16
15	2900	15
18	3300	14
21	3850	14
24	4400	14
27	4700	13
30	5000	13
33	5500	13
36	6000	13
39	6500	13
42	7000	12

630.03.02 - TRENCHLESS CONSTRUCTION

A) General- All VCP and fittings must conform to the requirements of ASTM C-1208, "Standard Specification for Vitrified Clay Pipe and Joints for Use in Microtunneling, Sliplining, Pipe Bursting, and Tunnels".

B) Sliplining Installations - Pipes used for sliplining installations must meet the following requirements:

1) For existing pipes with a nominal inside diameter (I.D.) less than or equal to thirty-three inches (33-in), the outside diameter (O.D.) of the sliplining pipe must not be more than three inches (3-in) smaller than the nominal I.D. of the existing pipe.

2) For existing pipes with a nominal I.D. greater than thirty-three inches (33-in), the O.D. of the sliplining pipe must not be more than six inches (6-in) smaller than the nominal I.D. of the existing pipe.

   a) In addition, the maximum outside diameter, and wall thickness of VCP liner pipe must be as follows:

Existing Sewer Line Nominal Inside Dia. (inches)	Maximum Outside Diameter of VCP (inches)	Minimum VCP Wall Thickness (inches)
12	10.50	1.31
15	14.17	2.17
18	15.60	1.75
21	15.60	1.75
24	20.70	2.50
27	24.55	2.43
30	28.60	2.80
33	31.03	2.86
36	33.46	2.95
42	37.80	3.15

630.04 – METHOD OF MEASUREMENT

Payment for "Vitrified Clay Sewer Pipe" must be made at the contract unit price per liner foot. The price established must be full compensation for all materials and labor including materials, surface preparation, application, tools, equipment, site cleanup and incidentals necessary to complete this item of work.

630.05- BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

VITRIFIED CLAY SEWER PIPE (VCP) (SIZE) L.F.

SECTION 631 – DUCTILE IRON PIPE (DIP)

631.01 – DESCRIPTION

This section covers Ductile Iron Pipe (DIP) and fittings intended to be used for conveyance of sewage and industrial waste. Pipes may be supplied in sizes ranging from four inches (4-in) to sixty-four inches (64-in) in diameter.

631.02 – MATERIALS

631.02.01 – SUBMITTALS

Review and approval of the Contractor submittals, by the Engineer, must not be construed in any way as relieving the Contractor and the manufacturers of their responsibilities as specified in these Specifications. When requested by the Engineer, the Contractor must submit the following, but not limited to, for review and approval:

A) Type "A" Certification for pipe, See section 109.17.02 “Control of Work and Materials – Materials Certifications – Types of Certifications” for details on types of certifications.

B) Type "D" Certification for elastomeric gasket, See section 109.17.02 “Control of Work and Materials – Materials Certifications – Types of Certifications” for details on types of certifications,

C) Shop drawings of the pipe and joints

D) Documentation of an ongoing Manufacturer's quality control program

All material furnished under certification must be tagged, stenciled, stamped or otherwise marked with a lot number, heat number, order number, or other appropriate identification which can be readily recognized and checked against the certification.

631.02.02 – GENERAL, FITTINGS

All ductile iron pipe and fittings must conform to the requirements of the following ASTM Standards listed below or as modified herein.

A) ASTM A-746, Standard Specifications for Ductile Iron Gravity Sewer Pipe

B) AWWA C-111/ANSI A21.11, Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings

C) AWWA C-150/ANSI A21.50, Thickness Design of Ductile-Iron Pipe

D) AWWA C-151/ANSI A21.51, Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lines Molds, for Water or Other Liquids

E) AWWA C-600, Installation of Ductile Iron Water Mains, and their Appurtenances

Pipe must be provided on nominal lengths of twenty feet (20-ft). Pipe joints must be push-on joints and comply with all applicable requirements of AWWA C-111/ANSI A21.11, “Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings”.

631.02.03 – COATING AND LINING

A) Exterior Coating – The exterior of ductile iron pipe, specials and fittings must be coated with an asphaltic coating in accordance with ASTM A-746, Section 6.1, “Standard Specification for Ductile Iron Gravity Sewer Pipe”. The coating must have a minimum thickness of one mil (1-mil). The finished coating must be smooth, continuous and strongly adherent to the pipe. Any damage to the outside coating during shipping, storage, handling and installation must be field repaired with a fresh coating in accordance with the Manufacturer's recommendations.

B) Interior Lining – Interior surfaces of pipe and fittings must be lined with forty (40) mils of Virgin Polyethylene complying with ASTM D-1248, “Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable”. The lining materials must be compounded with a minimum of two percent (2%) carbon black to resist ultraviolet rays.

631.02.04 – MINIMUM PIPE DESIGN

Unless otherwise specified, Ductile Iron Pipe must have the following nominal thickness, in inches, and pressure class shown in the following table.

TABLE 631.02.04 – Minimum Pipe Design - DIP

Pipe Nominal Size (inches)	Depth of Cover (feet)									
	< 10-ft		>10-ft and <15-ft		>15-ft and <20-ft		>20-ft and <25-ft		>25-ft and <30-ft	
	Nominal Thickness (Inches)	Standard Pressure Class AWWA C-151	Nominal Thickness (Inches)	Standard Pressure Class AWWA C-151	Nominal Thickness (Inches)	Standard Pressure Class AWWA C -151	Nominal Thickness (Inches)	Standard Pressure Class AWWA C-151	Nominal Thickness (Inches)	Standard Pressure Class AWWA C-151
4	0.25	360	0.25	350	0.25	350	0.25	350	0.25	350
6	0.25	360	0.25	350	0.25	350	0.25	350	0.25	350
8	0.25	360	0.25	350	0.25	350	0.25	350	0.25	350
10	0.26	360	0.26	350	0.26	350	0.26	350	0.26	350
12	0.28	360	0.28	350	0.28	350	0.28	350	0.28	350

18	0.31	260	0.31	250	0.31	250	0.31	350	0.34	300
24	0.33	200	0.33	200	0.33	200	0.38	300	0.38	300
30	0.34	160	0.34	150	0.34	150	0.42	250	0.45	300
36	0.38	160	0.38	150	0.38	150	0.47	250	0.50	300
42	0.41	160	0.41	150	0.41	150	0.52	250	0.63	350
48	0.46	160	0.46	150	0.46	150	0.64	300	0.70	350
54	0.51	160	0.51	150	0.51	150	0.72	300	0.79	350
60	0.54	160	0.56	150	0.54	150	0.76	300	0.83	350
64	0.56	160	0.56	150	0.56	150	0.80	300	0.87	350

631.03 – METHOD OF MEASUREMENT

Payment for "Ductile Iron Pipe" must be made at the contract unit price per liner foot. The price established must be full compensation for all materials and labor including materials, surface preparation, application, tools, equipment, site cleanup and incidentals necessary to complete this item of work.

631.04 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

DUCTILE IRON PIPE (DIP)(SIZE) L.F.

SECTION 632 – HIGH DENSITY POLYETHYLENE (HDPE) PIPE

632.01 – DESCRIPTION

This section covers High Density Polyethylene (HDPE) pipe and fittings intended to be used for conveyance of sewage and industrial waste.

632.02 – MATERIALS

632.02.01 – SUBMITTALS

Submittals must be furnished in accordance with Section 631, "Ductile Iron Pipe".

632.02.02 – PIPE MATERIALS

The HDPE pipe must be made of high density plastic compound meeting the requirements of Type Ill, Class C, Category 5, Grade P34 as defined in ASTM D-1248, "Standard Test Method for Staining of Porous Substrate by Joint Sealants", and with an established hydrostatic design basis (HDB) of not less than sixteen hundred pounds per square inch (1,600-psi) for water at 73.4 degrees Fahrenheit determined in accordance with ASTM Test Method D-2837, "Standard Test Method for Obtaining Hydrostatic Design

Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products".

Materials must also meet the requirements of cell classification PE 345434C or higher cell classification with light color inside, when classified in accordance with ASTM D-3350, "Standard Specification for Polyethylene Plastics Pipe and Fittings Materials", and as shown below.

HDPE pipes manufactured for trenchless installations such as sliplining, pipe bursting, etc. may be made, entirely or having inside surface, in light color (e.g. natural, white, green, etc.) to allow light reflection for robotic television inspection. Contractor/Manufacturer must provide certification that the product has sufficient UV stabilizer for a minimum two years (2-yr) of storage life and meets the requirements established in the following table at the time of installation.

Property	ASTM Test Method	Minimum Value
Density	D-1505	0.941 (gm/cm^3)
Melt Index	D-1238	< 0.15 (gm/10 min.)
Initial Flexural Modulus	D-790	110,000-psi
Long-Term Flexural Modulus	*	28,200-psi
Initial Flexural Strength	D-790	3,000-psi
Long-Term Flexural Strength	*	1,500-psi
Environmental Stress Crack Resistance, Test Condition C, (failure % = hours)	D-1693	F20(20% of Failure Point) = 192
Hydrostatic Design Basis	D-2837	1,500-psi

Color & Ultraviolet Stabilizer	D-3350	Black with minimum 2% carbon black

* Note: The long-term values are considered to be for a continuous load duration of fifty years (50-yr) for design loading conditions and must be certified by the Manufacturer.

632.02.03 – SOLID WALL (HDPE)

A) General – All solid wall HDPE pipes may be used for open-cut and sliplining installations, in sizes ranging from six inches (6-in) to forty-eight inches (48-in) in diameter. All solid wall HDPE pipe and fittings must be manufactured in accordance with ASTM F-714, "Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter".

B) Joint System – Sections of polyethylene pipe must be assembled and joined on the project site. Jointing must be accomplished by the heating and butt-fusion method in strict conformance with the manufacturer's printed instructions.

The butt-fusion method for pipe jointing must be carried out in the field by operators with prior experience in fusing polyethylene pipe with similar equipment using proper jigs and tools per standard procedures outlined by the pipe Manufacturer. These joints must have a smooth, uniform, double rolled back bead made while applying the proper melt, pressure, and alignment. It must be the sole responsibility of the Contractor to provide an acceptable water-tight butt-fusion joint. Butt fusion procedures must be qualified in accordance with Title 49 Code of Federal Register, Part 192.283 and personnel qualified in accordance with 49 CFR 192.285.

C) Pipe Stiffness – For all open-cut installations, HDPE pipe must have a minimum pipe stiffness of forty-six pounds per square inch (46-psi) as determined in accordance with ASTM D-2412, "Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading".

632.02.04 – PROFILE WALL (HDPE)

A) General – All open or closed profile wall HDPE pipe and fittings may be manufactured in accordance with ASTM F-894, "Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe". Pipes must be supplied in sizes from eighteen inches (18-in) to one hundred and twenty inches (120-in) in diameter. Regardless of size, open profile wall pipes will be allowed only on sections of pipe when there are no apparent service connections. Otherwise, open profile wall pipes will not be allowed.

B) Pipe Stiffness – For all installations specified, HDPE pipe and fittings must have a minimum pipe stiffness of forty-six pounds per square inch (46-psi) as determined in accordance with ASTM D-2412, "Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading".

C) Joint System – Pipe joining system must be gasketed type and consist of integrally formed bell and spigot, one which is designed to accommodate a gasket, which when assembled forms a watertight seal by the radial compression. Joints must provide a watertight seal and meet the requirements of ASTM D-3212, “Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals”.

D) Gaskets – Gaskets must meet the requirements of ASTM F-477, “Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe” and be molded into a circular form or extruded to the proper section, then spliced into circular form, and must be made of a properly cured high grade elastomeric compound. The basic polymer must be neoprene, synthetic elastomer, or a blend of both. The gasket must be designed with an adequate compressive force, so as to affect a positive seal under all combinations of joint tolerances. Natural rubber gaskets will not be acceptable.

E) Lubricant – The lubricant used for assembly must have no detrimental effect on the gasket or on the pipe. Type and application of the lubricant must be in accordance with the manufacturer's recommendations.

632.03 – CONSTRUCTION METHODS

632.03.01 – SLIPLINING

A) General **–** Pipes used for sliplining installations must meet the following requirements:

1) For existing pipes with a nominal inside diameter (I.D.) less than or equal to thirty-three inches (≤ 33-in), the outside diameter (O.D.) of the sliplining pipe must not be more than three inches (> 3-in) smaller than the nominal I.D. of the existing pipe.
2) For existing pipes with a nominal I.D. greater than thirty-three inches (> 33-in), the O.D. of the sliplining pipe must not be more than six inches (6-in) smaller than the nominal I.D. of the existing pipe.

3) In addition, sliplining pipes must meet the requirements outlined in parts 2 or 3 as applicable.

B) **Solid Wall HDPE Pipes**

1) General – Solid Wall HDPE Pipes must meet the requirements of Section 632, “ High Density Polyethylene (HDPE) Pipe”, Parts "A" and "B”.

2) SDR **–** The HDPE liner pipe must have the following minimum Standard Dimension Ratio (SDR) for various depths:

Maximum Depth of Cover (feet)	SDR
10	26
15	21
20	19
30	17

3) Outside Diameter – The minimum outside diameter (O.D.) of HDPE liner pipe must be as designated below:

Existing Sewer Line Nominal Inside Diameter (inches)	Minimum O.D. of Liner (inches)
8	7.125
10	8.625
12	10.750
15	12.750
18	16.000
21	18.000

24	22.000
27	24.000
30	28.000
33	30.000
36	32.000
42	36.000
48	42.000
54	48.000

C) Profile Wall HDPE Pipes – Profile wall HDPE pipe must meet the requirements of Section 632, “High Density Polyethylene (HDPE) Pipe” Parts "A" through "E".

632.03.02 – PIPE BURSTING, BORING, AND TUNNELING

The HDPE pipe used for these installations must meet the material requirements of Section 632, “High Density Polyethylene (HDPE) Pipe” and meet the SDR requirements of Section 632, Paragraph B 2 and have a minimum inside diameter equal to nominal pipe size. Outside diameter requirements of Section 632 Paragraph B 3 are not applicable.

632.04 – METHOD OF MEASUREMENT

Payment for "High Density Polyethylene (HDPE) Pipe” must be made at the contract unit price per liner foot. The price established must be full compensation for all materials and labor including materials, surface preparation, application, tools, equipment, site cleanup and incidentals necessary to complete this item of work.

632.05 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

HIGH DENSITY POLYETHYLENE (HDPE) PIPE (SIZE) L.F.

SECTION 633 – POLYVINYL CHLORIDE (PVC) PIPE

633.01 – DESCRIPTION

This section covers polyvinyl chloride (PVC) pipe and fittings intended to be used for

conveyance of sewage and industrial waste.

633.02 – MATERIALS

633.02.01 – SUBMITTALS

Submittals must be furnished in accordance with Section 631, “Ductile Iron Pipe (DIP)”.

633.02.02 – SOLID WALL (PVC)

All solid wall PVC pipe and fittings must conform to the requirements of the appropriate ASTM listed below or as modified herein.

A) ASTM D-3034 – Standard Specification for “Type PSM Poly (Vinyl Chloride) (VC) Sewer Pipe and Fittings”. Pipe and fittings must have a minimum stiffness of forty-six pounds per square inch (46-psi) and a minimum SDR of thirty-five (35). Pipe and fittings may be supplied in sizes ranging from four inches (4-in) to fifteen inches (15-in) in diameter.

   The pipe must be made of PVC plastic having a cell classification of 12454-B or 12454-C or 12364-C or 13364-B (with minimum tensile modulus of 500,000-psi) as defined in ASTM D-1784. The fittings must be made of PVC plastic having a cell classification of 12454-B, 12454-C, or 13343-C as defined in ASTM D-1784, “Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds”.

   Elastomeric Gasketed Joints must be used to provide a watertight seal and must meet the requirements of ASTM D-3212, “Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals”.

B) ASTM F-679 **–** Standard Specification for “Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings”. Pipe and fittings must have a minimum stiffness of forty-six pounds per square inch (46-psi) and a minimum SDR of thirty-five (35). Pipe and fittings may be supplied in sizes ranging from eighteen inches (18-in) to thirty-six inches (36-in) in diameter.

   The pipe and fitting materials must be made of PVC plastic having a minimum cell classification of 12364-C or 12454-C as defined in ASTM D-1784, “Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds”. Homo-polymer PVC compounds must equal or exceed the requirements of the above listed minimum cell classification number.

   Integral Bell Gasket Joint must be used to provide a watertight seal and must meet the requirements of ASTM D-3212, “Standard Specification for Joints for Drain and

Sewer Plastic Pipes Using Flexible Elastomeric Seals".

C) Pipe and fittings must have a minimum stiffness of forty-six pounds per square inch (46-psi). Pipe and fittings may be supplied in sizes ranging from four (4-in) inches to eighteen (18-in) inches in diameter.

The pipe must be made of PVC plastic having a minimum cell classification of 12164-B as defined in ASTM D-1784, "Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals". The fittings must be made of PVC plastic having a cell classification of 12454-C or 13343-C as defined in ASTM D-1784, "Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals".

Elastomeric Gasketed Joints must be used to provide a watertight seal and must meet the requirements of ASTM D-3212, "Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals". Joints must also be compatible to ASTM D-3034, "Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings" joint dimensions.

633.02.03 – PROFILE WALL (PVC)

All profile (open or closed) wall PVC pipe and fittings must conform to the requirements of the appropriate ASTM listed below and modified herein. Regardless of size, open profile wall pipes will be allowed only on sections of pipe when there are no apparent service connections. Otherwise, open profile wall pipe will not be allowed.

A) ASTM F-794 – Standard Specification for "Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter". Pipe and fittings must have a minimum stiffness of forty-six pounds per square inch (46-psi). Pipe and fittings may be supplied in sizes ranging from eighteen inches (18-in) to forty-eight inches (48-in) in diameter.

The pipe and fittings must be made of PVC plastic having a minimum cell classification of 12454-B or 12364-C as defined in ASTM D-1784, "Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds".

Gasketed Joint Systems must be used. The integral bell gasketed joint, coupling or fitting joints must be designed so that when assembled, the gasket will be compressed radially on the pipe spigot or in the bell to form a watertight seal. The joints must be designed to comply with and show no leakage when tested in accordance with ASTM D-3212, "Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals".

Closed profile PVC pipes manufactured with a gasketed joint coupling system, with no bell and spigot, may be used for sliplining installations.

Couplings must form a watertight seal when assembled with plain end pipe and show no sign of leakage when tested in accordance with ASTM D-3212, “Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals” defined at top of section.

B) ASTM F-949 – Standard Specification for “Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings”. Pipe and fittings must have a minimum stiffness of fifty pounds per square inch (50-psi). Pipe and fittings may be supplied in sizes ranging from twelve inches (12-in) to thirty-six inches (36-in) in diameter.

The pipe must be made of PVC plastic having a minimum cell classification 12454-B or 12454-C as defined in ASTM D-1784, “Standard Classification System and Basis for Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds”. The fittings must be made of PVC plastic having a cell classification of 12464-B, 12464-C, or 13343-C as defined in ASTM D-1784, “Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals”.

Elastomeric Gasketed Joints must be used to provide watertight seal and must meet the requirements of ASTM D-3212, “Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals”.

633.02.04 – SPECIAL PVC PIPE

Special PVC pipe and fittings must conform to the requirements of the appropriate standards listed below or as modified herein.

A) ASTM D-2241 – Standard Specifications for Polyvinyl Chloride (PVC) Pressure-rated Pipe (SDR Series). Pipe and fittings must have a minimum SDR of thirty-two and one-half (32.5) and may be supplied in sizes ranging from four inches (4-in) to thirty-six inches (36-in) in diameter.

The pipe and fittings must be made of PVC compounds having a cell classification of 12454- B, 12454-C, or 14333-D as defined in ASTM D-1784, “Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds”.

Elastomeric gasketed joints meeting the requirements of ASTM D-3212, “Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals”, must be used to provide a watertight seal.

B) AWWA C-900-16, or as revised– Standards for PVC Pressure Pipe from four inches (4-in) through sixty inches (60-in). Pipes must have a minimum DR rating of eighteen (18) for diameters four inches (4-in) through twelve inches (12-in). For

pipes greater than twelve inches (12-in) in diameter, the minimum DR must be thirty-two and one-half (32.5). Diameters listed here are cast Iron Outside Diameters.

The pipe and fittings must be made of PVC compounds having a cell classification of 12454- A or 12454-B as defined in ASTM D-1784, “Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals”.

Elastomeric gasketed joints meeting the requirements of ASTM D-3139, “Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals” when measured in accordance with ASTM D-2122, “Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings”, must be used to provide a watertight seal.

633.02.05 – GASKETS AND LUBRICANTS

Gaskets and lubricants must conform to the applicable requirements of Section 632 “High Density Polyethylene (HDPE) Pipe” and 633 “Polyvinyl Chloride (PVC) Pipe”

633.02.06 – CHEMICAL RESISTANCE

All PVC pipe and fittings must have demonstrated a resistance to damage when subjected to exposure and/or contact with liquid sewage and/or gasses associated with sewage and/or high hydrogen sulfide concentration.

633.03 – CONSTRUCTION METHODS

A) Methods for PVC

1) Open-Cut – PVC pipe and fittings must meet the requirements of Section 652 as applicable.

2) Pipe Bursting – PVC pipe and fittings must conform to the requirements of Section 652.

3) Jacking – PVC pipe and fittings must conform to the requirements of Section 652.

4) Boring and Tunneling – PVC pipe and fittings must meet the requirements of Section 652.

5) Micro or Small Diameter Tunneling – PVC pipe and fittings must meet the requirements of Section 652

B) General – PVC pipe must be manufactured with a gasketed joint coupling system with no bell and spigot providing a watertight seal and meeting the requirements of ASTM D-3212, “Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals”. PVC pipe must meet the material requirements specified in Section 652.02 “Polyvinyl Chloride (PVC) Pipe - Materials”. The Contractor must submit detailed drawings of joints to the Engineer for review and approval prior to manufacturing.

C) Dimensions – Pipes used for sliplining – installations must meet the following general requirements:

1) For existing pipes with a nominal inside diameter (I.D.) less than or equal to thirty-three inches (33-in), the outside diameter (O.D.) of the sliplining pipe must not be more than three inches (3-in) smaller than the nominal I.D. of the existing pipe.

2) For existing pipes with a nominal I.D. greater than thirty-three inches (33-in), the O.D. of the sliplining pipe must not be more than six inches (6-in) smaller than the nominal I.D. of the existing pipe.

In addition, sliplining pipes must minimum pipe inside diameter specified and must meet the following requirements:

Existing Sewer Line Nominal Inside Diameter (inches)	Minimum O.D. of Liner (inches)	Maximum I.D. of Liner (inches)
24	22.110	As Specified on the plans and or contract Documents
27	25.115	
30	28.232	
33	31.415	
36	31.415	
42	37.800	

48	44.200	
64	60.670	

633.04 – METHOD OF MEASUREMENT

Payment for "Polyvinyl Chloride Pipe" must be made at the contract unit price per liner foot. The price established must be full compensation for all materials and labor including materials, surface preparation, application, tools, equipment, site cleanup and incidentals necessary to complete this item of work.

633.05 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

POLYVINYL CHLORIDE (PVC) (SIZE) L.F.

SECTION 634 – REINFORCED FIBERGLASS PIPE (RFP)

634.01 – DESCRIPTION

This section covers reinforced fiberglass pipe and fittings intended to be used for the conveyance of sewage and industrial waste.

634.02 – MATERIALS

634.02.01 – SUBMITTALS

Submittals must be furnished in accordance with Section 631, "Ductile Iron Pipe(DIP)".

634.02.02 – GENERAL

All pipes, joints and fittings must be manufactured in accordance with the requirements of ASTM D-3262, "Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe", or as modified herein. Pipes must be supplied in sizes twelve inches (12-in) and larger.

Pipes must be centrifugally cast, fiberglass-reinforced polyester resin.

Prior to manufacturing, the pipe supplier must provide the Engineer with test reports certifying that the pipe has been tested in accordance with and exceeds all minimum requirements of ASTM D-2992, "Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings", ASTM D-3262, "Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe", and ASTM D-3681, "Standard Test Method for Chemical Resistance of "Fiberglass" (Glass–Fiber–Reinforced Thermosetting-Resin) Pipe in a Deflected Condition". Manufacturer's "in house" testing reports WILL NOT be

acceptable as a substitute for independent laboratory testing.

634.02.03 – MINIMUM PIPE STIFFNESS

The pipe stiffness must be a minimum of forty-six pounds per square inch (46-psi) when measured in accordance with ASTM D-2412, “Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading”, for all installations except jacking. Other pipe stiffness’s may be used when called for on the plans or as directed by the Engineer.

634.02.04 – MATERIAL COMPONENTS

A) Resin System – The Manufacturer must use only approved polyester or epoxy resin systems for which he can provide a proven history of performance for the intended application. The historical data must have been acquired from a composite material of similar construction and composition as the proposed product.

B) Glass Reinforcements – The reinforcing glass fibers used to manufacture the components must be of highest quality commercial grade of E-glass filaments with binder and sizing compatible with impregnating resins.

C) Fillers – Sand may be used as fillers providing that sand must be a minimum ninety-eight percent (98%) silica with a maximum moisture content of 0.2 percent (0.2%).

D) Additives – Resin additives, such as pigments, dyes, and other coloring agents, if used, must in no way be detrimental to the performance of the product nor must they impair visual inspection of the finished product.

E) Internal Liner Resin – The internal liner resin must be suitable for service as sewer pipe and must be inert to exposure to sulfuric acid as produced by biological activity from hydrogen sulfide gases. Provide the certified test results from an independent laboratory that the pipe exceeds the requirements of ASTM D-3681, “Standard Test Method for Chemical Resistance of “Fiberglass” (Glass–Fiber–Reinforced Thermosetting-Resin) Pipe in a Deflected Condition”.

634.02.05 – DIMENSIONS

A) General – Pipe outside diameters must be in accordance with AWWA Standards C-151/A21.51, “Ductile-iron Pipe, Centrifugally Cast” and C-950, “Fiberglass Pressure Pipe” and as shown below. The minimum wall thickness(es) shown are for a minimum pipe stiffness of forty-six pounds per square inch (46-psi).

Nom. Pipe Dia. (inches)	Pipe O.D. (inches)	Min. Wall Thickness
12	13.20	0.30
14	15.30	0.34
16	17.40	0.38
18	19.50	0.42
20	21.60	0.46
24	25.80	0.54
30	32.00	0.66
36	38.30	0.78
42	44.50	0.90
48	50.80	1.02
54	57.10	1.14
60	62.90	1.26
66	69.20	1.38
72	75.40	1.50
78	81.60	1.62
84	87.00	1.74
90	94.30	1.86
96	100.60	1.98
102	108.00	2.13

Pipe must be supplied in nominal lengths of ten feet (10-ft) or twenty (20-ft) feet for Jacking, and twenty feet (20-ft) for all other installations. For sliplining installations, where radius curves in the existing pipe or limitations in the entry pit dimensions restrict the pipe to shorter lengths, nominal sections of ten feet (10-ft) or six and two-thirds feet (6.33-ft) must be used. Actual laying length must be the nominal plus or minus (±) two inches (2-in). Except for special order lengths, all pipes must be furnished in the nominal lengths specified herein. All pipe ends must be square to the pipe axis plus or minus (±) one-fourth inch (0.25-in), or plus or minus (±) five-tenths percent (0.5%) of the nominal diameter (whichever is greater).

B) Jacking Installations – Minimum pipe wall thickness measured at the bottom of the spigot gasket groove where the wall cross-section has been reduced, is determined from the maximum allowable jacking load, and must not be less than as shown in the table below:

TABLE 634.02.05 - Jacking Installations Wall Thickness

Nom. Pipe Dia. (inches)	Pipe O.D. (inches)	Min. Wall Thickness (inches)

12	13.20	0.39
14	15.30	0.41
16	17.40	0.42
18	19.50	0.44
20	21.60	0.46
24	25.80	0.60
30	32.00	0.68
36	38.30	0.81
42	44.50	1.03
48	50.80	1.10
54	57.10	1.22
60	62.90	1.29
66	69.20	1.32
72	75.40	1.34
78	81.60	1.54
84	87.00	1.76
90	94.30	1.78
96	100.60	1.88

C) Sliplining Installations – Pipes used for sliplining installations must meet the following general requirements:

1) For existing pipes with a nominal inside diameter (I.D.) less than or equal to thirty-three inches (≤33-in), the outside diameter (O.D.) of the sliplining pipe must not be more than three inches (3-in) smaller than the nominal I.D. of the existing pipe.

2) For existing pipes with a nominal I.D. greater than thirty-three inches (>33-in), the O.D. of the sliplining pipe must not be more than six inches (6-in) smaller than the nominal I.D. of the existing pipe.
3) In addition, sliplining pipes must meet the following requirements:

Exist. Sewer Line Nominal Inside Diameter (inches)	RFP Liner O.D. (inches)	Wall Thickness (inches)
15	13.20	0.30
18	15.30	0.34
21	19.50	0.42
24	21.60	0.46
27	25.80	0.54
30	27.00	0.60
33	30.00	0.66

36	32.00	0.66
42	38.30	0.78
48	44.50	0.90
54	50.80	1.02
60	57.10	1.14
66	62.90	1.26
72	69.90	1.38
78	75.40	1.50
84	81.60	1.62
90	87.00	1.74
96	94.30	1.86
102	100.60	1.98

634.02.06 – JOINTS

A) General – Unless otherwise specified, the pipe must be field connected with fiberglass sleeve couplings that utilize elastomeric sealing gaskets for all installations except jacking and sliplining installations. The joints must meet the performance requirements of ASTM D-4161, “Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals”.

B) Sliplining Installations – Unless otherwise specified, the pipe must be field connected with low-profile fiberglass bell and spigot joints. The joints must meet the performance requirements of ASTM D-4161, “Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals”.

C) Jacking Installations – Unless otherwise specified, the pipe must be field connected with sleeve couplings or bell spigot joints that utilize elastomeric sealing gaskets as the sole means to maintain joint water tightness. The joint must have the same outside diameter (O.D.) as the pipe, so when the pipes are assembled, the joints are flush with the outside surface.

634.02.07 – GASKETS AND LUBRICANTS

Gaskets and lubricants must conform to the requirements of Section 631, “Ductile Iron Pipe".

634.02.08 – FITTINGS

Where applicable, flanges, elbows, reducers, tees, wyes, laterals, and other fittings must, when installed, be capable of withstanding all operation conditions. Acceptable

configurations include contact molded or mitered fiberglass properly protected standard ductile iron, fusion bonded epoxy coated steel and stainless steel constructions.

The tolerance of the angle of an elbow and the angle between the main and leg of a wye or tee must be plus or minus (±) two degrees (2-degrees). The tolerance on the laying length of a fitting must be plus or minus (±) two inches (2-in).

634.03 – METHOD OF MEASUREMENT

Payment for "Reinforced Fiberglass Pipe" must be made at the contract unit price per liner foot. The price established must be full compensation for all materials and labor including materials, surface preparation, application, tools, equipment, site cleanup and incidentals necessary to complete this item of work.

634.04 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

REINFORCED FIBERGLASS PIPE (RFP) (SIZE)	L.F.

SECTION 635 – STEEL CASING PIPE

635.01 – DESCRIPTION

This section covers steel pipe intended to be used as a carrier pipe for sanitary sewer aerial crossings or casing pipe for boring and micro and small diameter tunneling installations.

635.02 – MATERIALS

635.02.01 – SUBMITTALS

Review and approval of the Contractor submittals, by the Engineer, must not be construed in any way as relieving the Contractor and the Manufacturers of their responsibilities for Manufacturing steel pipe and fittings as described herein. When requested the Contractor must submit the following, provided that all applicable requirements are met, and that visual inspection at destination shows the workmanship and condition of material to be satisfactory:

A) Type "A" certification for pipe and coating, See section 109.17.02 "Control of Work and Materials – Materials Certifications – Types of Certifications" for details on types of certifications.

B) Shop drawings of pipe, joints, and seams

C) Documentation of manufacturer's on-going quality control program.

635.02.02 – GENERAL

A) General – Steel pipe must conform to ASTM A139, “Standard Specification for Electric-Fusion (ARC) Welded Steel Pipe (NPS 4 and Over)”. The steel material must be new, smooth wall, carbon steel, Grade B, with minimum sixty thousand pounds per square inch (60,000-psi) tensile strength, and minimum thirty-five thousand pounds per square inch (35,000-psi) yield strength.

The pipe must be straight seam pipe, seamless pipe, or spiral weld pipe. For spiral weld pipe, the spiral must be one hundred percent (100%) welded, and the weld's height over the outside wall surface must be equal to or less than three-sixteenths inch (0.1875-in). All steel pipe must be square cut and must have a roundness such that the difference between the major and minor outside diameters must not exceed one percent (1%) of the specified nominal outside diameter or one-fourth inch (0.25-in), whichever is less. The outside circumference must be within plus or minus (±) one percent (1%) of the nominal circumference or within plus or minus (±) one-half inch (0.5-in), whichever is less. The pipe must have a maximum allowable straightness deviation in any ten-foot (10-ft) length of one-eighth inch (0.125-in). Steel pipe joints must be continuously welded with an approved butt weld. The welds must attain the full strength of the pipe and must result in a fully watertight section. The welded joints must conform to the requirements of AWWA C-206, “Field Welding of Steel Water Pipe”.

B) Boring Installations

1) Casing Pipe Size – The Contractor will submit to the Engineer the proposed steel casing pipe size and thickness for approval prior to purchase and installation.

2) Casing Pipe Thickness – Steel casing pipe must the following minimum thickness(es), in inches, for the indicated maximum depth of cover(s), in feet

OUTSIDE DIAMETER	UNDER HIGHWAY		UNDER RAILROAD		
(inches)	Wall Thickness (inches)	Maximum Cover (feet)	BNSF (Uncoated) Wall Thickness (inches)	Union Pacific Wall Thickness (inches)	Maximum Cover (feet)
<12	0.188	30	0.250	0.25	30
16	0..250	30	0.281	0.3125	30
18	0.250	30	0.322	0.322	30

20	0.250	30	0.344	0.344	30
24	0.250	30	0.406	0.406	30
30	0.322	30	0.469	0.469	30
36	0.375	30	0.531	0.531	30
42	0.375	25	0.563	0.563	30
48	0.438	25	0.625	0.625	25
54	0.438	25	0.719	Over 48"	20
60	0.438	25	0.781	Must Be	20
66	0.438	20	0.875	Approved by U.P.R.R.CO.	20

3) Micro and Small Diameter Tunneling – The steel casing pipe minimum wall thickness for micro and small diameter tunneling must be one-fourth inch (0.25-in).

4) Aerial Crossings – The minimum thickness for steel carrier pipe must be three-sixteenths inch (0.1875-in) and one-fourth inch (0.25-in) for diameters of forty-two inches (42-in) and less, and greater than forty-two inches (42-in), respectively.

635.02.03 – EXTERIOR PROTECTIVE COATING

Exposed exterior surfaces must have protective coating, shop applied coal-tar enamel, conforming to the requirements of AWWA C-203, “Standard Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation”. The coating thickness must be forty mils (40-mils), applied in two (2) coats.

635.03 – METHOD OF MEASUREMENT

Payment for "Steel Casing Pipe" must be made at the unit price bid per linear foot for each Carrier pipe size. Installation method will be included in the payment for "Steel Casing Pipe." The price established must be full compensation for furnishing and installing of all materials including, labor, tools, equipment, and incidentals necessary to complete this item of work.

635.04 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid

STEEL CASING PIPE (CARRIER PIPE SIZE) L.F.
BORE AND STEEL ENCASEMENT (CARRIER PIPE SIZE) L.F.
STEEL ENCASEMENT BY TRENCHING (CARRIER PIPE SIZE) L.F.

SECTION 636 – DEFORMED HIGH DENSITY POLYETHYLENE PIPE

636.01 – DESCRIPTION

This section covers reconstruction and rehabilitation of sanitary sewer lines by installation of a deformed High Density Polyethylene (HDPE) extruded pipe. The process must use steam and air pressure to progressively inflate the deformed HDPE pipe to conform to the existing pipe wall.

636.02 – MATERIALS

Materials must meet the requirements of Section 631, “Ductile Iron Pipe”, except that it must be Class B as defined in ASTM D-1248, “Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable”. The minimum cell classification must be PE 3464340, white color, as defined in ASTM D-3350, “Standard Specification for Polyethylene Plastics Pipe and Fittings Materials”.

636.02.01 – MINIMUM THICKNESS

Unless otherwise specified, the installed HDPE pipe must have the following minimum thickness(es), in inches, shown below, meeting the requirements stated in these specifications and design assumptions outlined in Section 607, “Formed – in Place Pipe (FIPP)”.

Pipe Nominal Size (inch)	Depth of Cover (feet)				
	<10-ft	>10-ft or <15-ft	>15-ft or <20-ft	>20-ft or < 25-ft	>25-ft or <30-ft
8	0.307	0.358	0.409	0.450	0.487
10	0.383	0.448	0.511	0.562	0.608
12	0.460	0.538	0.613	0.675	0.730
15	0.575	0.672	0.766	0.844	0.912
18	0.690	0.806	0.919	1.012	1.097
21	0.805	0.941	1.072	1.181	1.277
24	0.920	1.075	1.226	1.350	1.460

636.03 – METHOD OF MEASUREMENT

Payment for "Deformed High Density Polyethylene Pipe" must be made at the contract unit price per liner foot. The price established must be full compensation for all materials and labor including materials, surface preparation, application, tools, equipment, site cleanup and incidentals necessary to complete this item of work.

636.04 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

DEFORMED HIGH DENSITY POLYETHYLENE PIPE (SIZE) L.F.

SECTION 637 – FOLDED POLYVINYL CHLORIDE (PVC) PIPE

637.01 – DESCRIPTION

This section covers reconstruction and rehabilitation of sanitary sewer lines by the insertion of a heated, folded PVC pipe which is then pressurized internally causing it to sequentially unfold and expand against the interior surface of the existing pipe.

637.02 – MATERIALS

The installed folded PVC pipe must meet the performance requirements of ASTM D-3034, "Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings". In addition, the PVC Compound used, must conform to the properties outlined in ASTM D-1784, "Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals", Classification 12454-B or 12454-C and as outlined below:

PROPERTY	ASTM METHOD	MINIMUM VALUE
Pipe Stiffness	D-2412	46-psi
Pipe Impact Strength	D-2444	220-lb/ft
Pipe Flattening	D-3034	60% Deflection
Initial Flexural Modulus	D-790	360,000-psi
Long-Term Flexural Modulus	*	180,000-psi
Tensile Strength	D-638	6,000-psi

* Note: The long-term values are considered to be for a continuous load duration of fifty years (50-yr) for design loading conditions and must be certified by the manufacturer.

637.02.01 – MINIMUM THICKNESS

Unless otherwise specified, the installed PVC pipe must have the following minimum thickness(es), in inches, shown below, meeting the requirements stated in these specifications and design assumptions outlined in Section 607, “Formed – in Place Pipe (FIPP)”.

Pipe Nominal Size (inch)	Depth of Cover (feet)				
	<10-ft	>10-ft or <15-ft	>15-ft or <20-ft	>20-ft or < 25-ft	>25-ft or <30-ft
8	0.165	0.193	0.220	0.243	0.262
10	0.207	0.242	0.275	0.303	0.328
12	0.248	0.290	0.330	0.364	0.393
15	0.310	0.362	0.413	0.455	0.493

637.03 – METHOD OF MEASUREMENT

Payment for "Reinforced Fiberglass Pipe” must be made at the contract unit price per liner foot. The price established must be full compensation for all materials and labor including materials, surface preparation, application, tools, equipment, site cleanup and incidentals necessary to complete this item of work.

637.04 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

FOLDED POLYVINYL CHLORIDE (PVC) PIPE (SIZE) L.F.

SECTION 638 – RESIN IMPREGNATED TUBE

638.01 – DESCRIPTION

This section covers reconstruction and rehabilitation of sanitary sewer lines by the installation of a resin impregnated flexible felt tube (i.e. Cured-In-Place Pipe, CIPP), inverted into an existing sewer line. Resin impregnated tube must conform to the requirements of ASTM F-1216, “Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube”.

638.02 – MATERIALS

A) Tube – The tube must be compatible with the resin system and must consist of one or more layers of flexible felt or an equivalent woven or nonwoven material. The material must be able to stretch to fit irregular pipe sections and conform to changes in alignment. Allowance must be made in the fabrication of the tube so that the installed CIPP fits snugly to the interior circumference of the existing pipe while allowing for stretching during inversion.

B) Resin – The resin must be a thermoset and catalyst type, or an epoxy resin and hardener that is compatible with the inversion process.

C) Minimum Physical Properties – The cured resin impregnated tube must meet the minimum physical properties as specified below:

Property	ASTM Method	- Minimum Value (psi)	+ Minimum Value (psi)
Initial Flexural Strength	D-790	4,500	4,000
Long-term Flexural	*	2,250	2,000
Initial Flexural Modulus	D-790	250,000	400,000
Long-term Flexural	*	125,000	200,000

Notes:
-Materials with initial flexural modulus of 250,000 psi
+Materials with initial flexural modulus of 400,000 psi
*The long-term values are considered to be for a continuous load duration of fifty (50) years for design loading conditions and must be certified by the manufacturer.

D) Chemical Resistance – The resin impregnated tube must be fabricated from materials with when cured must be chemically resistant to withstand internal exposure to domestic sewage. Chemical resistance testing must be performed in accordance with Appendix X2 of ASTM F-1216, “Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube” and meet all the requirements specified therein.

638.02.01 – MINIMUM THICKNESS

Unless otherwise specified, for the materials indicated, the installed resin impregnated tube must have the following minimum thickness(es), in inches, shown below, meeting the requirements stated in Section 638.02 and design assumptions outlined in Section 638.02. Should the Contractor propose a resin system that differs from Section 607, “Formed – in Place Pipe (FIPP) – Materials – FIPP Design Basis” they must submit the proposed physical properties for design and calculated minimum thickness for review and approval by the Engineer. The Engineer must be the sole judge as to the appropriate minimum thickness to be furnished and the use of the product.

Pipe Nominal Size (inches)	Depth of Cover (feet)									
	<10-ft		>10-ft or <15-		>15-ft or <20-		>20-ft or <25-		>25-ft or <30-ft	
	- Minimum Thickness (Inches)	+ Minimum Thickness (Inches)	- Minimum Thickness (Inches)	+ Minimum Thickness (Inches)	- Minimum Thickness (Inches)	+ Minimum Thickness (Inches)	- Minimum Thickness (Inches)	+ Minimum Thickness (Inches)	- Minimum Thickness (Inches)	+ Minimum Thickness (Inches)
8	0.187	0.153	0.218	0.187	0.249	0.213	0.274	0.235	0.297	0.254
10	0.233	0.191	0.273	0.234	0.311	0.266	0.343	0.293	0.371	0.317
12	0.280	0.229	0.328	0.280	0.373	0.319	0.411	0.352	0.445	0.380
15	0.350	0.286	0.410	0.350	0.467	0.400	0.514	0.439	0.556	0.475
18	0.420	0.344	0.491	0.420	0.560	0.479	0.617	0.627	0.667	0.670
21	0.490	0.401	0.673	0.490	0.653	0.558	0.719	0.615	0.777	0.665
24	0.560	0.458	0.655	0.560	0.746	0.888	0.822	0.703	0.889	0.760
27	0.630	0.515	0.736	0.630	0.839	0.718	0.925	0.791	1.000	0.855
30	0.700	0.573	0.818	0.700	0.933	0.798	1.027	0.879	1.111	0.960
33	0.770	0.630	0.900	0.770	1.026	0.877	1.130	0.966	1.222	1.045
36	0.840	0.687	0.982	0.840	1.119	0.957	1.233	1.054	1.333	1.140
42	0.980	0.801	1.145	0.980	1.306	1.117	1.438	1.230	1.655	1.330
48	1.120	0.916	1.309	1.119	1.492	1.276	1.644	1.406	1.777	1.520
54	1.260	1.030	1.473	1.259	1.679	1.436	1.849	1.581	2.000	1.710
60	1.400	1.145	1.636	1.400	1.865	1.595	2.054	1.757	2.221	1.900
66	1.540	1.260	1.800	1.540	2.052	1.754	2.260	1.932	2.443	2.100
72	1.680	1.373	1.963	1.679	2.238	1.914	2.465	2.108	2.665	2.280
78	1.820	1.490	2.127	1.819	2.423	2.073	2.671	2.284	2.888	2.470
84	1.960	1.602	2.291	1.959	2.611	2.233	2.876	2.459	3.110	2.660
90	2.100	1.717	2.454	2.100	2.798	2.392	3.082	2.635	3.332	2.850
96	2.240	1.831	2.618	2.239	2.984	2.552	3.284	2.811	3.554	3.040

Notes:
-Materials with initial flexural modulus of 250,000-psi
+Materials with initial flexural modulus of 400,000-psi

638.03 – METHOD OF MEASUREMENT

Payment for "Resin Impregnated Tube" must be made at the contract unit price per liner foot. The price established must be full compensation for all materials and labor including materials, surface preparation, application, tools, equipment, site cleanup and incidentals necessary to complete this item of work.

638.04 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

RESIN IMPREGNATED TUBE (SIZE) L.F.

SECTION 639 – SPECIAL SANITARY SEWER PIPE

639.01 – GENERAL

This section covers installation of sewer pipes, as specified herein, at locations called for on the plans, as required to satisfy minimum horizontal and vertical clearance requirements, from waterline, wells, and petroleum storage tanks, as established by the Oklahoma Department of Environmental Quality (DEQ).

639.02 – PIPE MATERIALS

Acceptable pipe materials and fittings must meet the requirements of the appropriate sections listed below:

Pipe Type	Pipe Material	Section
Flexible	Ductile-Iron Pipe (DIP)	631
Flexible	Polyvinyl Chloride (PVC) Pipe	633

639.03 – CONSTRUCTION METHODS

Pipe installation must be in accordance with the requirements and in conformance with the applicable sections of these specifications. If joining dissimilar pipe materials, concrete collars, as per "Standard Detail for Pipe Encasement & Collar", must be used.

639.04 – METHOD OF MEASUREMENT

Payment for "Special Sanitary Sewer Pipe" must be made at the unit price bid per linear foot installed for each size. The price established must be full compensation for all materials including pipe, concrete collars when necessary, labor, tools, equipment, and incidentals necessary to complete this item of work. Payment must not include the cost of trench excavation and backfill nor foundation and embedment materials.

"Special Sanitary Sewer Pipe" must be measured along the pipe, through manhole, junction boxes and other small structures.

639.05 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SPECIAL SANITARY SEWER PIPE (SIZE) L.F.

SECTION 640 – PIPE ENCASEMENT AND COLLAR

640.01 – DESCRIPTION

This section covers protection of sewer lines by concrete pipe encasement and collar when called for on the plans, or as directed by the Engineer.

640.02 – CONSTRUCTION REQUIREMENTS

A) General – Pipe encasement and collar must be constructed in accordance with the "Standard Detail for Pipe Encasement and Collar".

B) Pipe Encasement – Pipe encasement must be placed to the limits shown on the plans.

C) Collar – Collar must be concrete encasement placed to a minimum twelve inches (12-in) on either side of the joint.

640.03 – METHOD OF MEASUREMENT

Payment for "Pipe Encasement" and "Collar" must be made at the unit price bid per cubic yard of concrete. The price established must be full compensation for labor, materials, including concrete, tools, equipment, and incidentals necessary to complete this item of work.

SECTION 641 – AERIAL CROSSING

641.01 – DESCRIPTION

This section covers construction of aerial sewer crossing as shown on the plans. Each crossing involves excavation and backfill, construction of reinforced concrete bases and piers, carrier pipe, sewer pipe, and all incidental work.

641.02 – MATERIALS

A) Sewer Pipes – All pipes must conform to the requirements of Section 601, “Pipe Installation”.

B) Carrier Pipe **–** Acceptable carrier pipe material must meet the requirements of the appropriate section listed below:

Carrier Pipe Material	Section
Steel Casing Pipe	635

C) Formed Reinforced Concrete – Unless otherwise specified, all concrete used in construction of sanitary sewers and their appurtenances must have a minimum twenty-eight (28) day compressive strength of thirty-five hundred pounds per square inch (3,500-psi). All steel reinforcement used must be grade sixty (60) with a minimum yield strength of sixty pounds per square inch (60,000-psi).

641.03 – CONSTRUCTION METHODS

A) General – Construction of aerial crossing must be as called for on the plans and in accordance with the "Standard Detail for Aerial Crossing".

B) Casing Spacers – Casing spacers must be PVC with stainless steel bands. Use and positioning of spacers shall be in accordance with manufacturer's recommendations

C) Plugging Pipe Ends – Plugging Pipe Ends must comply with the requirement of Section 252.04, "Boring – Construction Methods", Part "D".

D) Piers – Pier construction must comply with all applicable subsections of section 400.

1) When the material encountered at footing grade of a bridge bent or pier is found to be partially of rock or incompressible material, and partially of a compressible material, the foundation cannot be placed until the Engineer has inspected the footing and authorized such changes found necessary to provide an adequate foundation.
2) Plans for forms and falsework for concrete piers which spans over twenty (20) feet in length and for all widening details must be submitted to the Engineer for review and approval. Similar plans must be submitted for other units of structure if requested by the Engineer. The plans shall be prepared on standard twenty-two (22) inch by thirty-six (36) inch sheets
3) Unless otherwise specified, top of caps and piers will be given a smooth finish with a steel trowel. Other surfaces must be wood float finished and striped with a fine brush leaving a fine grained texture.
4) Holes for anchor bolts in piers may be drilled or may be formed by the insertion of oiled wooden plugs or metal sleeves in the plastic concrete. The plugs or sleeves shall be withdrawn after the concrete has set. Formed holes must be of such diameter to permit horizontal adjustments of the bolts. The bolts shall be set carefully in mortar. In lieu of the above methods of placing, anchor bolts may be set to exact locations in concrete when it is placed
5) The minimum covering measured from the surface of the concrete to the face of any reinforcing bar must be not less than two (2) inches or as otherwise

shown on the plans. In the footings of abutments and retaining walls and in piers the minimum covering must be three (3) inches.

641.04 – METHOD OF MEASUREMENT

A) Payment for "Aerial Crossing" must be made at the unit price bid per linear foot of pipe and steel casing in accordance to Section 635 " Steel Casing Pipe". for each size. The price established must be full compensation for materials including carrier pipe, sanitary sewer pipe, casing spacers, plugging pipe, tie-down straps, anchor bolts, and all tools, labor, equipment, and incidentals necessary to complete this item of work.

B) Payment for "Concrete Collar with Spread Footing" must be made at the unit price bid per each. The price established must be full compensation for excavation and backfill, compacted rock foundation, materials including reinforced concrete for footing and collar, labor, tools, equipment, and incidentals necessary to complete this item of work.

C) Payment for "Pier" must be made at the unit price bid per vertical foot for each pier shaft for either Type I or Type II. The price established must be full compensation for excavation materials, including reinforced concrete for piers, labor, tools, equipment, and incidentals necessary to complete this item of work. Measurement for payment must be made from the top of the collar to the bottom of the pier.

641.05 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

AERIAL CROSSING (SIZE)	L.F.
FOOTING	EA.
PIERS(TYPE)	V.F.

SECTION 642 – SANITARY SEWER CONSTRUCTION STANDARD BID ITEMS

642.01 – DESCRIPTION

This section covers Standard Bid Items used in the contract documents for the construction of sanitary sewers and their appurtenances. Additional bid items may be called out in the bidding documents, other sections of the Standard Specifications, or as directed by the Engineer for additional work covered and change orders.

SECTION	DESCRIPTION	UNIT
601	SANITARY SEWER PIPE (SIZE)	L.F.
602	SEWER SERVICE CONNECTION	EA.
620	RISER PIPE	L.F.
603	SEWER SERVICE LINE	L.F.
604	ABANDONING SEWER	C.Y.
605	PIPE BURSTING (SIZE)	L.F.
606	SLIPLINING (SIZE)	L.F.
606	GROUTING	C.Y.
607	FORMED-IN-PLACE PIPE (SIZE)	L.F.
608	SEWER FLOW CONTROL	L.S.
609	CLEANING SEWER LINE	L.F.
610	SMOKE TESTING	L.F.
612	POINT REPAIR	EA.
613	DEFLECTION TEST (<24”)	L.S.
613	DEFLECTION TEST (≥24”)	L.F.
614	TELEVISION INSPECTION (CCTV)	L.F.
615	SEWER LEAK TEST (<24”)	L.S.
615	SEWER LEAK TEST ((≥24”)	L.F.
616	(SIZE) SANITARY SEWER MANHOLE(0-6FT)	EA.
616	EXTRA DEPTH MANHOLE WALL(SIZE)	V.F.
617	MANHOLE TESTING (<24”)	LS.
617	MANHOLE TESTING (≥24)	EA.
618	SANITARY SEWER MANHOLE REHABILITATION	V.F.
618	INVERT AND BENCH RECONSTRUCTION	EA
619	MANHOLE WATERPROOFING	EA.
620	MANHOLE JOINT WATERPROOFING	EA.
621	MANHOLE RING WATERPROOFING	EA.
622	MANHOLE COVER WATERPROOFING	EA.
623	GROUT CURTAIN	V.F.
629	ABANDONING MANHOLE	E.A.
629	REMOVING MANHOLE	E.A.
630	VITRIFIED CLAY SEWER PIPE (VCP)(SIZE)	L.F.
631	DUCTILE IRON PIPE (DIP)(SIZE)	L.F.
632	HIGH DENSITY POLYETHYLENE (HDPE) PIPE (SIZE)	L.F.
633	POLYVINYL CHLORIDE (PVC) (SIZE)	L.F.

Sanitary sewer Bid items continued

SECTION	DESCRIPTION	UNIT
634	REINFORCED FIBERGLASS PIPE (RFP) (SIZE)	L.F.
635	STEEL CASING PIPE (CARRIER PIPE SIZE)	L.F.
635	BORE AND STEEL ENCASEMENT (CARRIER PIPE SIZE)	L.F.
635	STEEL ENCASEMENT BY TRENCHING (CARRIER PIPE SIZE)	L.F.
636	DEFORMED HIGH DENSITY POLYETHYLENE PIPE (SIZE)	L.F.

637	FOLDED POLYVINYL CHLORIDE (PVC) PIPE (SIZE)	L.F.
638	RESIN IMPREGNATED TUBE (SIZE)	L.F.
639	SPECIAL SANITARY SEWER PIPE (SIZE)	L.F.
641	AERIAL CROSSING (SIZE)	L.F.
641	FOOTING	EA.
641	PIERS (TYPE)	VF.