

DIVISION 4 – SANITARY SEWERS AND STORM DRAINS

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DIVISION 4 - SANITARY SEWERS AND STORM DRAINS

401 PIPE AND FITTINGS FOR SANITARY SEWERS AND STORM DRAINS

401.01.00 MATERIALS

It is not intended that materials listed herein are to be considered equal or generally interchangeable for all applications. The type, class, and size of pipe, as applicable, will be specified in the contract documents for all City improvement projects. The City Engineer will determine material specifications for other applications.

401.01.01 CERTIFICATION OF MATERIALS

The contractor shall furnish certification for construction materials when such information is requested by the City Engineer. Certification submitted to the City Engineer shall be sufficient to show the materials meet the specified requirements. Costs associated with providing certification, including materials and testing, shall be borne by the contractor.

401.01.02 PIPE

401.01.02A DUCTILE IRON PIPE

Ductile iron pipe shall conform to Subsection 501.01.01 DUCTILE IRON PIPE.

401.01.02B CONCRETE PIPE

NON-REINFORCED CONCRETE PIPE

Non-reinforced concrete pipe shall conform to ASTM C 14 and the following additional requirements:

- (1) Cement shall be Type II conforming to ASTM C 150.
- (2) The minimum portland cement content shall be 564 pounds per cubic yard.
- (3) The water/cement ratio shall not exceed 0.49.

REINFORCED CONCRETE PIPE

Reinforced concrete pipe shall conform to ASTM C 76 with Wall B design and the following additional requirements:

- (1) Cement shall be Type II conforming to ASTM C 150.
- (2) The minimum portland cement content shall be 564 pounds per cubic yard.
- (3) The water/cement ratio shall not exceed 0.49.
- (4) The pipe shall have circular reinforcement.
- (5) The area of the outer circular reinforcing cage shall not be less than 75 percent of the inner cage on pipes 27 inches in diameter and larger.

401.01.02C POLYVINYL CHLORIDE (PVC) PIPE

NON-PRESSURE PVC PIPE

PVC pipe for non-pressure applications shall conform to ASTM D 3034 SDR 35 for pipe sizes 4" through 15" diameter and ASTM F 679 SDR 35 for pipe sizes 18" through 27" diameter.

PRESSURE PVC PIPE

PVC pipe for pressure applications shall conform to AWWA C900.

401.01.02D STEEL AND ALUMINUM ALLOY PIPE

Steel and aluminum alloy pipe are not used for standard applications. Designs for special applications will be reviewed for approval on a case-by-case basis.

401.01.02E SANITITE HP POLYPROPYLENE PIPE

SaniTite HP polypropylene pipe shall be for storm drain applications. Designs for sanitary sewer applications shall be considered on a case-by-case basis.

12-inch through 30-inch SaniTite HP dual pipe shall have a smooth interior and annular exterior corrugations; 30-inch through 60-inch SaniTite HP triple wall pipe shall have a smooth interior and exterior surfaces with annular inner corrugations.

- (1) 12-inch through 30-inch (300 to 750 mm) dual wall pipe shall meet ASTM F2736
- (2) 30-inch through 60-inch (750 to 1500 mm) triple wall pipe shall meet ASTM F2764
- (3) 12-inch through 60-inch (300 to 1500 mm) pipe shall have a minimum pipe stiffness of 46 pii when tested in accordance with ASTM D2412.

Polypropylene compound for pipe and fitting production shall be an impact modified copolymer meeting the material requirements of ASTM F2736, ASTM F2764, and AASHTO M330, for the respective diameters.

401.01.03 FITTINGS

Fittings shall be of sufficient strength to withstand all handling and load stresses, including pressure testing, that will be encountered in the work.

Fittings shall be supplied with joint connections of the same type used on the pipe.

401.01.03A CONCRETE FITTINGS

Concrete fittings shall be fabricated by the manufacturer of the concrete pipe using materials conforming to applicable requirements in Subsection 401.01.02B CONCRETE PIPE. Concrete fittings shall have the same strength classification as the concrete pipe on which the fittings are being used.

401.01.03B DUCTILE AND CAST IRON FITTINGS

Ductile and cast iron fittings shall conform to applicable requirement in Subsection 501.01.04 DUCTILE AND CAST IRON FITTINGS.

401.01.03C PVC FITTINGS

PVC fittings shall conform to requirements for PVC pipe in Subsection 401.01.02 PVC NON-PRESSURE PIPE.

Ductile iron fittings conforming to requirements in Subsection 501.01.04 DUCTILE AND CAST IRON FITTINGS shall be used with PVC C900 pressure pipe.

401.01.03D FITTINGS FOR STEEL AND ALUMINUM ALLOY PIPE

Fittings used on steel and aluminum alloy pipe shall conform to AASHTO M 196.

The type and configuration of fittings used with steel and aluminum alloy pipe will be specified in the contract documents.

401.01.03E FITTINGS FOR SANITITE HP POLYPROPYLENE PIPE

Fittings shall conform to ASTM F2736, ASTM F2764, and AASHTO M330, for the respective diameters. Bell and spigot connections shall utilize a welded or integral bell and spigot with gaskets meeting ASTM F477. Fittings and connections shall provide a watertight connection according to the requirements of ASTM D3212.

401.01.04 PIPE AND FITTING CONNECTIONS

401.01.04A LUBRICANTS FOR JOINT GASKETS

Lubricants used for jointing materials shall be approved by the manufacturer of the gasket and/or pipe and shall be consistent with the intended use of the piping system.

401.01.04B CONCRETE PIPE

Concrete pipe shall be supplied with bell and spigot-type joint connections. Bell and spigot pipe joints shall be sealed with O-ring style rubber gaskets conforming to ASTM C 443. Joints shall be able to withstand hydrostatic pressures to 13 psi (30 ft.). Spigot pipe ends with a confined O-ring gasket design shall be used for pipe 24 inches in diameter and larger.

Concrete pipe with tongue and groove-type joints shall be used only where approved by the City Engineer. Where approved for use, tongue and groove pipe joints shall be sealed with mortar. Mortar shall conform to applicable requirements in Section 205 CONCRETE, ASPHALT, AND AGGREGATE MATERIALS.

401.01.04C DUCTILE IRON PIPE

The type of joint connection for ductile iron pipe will be specified in the contract documents. Rubber gaskets shall conform to applicable requirements in Subsection 501.01.06 PIPE JOINTS.

401.01.04D PVC PIPE

PVC pipe shall have push-on-type joint connections. Rubber gaskets for PVC pipe shall conform to ASTM F 477 with joints capable of withstanding hydrostatic testing to 10.8 psi (25 feet) for 10 or more minutes by the criteria defined in ASTM D 3212.

For PVC pipe six inches in diameter and smaller, where a plain end of PVC pipe is to be connected to the plain end of another type of plastic pipe, a solid sleeve, gasketed coupler shall be used. Flexible and/or mechanical couplers shall be prohibited from this application.

401.01.04E STEEL AND ALUMINUM ALLOY PIPE

Couplings and bands used with steel and aluminum alloy pipe shall conform to AASHTO M 196.

401.01.04F SANITITE HP POLYPROPYLENE PIPE

Bell and spigot connections shall utilize a welded or integral bell and spigot with gaskets meeting ASTM F477. Fittings and connections shall provide a watertight connection according to the requirements of ASTM D3212.

401.01.05 FLEXIBLE, MECHANICAL COUPLINGS AND ADAPTERS

Flexible, mechanical couplers and adapters shall be used for connecting plain ends of non-compatible types or sizes of pipe and for the installation of tee connections and other fittings in existing lines.

Couplers and adapters shall be supplied with No. 305 stainless steel bands.

Acceptable flexible mechanical couplers and adapters:

Calder
Fernco, Inc.

401.01.06 STANDARD CLEANOUT FRAME AND COVER

Standard frame and cover assemblies shall be cast iron. "SEWER" shall be cast into the cover for sanitary sewer service lateral cleanouts. "STORM" shall be cast into the cover for storm drain service cleanouts. The height of the assembly frame shall be 18 inches as measured from the bottom of the assembly sleeve to the top of the flange face. Adjustable valve boxes shall be supplied without bottom flanges.

Acceptable valve box assemblies:

Olympic Foundry, Inc.	Part No. VB 910
Kiswok Industries Pvt. Ltd.	Part No. 910
East Jordan Iron Works	Part No. 00363912

401.02.00 CONSTRUCTION

401.02.01 EXCAVATION AND BACKFILL

Excavation and backfill shall conform with applicable requirements of Section 204 EXCAVATION, BACKFILL, AND OTHER SITE WORK.

401.02.02 TOLERANCES IN SPECIFIED LINE AND GRADE

The maximum allowable deviation from specified line and grade for sanitary sewers and storm drains is 0.05 of a foot for line and 0.02 of a foot for grade, provided such variations in grade do not result in a pipe or run of pipe having a level or reverse slope.

Impounding of water, regardless of amount, will not be permitted in any section of the completed sanitary sewer or storm drain system.

Any pipe or run of pipe that has not been installed within the allowable tolerance for line and grade or impounds water to any extent shall be removed and reinstalled or replaced as necessary to bring the work into compliance with the specified requirements.

401.02.03 DELIVERY AND ACCEPTANCE OF MATERIALS

Construction materials that are damaged or do not have approved certification shall be immediately removed from the job site or stockpiled in a location away from, or separate from, the work area.

401.02.04 PIPE INSTALLATION

Sheet shoring and movable trench shields shall be placed, removed, and/or operated in conformance with applicable requirements in Subsection 204.04.03 TRENCH EXCAVATION AND SHORING.

Cracked, broken, or otherwise defective pipe and fittings shall not be used. Pipe shall be lowered into the trench by slings or other suitable means.

Pipe and fittings with damaged protective coatings shall be repaired using methods and materials recommended by the manufacturer of the pipe and/or fittings.

Sewer pipes 36 inches or smaller in diameter entering or leaving manholes or other structures shall have a flexible joint within 18 inches of the exterior wall. Pipes larger than 36 inches in diameter shall have this flexible joint within a distance from the exterior wall equal to one-half the inside pipe diameter.

Fittings shall not be installed closer than 12 inches to any joint in a main line sewer that is 12 inches or less in diameter.

401.02.04A PIPE LAYING

The pipe laying operation shall proceed upgrade with the spigot or plain ends of the pipe pointing in the direction of flow.

When pipe laying operations are not in progress, the open end of the pipe shall be covered to prevent entry of rock and debris. Each section of pipe shall be cleaned as necessary to remove excessive amounts of dirt or other debris that may not be removed during the flushing operation.

Pipe alignment shall not be deflected from a straight line, in either the vertical or horizontal plane, unless such deflections are specified in the contract documents or approved by the City Engineer.

After installation, each length of pipe shall be covered with a sufficient amount of backfill to maintain the pipe at the specified line and grade during subsequent construction operations.

401.02.04B CUTTING PIPE

All types of pipe shall be sawcut when special lengths or end configurations are needed to complete the work as specified. Striking concrete pipe with hammers or other similar tools to induce transverse cracking of the pipe barrel is not permitted. PVC and ductile iron pipe ends that have been sawcut shall be beveled as necessary to prevent damage to the gaskets in push-on joint connections.

Sawcut ends on steel and aluminum alloy pipe shall be filed or trimmed as necessary to remove all sharp edges and slivers of metal.

401.02.04C SEWER SERVICE AND STORM DRAIN SERVICE LATERALS

Sewer service laterals shall have a minimum diameter of four inches and shall be installed with a minimum slope of ¼ inch per foot of run. Minimum depth of service laterals at the edge of the easement or public right-

of-way shall be 4½ feet below finish surface grade. More depth may be required to accommodate existing site conditions.

Individual sewer service laterals shall not be connected to manholes unless specified as such in the contract documents or approved by the City Engineer.

The maximum line or grade change made with any one fitting shall not exceed 45°.

Ends of service lines and service fittings shall be provided with approved watertight plugs, caps, or stoppers, suitably braced to prevent blowoff during internal air testing. Such plugs or caps shall be removable without damage to the pipe or fitting.

Cleanout risers shall be installed plumb and centered on the tee.

Service laterals installed other than perpendicular to the public main shall have 12-gauge minimum thickness tracer wire installed. Tracer wire shall be accessible from the property line cleanout and shall extend to the public main, centered over the service lateral pipe.

Deep trench service connections shall be constructed as specified in the contract documents and the applicable standard detail.

401.02.04D LOCATING SEWER FORCE MAINS

Sanitary sewer force mains shall be located by installing Omni Marker™ locate balls, Model 162, green in color. Locate balls shall be placed every 40 feet along the length of the pipe in tangent sections; and every 20 feet along the length of the pipe where the pipe is deflected along a curve. Locate balls shall be located over tees, elbows, and other appurtenances except where a structural component is identifiable at the surface. Locate balls shall be installed within four feet of finished grade, centered over the pipe.

401.02.05 PIPE AND FITTING CONNECTIONS

Pipe and fitting ends shall be cleaned and properly aligned before making the joint connection.

Joints shall be fitted together as tightly as the joint design will permit. Gaps at pipe joints shall not exceed one half inch or that recommended by the manufacturer of the pipe and fittings, whichever is more restrictive.

Pipe and fitting connections shall not be deflected in excess of that recommended by the manufacturer of the pipe and fittings.

Fabricated fittings and connections incorporating materials or methods of construction not specified herein or in the contract documents shall not be used in the work.

401.02.05A CONCRETE PIPE

When mortared joints are specified for tongue and groove pipe connections, the entire joint for the full circumference of the pipe shall be brushed clean and completely filled with mortar.

Bell ends of pipe with bell and spigot joints shall be cleaned of rock and other debris prior to assembly of the joint. Spigot ends of pipe with a confined-gasket design shall be cleaned and the gasket lubricated prior to assembly of the joint.

401.02.05B DUCTILE IRON PIPE

Ductile iron pipe and fitting connections shall be made in conformance with Subsection 501.02.07C PIPE CONNECTION PROCEDURES.

401.02.05C STEEL AND ALUMINUM ALLOY PIPE

Rock and dirt shall be removed from between the connecting band and the pipe ends prior to tightening the connecting band bolts.

When installing saddle-type fittings, all connecting bolts shall be installed through the pipe wall such that the threaded ends of the bolts will be on the outside of the pipe.

401.02.06 MECHANICAL PIPE COUPLERS AND ADAPTERS

Prior to installing mechanical couplers and adapters, pipe ends shall be sawcut as necessary to produce an edge that is free of cracks or other irregularities. Pipe ends shall be cut perpendicular to the length of the pipe.

After installation of the coupler or adaptor, pipe zone materials shall be thoroughly compacted to maintain proper alignment of the flow line and to prevent any movement of the pipe ends.

401.02.07 REPAIR OF EXISTING UTILITIES

Existing utilities damaged as a result of the contractor's operations shall be repaired in conformance with applicable requirements in Section 204 EXCAVATION, BACKFILL, AND OTHER SITE WORK.

401.02.08 WATER LINE CROSSINGS

In locations where new sanitary sewers cross over an existing water line or under an existing water line with less than 1½ feet of clearance between the two pipes, the contractor shall substitute the specified sewer pipe with a full length (20 feet minimum) of Class 50 ductile iron pipe of equivalent size, centered at the crossing point.

Watertight, mechanical couplers or adapters shall be used to connect the sewer pipe to the ductile iron pipe.

401.02.09 CONCRETE PIPE ENCASEMENT AND ARCH SUPPORT

The installation of concrete encasement and arch support for sanitary and storm drain pipe shall conform to applicable requirements in Section 204 EXCAVATION, BACKFILL, AND OTHER SITE WORK and as shown on the appropriate standard detail.

401.02.10 CONCRETE CLOSURE COLLARS

The use of concrete closure collars in lieu of mechanical-type couplers or other specified or approved connection materials and procedures is not permitted unless specified in the contract documents or approved by the City Engineer.

Where specified in the contract documents or approved by the City Engineer, concrete closure collars shall be constructed in conformance with the details provided and the following additional requirements:

- (1) Concrete shall conform to applicable requirements in Section 205 CONCRETE, ASPHALT, AND AGGREGATE MATERIALS.
- (2) Concrete shall be contained in forms constructed in conformance with applicable requirements in Section 206 CONCRETE STRUCTURES. Backfill materials or earth shall not be used in lieu of forms.

Concrete shall be confined to the specified dimensions of the collar. Forms shall be constructed such that the concrete will not be allowed to enter the pipe or structure around which the collar is being constructed.
- (3) Concrete reinforcement materials shall be supplied and placed in conformance with applicable requirements in Section 206 CONCRETE STRUCTURES.
- (4) Surfaces of pipe and fittings that are to come into contact with the concrete shall be thoroughly washed to remove all dirt and loose material.
- (5) Concrete shall not be placed on non-compacted base materials or in water.
- (6) The entire amount of concrete necessary to construct the collar shall be placed in one continuous operation. If the concrete is allowed to harden or obtain initial set prior to completion of the collar, the contractor shall remove the concrete and reconstruct the collar.
- (7) Concrete shall be consolidated in conformance with applicable requirements in Subsection 206.03.05 HANDLING AND PLACING.

The concrete shall be thoroughly consolidated around the pipe or structure as necessary to ensure no voids will be formed in the collar.

- (8) Concrete shall be allowed to obtain initial set prior to placing backfill over the collar. Concrete shall be allowed a minimum of seven days of cure time prior to compacting the backfill over and adjacent to the collar.

401.02.11 MARKERS

Pipe ends that are to be covered with backfill shall be marked with a 2" × 4" lumber marker.

Markers shall be in one piece. Splicing of lumber used for markers is only permitted in situations where the depth of the pipe is in excess of standard lumber lengths.

Markers shall be installed in a vertical position with the bottom end of the marker against the end of the pipe. Markers shall be extended a minimum of 12 inches above finish grade of the ground surface. Markers that are broken, too short, or are not installed vertically in the ground shall be replaced by removing the backfill and replacing and/or repositioning the marker.

The entire portion of the marker above ground level shall be painted with weatherproof white paint. After the paint has dried, weatherproof black paint or other permanent materials shall be used to neatly indicate the distance from the ground surface at the marker to the top of the pipe.

In areas where it is not practical to extend markers above the ground surface, as determined by the City Engineer, the tops of the markers shall be installed flush with the ground surface.

401.02.12 SURFACE RESTORATION

Surface restoration shall be in conformance with applicable requirements of Section 208 RESURFACING and Section 209 CLEANUP AND SITE RESTORATION.

401.02.13 TESTING SANITARY SEWERS AND STORM DRAINS

Gravity sanitary sewers including service laterals and appurtenances shall successfully pass the air test prior to final acceptance and shall be free of leakage and visible infiltration of water. Pressure sewer lines shall be tested in accordance with the contract documents.

Sewer pipe 30 inches in diameter and larger may be tested using an approved pneumatic joint testing device. Such testing methods and equipment shall meet the approval of the City Engineer.

Sanitary sewers shall not be coated internally or externally with any substance of any kind in an effort to improve the performance of the pipe when tested.

The City Engineer may require testing of manhole-to-manhole sections as they are completed in order to expedite the acceptance of completed portions of the system and allow connections prior to the whole system being completed.

Deflection testing shall be performed on sanitary sewers and storm drains when such systems are constructed of PVC pipe.

401.02.13A AIR TESTING GRAVITY SANITARY SEWERS

The entire sewer system shall be cleaned prior to air testing. The system shall be flushed as many times as necessary to remove all debris.

Air testing shall be accomplished after all service connections, manholes, and backfilling and compaction operations have been completed between the stations to be tested.

The contractor shall furnish all necessary testing equipment and shall perform the tests in a manner satisfactory to the City Engineer. Testing equipment shall provide observable and accurate measurements of air leakage under the specified conditions. A pressure gauge having minimum divisions of 0.10 psi and an accuracy of 0.0625 psi shall be used for testing. Air used for testing shall pass through a single control panel. The City Engineer may require, at any time, a calibration check of the instrumentation used.

The testing equipment shall include a pressure relief device designed to relieve pressure in the sewer under test at 10 psi or less and shall allow for continuous monitoring of the test pressures in order to avoid excessive pressure.

The City Engineer will determine the height of the water table at the time of testing.

TESTING METHOD

The time-pressure drop method shall be used for all air testing. The test shall be conducted in conformance with the following procedures:

- (1) The sewer system shall be cleaned prior to testing.
- (2) The required test pressure shall be increased 0.433 psi for each foot of average water depth over the invert of the pipe at the time of testing.
- (3) Air shall be added slowly to the section of sewer being tested until the internal air pressure is raised to 4.0 psi plus additional pressure as calculated in number (2) above.
- (4) After the specified test pressure is reached, the internal air temperature shall be allowed to stabilize for at least two minutes prior to adding additional air to maintain test pressure.
- (5) The air supply shall be disconnected after the temperature stabilization period has passed and the pressure has been elevated to the specified test pressure.
- (6) The City Engineer will determine and record the amount of time in seconds that is required for the internal air pressure to drop from 3.5 psi to 2.5 psi greater than the average back pressure of any ground water that may be over the pipe.

BASIS OF ACCEPTANCE

The sewer system shall be considered acceptable if the test section does not lose air at a rate greater than 0.003 cfm per square foot of internal sewer surface, or two cfm, whichever is greater.

This specification shall also be considered as satisfied if the time, as measured by the preceding described method, is not less than the time as computed according to the following procedure:

- (1) Record the diameter in inches (d) and the length in feet (L) of all pipe in the section to be tested, including the house branches, in a table similar to the one shown below:

Diameter Inches	Length Feet	$K = 0.011 d^2L$	$C = 0.0003882dL$
_____	_____		

Total K and C values =				
Time required by specification	_____	=	_____	Seconds
Actual time as determined by test	_____	=	_____	Seconds

- (2) Compute values for K and C by using the above formulas (d=inside diameter in inches and L=length in feet) and record them in the table.
- (3) Add all values of K and all values of C for the section being tested.
- (4) If the total of all the C values is less than one, the time required by the specifications shall be the total of the K values.
- (5) If the total of all the C values is more than one, the time required by the specifications shall be found by dividing the total of all the K values by the total of all the C values. The quotient is the time required by the specifications.

401.02.13B DEFLECTION TEST FOR PVC PIPE

A deflection test shall be performed for sanitary sewers and storm drains constructed of PVC and other flexible conduits. Deflection testing shall be performed by the contractor and shall be conducted after the trench backfill and compaction operations have been completed.

The deflection test shall be conducted by pulling an approved solid, pointed mandrel or a variable deflection measuring gauge through the completed pipeline. The diameter of the mandrel shall be 95 percent of the internal pipe diameter.

401.02.13C TELEVISED INSPECTION OF SANITARY AND STORM SEWERS

The owner will conduct a television inspection of all sewer and storm drain lines upon successful completion of required testing and cleaning. A video recording will be submitted to the Engineer in a digital DVD format.

Any discrepancies noted by the City Engineer during the television inspection shall be corrected by the contractor prior to acceptance of the system. The contractor shall submit testing documentation and a new video recording to the City Engineer in a digital DVD format, which demonstrates the correction of the discrepancies.

Contractors, when hired to inspect newly constructed or rehabilitated pipe for the City's sewer or storm system, shall be certified operators per the National Association of Sanitary Sewer Companies (NASSCO) Pipe Assessment Certification Program (PACP). Inspections, the inspection report, and CCTV data shall be provided as NASSCO compliant export files and shall be easily transferrable to the City's asset management system.

401.02.13D NON-COMPLIANCE WITH SPECIFIED TEST REQUIREMENTS

The contractor shall replace or repair, in a manner satisfactory to the City Engineer, any section of pipe not meeting the specified test requirements.

Infiltration of ground water in an amount greater than 3.84 gallons per day per inch diameter per 100 feet, following a successful air test as specified, shall be considered as evidence that the original test was in error or that subsequent failure of the pipeline has occurred. The contractor shall locate and correct such failures occurring within the warranty period in a manner satisfactory to the City Engineer and at the contractor's sole expense.

401.03.00 MEASUREMENT AND PAYMENT

401.03.01 SANITARY SEWER AND STORM DRAIN PIPE

Measurement and payment for installation of sanitary sewer and storm drain pipe will be made on a linear-foot basis within the limits shown in the contract documents.

Pipe will be measured horizontally from center-to-center of manholes, inlets, catch basins, and similar structures, or to the ends of the pipe, whichever is applicable.

Payment for pipe installation shall constitute full compensation for all labor; equipment; materials; clearing and grubbing; trench excavation; provision and installation of pipe bedding, pipe zone material, and backfill; compaction operations; anchorage and reaction blocking for pressure systems; flushing and cleaning; testing; all fittings, spools, and mechanical couplings required to complete the pipeline as designed; connection to and abandonment of existing pipe systems; installation of markers; and any other incidental expenses necessary to construct the pipeline in conformance with the contract documents.

401.03.02 INCIDENTALS

Other materials, labor, and equipment required to complete the work in conformance with the contract documents and not listed as separate pay items in the proposal will be considered incidental to other items of work and no separate payment will be made.

402 MANHOLES, INLETS, AND CATCH BASINS

402.01.00 MATERIALS

402.01.01 BASE ROCK

Base rock shall conform to requirements for aggregate base materials in Section 205 CONCRETE, ASPHALT, AND AGGREGATE MATERIALS.

402.01.02 PORTLAND CEMENT CONCRETE AND MORTAR

Portland cement concrete and mortar shall conform to applicable requirements in Section 205 CONCRETE, ASPHALT, AND AGGREGATE MATERIALS.

402.01.03 NON-SHRINK GROUT

Non-shrink grout shall conform to applicable requirements in Subsection 205.01.04 PORTLAND CEMENT GROUT.

Non-shrink grout shall be placed with the use of an approved commercial concrete bonding agent applied to all cured concrete surfaces being grouted. The bonding agent shall be compatible with the brand of grout being used. Water shall not be used as a substitute for the commercial bonding agent.

402.01.04 MANHOLES

Precast, reinforced concrete manhole bases, barrel sections, cones, flat slab tops, and grade rings shall conform to ASTM C 478 and shall be used in the construction of all manholes.

Standard, 48-inch diameter manhole components shall be used for pipe that is 24 inches in diameter or smaller. Manhole diameter and requirements for components for larger pipe will be specified in the contract documents. Manhole components shall be supplied with steps.

Permeability tests of manhole components may be required by the City Engineer. When such testing is required, the materials to be tested will be selected at random by the City Engineer from stockpiled materials that are to be supplied for the job. Permeability testing shall be conducted at the location where the materials were manufactured. Test specimens shall meet permeability test requirements of ASTM C 14 and ASTM C 497.

402.01.04A CONES AND FLAT SLAB MANHOLE TOPS

Eccentric cones with precast keyway grooves shall be used in the construction of manholes that are over six feet in depth. Cones shall have the same wall thickness and reinforcement as the manhole riser sections.

Concentric short cones (18" or 24") or flat slab manhole tops with precast keyway grooves shall be used in the construction of manholes that are six feet deep and less. Flat slab manhole tops shall be reinforced to withstand AASHTO H-20 loadings.

402.01.04B MANHOLE BASES

Manhole bases shall be manufactured such that the base riser section is integral with the base slab.

Manhole bases shall be provided with core-drilled openings and flexible, manhole-to-pipe connectors for the connection of stubouts.

Steps installed in base sections shall be located 180° from the manhole outlet.

Openings for stubouts in storm drain manhole bases shall be either core-drilled or formed by blocking out a section of the wall during the casting process.

402.01.04C MANHOLE GRADE RINGS

Concrete grade rings shall have precast keyway grooves and shall be a maximum of six inches in height.

402.01.04D JOINTING MATERIALS

Preformed, plastic gasket material conforming to requirements of AASHTO M-1-98 or confined O-ring-type joints with rubber gaskets conforming to ASTM C 990 shall be used in the assembly of manhole components.

402.01.04E MANHOLE FRAME AND COVER ASSEMBLIES

Castings shall be true to the size, weight, and tolerances shown on the standard details. Castings shall display the Fish Logo or the City Logo specified in Standard Detail No. 407 "Manhole Frame And Cover" Storm and Sanitary Sewers, respectively. Manholes requiring a lock-down lid will conform to the requirements of Standard Detail No. 408 "Waterproof And Tamperproof Manhole Frame And Cover".

The cover shall fit in the frame without binding and shall bear evenly on the seat without rocking. Frame and cover assemblies shall be able to sustain a concentrated load of 40,000 pounds applied at the center of the cover through a 2½-inch plug.

The castings shall be free of shrink cavities, cold shuts, cracks, excessive porosity, or any other defects that may impair serviceability. Frame and cover assemblies that have been repaired subsequent to casting, regardless of the type of defect or repair, shall not be used in the work. Castings shall be clean and shall be free of paint and other coatings.

Materials shall conform to ASTM A 48, Class 30B, with the following revisions:

Tensile Strength	30,000 psi
Traverse Strength (1.2-inch diameter bar – 18-inch centers):	
Load - Pounds	2,600 - 3,000
Deflection - Inches	0.22 - 0.34
Brinell Hardness (as cast)	173 - 200

The foundry shall certify as to the tensile and traverse properties and the Brinell hardness. The owner reserves the right to require a rough transverse bar (size of bar 1.2-inch diameter by 20 inches long) and/or a tensile bar as per ASTM A 48 for each 20 castings or for each heat when less than 20 castings are made.

Cap screws and washers for tamper proof and watertight manhole covers shall be stainless steel with 60,000 psi minimum tensile strength conforming to ASTM A 4 53.

402.01.04F STEP ASSEMBLIES

Precast manhole base assemblies, barrel sections, and cones shall be supplied with steps. Step assemblies shall be installed by the manufacturer of the manhole components. Steps shall be aligned in each manhole component so as to form a continuous ladder with steps equally spaced vertically in the assembled manhole at a maximum design distance of 16 inches apart. Steps installed in base sections shall be located 180° from the manhole outlet.

Acceptable manhole steps:

Model PS2-PF Copolymer polypropylene plastic step as manufactured by M.A. Industries, Inc., or approved equal.

402.01.05 STORM DRAIN INLETS AND CATCH BASINS

Precast, reinforced concrete storm drain inlet and catch basin bases, extension rings, and tops (for curb inlets) shall conform to ASTM C913. Concrete risers for extensions shall be a minimum of 4 inches in height and shall have the same wall thickness as the base section.

402.01.05A FRAME AND GRATE ASSEMBLIES FOR CATCH BASINS

Frame and grate assemblies for catch basins shall be fabricated of steel conforming to ASTM A 36 in accordance with the specifications shown on the standard details.

All connections shall be welded. Welding shall conform to applicable requirements of the American Welding Society.

The grate shall fit in the frame without binding and shall bear evenly on the seat without rocking.

402.01.05B TOP SECTIONS FOR CURB INLETS

Acceptable precast, reinforced concrete top sections for storm drain inlets:

Model No. CI-30-23FC as manufactured by Utility Vault Co., Wilsonville, Oregon.

402.01.06 PIPE AND FITTINGS

Pipe and fittings used in the construction of manholes, inlets, and catch basins shall conform to applicable requirements in Section 401 PIPE AND FITTINGS FOR SANITARY SEWERS AND STORM DRAINS.

402.02.00 CONSTRUCTION

402.02.01 EXCAVATION AND BACKFILL

Excavation and backfill shall conform with applicable requirements of Section 204 EXCAVATION, BACKFILL, AND OTHER SITE WORK.

Backfill around manholes, inlets, catch basins, and other appurtenances shall be the same type as the adjacent trench backfill.

402.02.02 MANHOLES

Base rock shall be graded and thoroughly compacted before placing the precast base section. The manhole base shall be fully and uniformly supported by the base rock at the specified grade and alignment and shall be set such that the top of the base section is level and plumb. The use of spacers between riser sections to accommodate an out-of-plumb base section is not permitted.

Cracked, broken, or otherwise damaged precast manhole bases, riser sections, and cones shall not be used in the construction of sanitary sewer manholes.

Components of sanitary sewer and storm sewer manholes shall be joined with the use of preformed, plastic gasket material, or butyl rubber gasket material. Gasket material shall be installed in accordance with the manufacturer's recommendations. Butyl rubber gasket materials shall conform to the requirements of AASHTO M-198, SS-S-00210 (210A), and ASTM C-990. Joint surfaces shall be cleaned and free of dirt and other debris prior to installing the gasket material.

Preformed, plastic gasket material shall be used in joining components of sanitary sewer manholes. Joint surfaces shall be cleaned of dirt and other debris prior to installing the gasket material. Preformed gaskets shall be installed in accordance with the manufacturer's recommendations. Mortar may be used in the assembly of storm drain manhole components.

Manhole channels shall be constructed in conformance with the appropriate standard detail. Water and debris shall be removed from precast base sections prior to placing concrete for the channel.

Channels shall be constructed with troweled surfaces and smooth transitions at all changes in direction. Channel bottoms shall not impound water. The channel configuration shall allow a three-foot long by six-inch diameter television camera assembly to be placed into, or removed from, the pipe without difficulty.

402.02.02A CAST-IN-PLACE MANHOLE BASES

Cast-in-place manhole bases shall be constructed only where specified in the contract documents or approved by the City Engineer.

Construction of cast-in-place manhole bases shall conform to the applicable standard detail and additional requirements specified herein.

The concrete for the base shall be contained in forms as necessary to conform to the specified requirements. Rock backfill, earth, or similar materials shall not be used as means to contain concrete.

Pipe stubouts shall be placed at the specified grade and alignment prior to placing concrete.

Concrete shall not be placed in water.

The concrete shall be consolidated as necessary to provide a watertight seal between the base and the first riser section and around all pipe connections.

The first precast riser section shall be placed in position on precast piers. The base riser section shall be level and plumb.

402.02.02B PIPE CONNECTIONS TO NEW MANHOLES

Openings for pipe connections shall be core-drilled.

For sanitary sewer manholes, core-drilled openings shall be fitted with flexible, manhole to pipe connectors.

Pipe connections to manholes shall be watertight.

402.02.02C DROP CONNECTIONS

Where possible, drop connection assemblies shall be installed on the outside of the manhole. Outside drop connections shall be constructed in conformance with the contract documents and the appropriate standard detail.

Inside drop connection assemblies will only be permitted where specified in the contract documents or approved by the City Engineer. Where permitted, inside drop assemblies shall be constructed in conformance with details contained in the contract documents and as approved by the City Engineer.

402.02.02D ADJUSTMENT OF MANHOLES TO GRADE

The frame and cover assembly shall be adjusted to finish grade with precast concrete grade rings. The maximum distance between the top of the manhole cone section and final surface grade shall not exceed 15 inches. The joints between grade ring extensions shall be watertight. The top step assembly shall be removed if found to be less than 16 inches from finish grade.

After final surface restoration, finish elevation of the manhole frame and cover assemblies shall be within .01 of a foot of the adjacent street grade.

If the difference in elevation exceeds .01 of a foot, a four-foot by four-foot square of asphalt shall be removed and the entire area excavated to a depth of ten inches below finish grade of the street. Concrete shall be placed to a depth of eight inches within the entire cut out area. The concrete shall be covered with a two-inch lift of class C asphalt.

See the appropriate standard detail for additional requirements.

CONCRETE SURFACES

When located in concrete surfaces, manhole frame and cover assemblies shall be adjusted to finish grade prior to replacing the concrete surface.

The frame and cover assembly shall be adjusted to finish grade with precast concrete grade rings. Grade rings shall be limited to a maximum height of 12 inches. Grade rings shall be set in mortar with sides plumb and tops level. The joints between grade ring extensions shall be watertight.

402.02.02E LEAKAGE TESTING OF MANHOLES

Completed sanitary sewer and storm drain manholes shall be subjected to leakage testing when such testing is determined to be necessary by the City Engineer.

Any visible infiltration of water in sanitary sewer manholes will be considered unacceptable.

Sanitary sewer manholes that exhibit visible water infiltration or do not pass leakage testing shall be repaired by the contractor using materials and/or methods approved by the City Engineer.

Any repairs made necessary by a leakage test failure or the presence of visible water infiltration shall be effective in preventing the infiltration of water under a pressure consistent with that which is obtained by filling the manhole with water.

The contractor shall conduct leakage testing using the following method:

VACUUM TESTING

Contractor shall plug all openings to the manhole and conduct vacuum testing in conformance with the requirements of ASTM 1244 and this Section.

The manhole shall be evacuated to create a minimum vacuum of 10" mercury (Hg). The vacuum shall be maintained for the minimum times indicated on the chart below. The test shall fail if the vacuum loss is greater than 1" Hg. (Note: 1" Hg = 0.4898 psi at 60° F)

Test Times By Manhole Depth And Diameter					
Depth, Feet	Diameter, Inches				
	48	54	60	66	72
	Time, Seconds				
8 or less	20	23	26	29	33
10	25	29	33	36	41
12	30	35	39	43	49
14	35	41	46	51	57
16	40	46	52	58	67
18	45	52	59	65	73
20	50	53	65	72	81
22	55	64	72	79	89
24	59	64	78	87	97
26	64	75	85	94	105
28	69	81	91	101	113
30	74	87	98	108	121

402.02.03 CONSTRUCTION OF INLETS AND CATCH BASINS

Base rock shall be graded and thoroughly compacted before placing the base section. The base section shall be evenly supported by the base rock. The base section shall be set such that the tops of the base section, riser sections, and extensions are level and plumb.

The curb and gutter top section over catch basins shall be cast-in-place. Frames shall be cast in the concrete when forming the top section. Frame anchors shall be firmly embedded in the concrete. Frame-bearing surfaces shall be clean and provide for uniform contact with the grate.

See the appropriate standard detail for additional requirements.

402.02.03A PIPE CONNECTIONS TO INLETS AND CATCH BASINS

Openings for pipe connections to precast structures shall be core-drilled. Openings for stubouts shall be the minimum size necessary to accept the pipe. All pipe connections shall be made to the base section.

Pipe connections shall typically be made in the center of a side wall of the base section. Pipe penetrations shall be located centered on a corner of the structure where pipes enter at an angle between 36° and 54° from perpendicular to the base side wall.

Pipes shall be installed flush with the inner wall of the structure. Pipe to structure connections shall be sealed with non-shrinking grout.

402.02.03B INLET AND CATCH BASIN EXTENSIONS

The number of precast extensions necessary to adjust the structure to the specified grade shall be kept to a practicable minimum. The use of several shorter extensions where a fewer number of taller extensions could be used is not permitted.

Extensions shall be set in mortar with sides plumb and tops to grade. The interior and exterior of the mortared joints shall be troweled smooth.

Extensions shall be watertight.

402.02.04 CLEANING

Upon completion of the work, all structures shall be cleaned of silt, rock, and other debris.

Where possible, such materials shall be removed through the top of the structure. When flushing is required to completely remove the materials, appropriate precautions shall be taken to trap the debris at the nearest downstream structure.

402.03.00 MEASUREMENT AND PAYMENT

402.03.01 MANHOLES

Measurement and payment for manholes will be made on a unit-price basis for each type shown in the proposal for manholes six feet deep and less, plus the unit price per foot shown in the proposal for extra depth of manholes over six feet. No deduction will be made for depths less than six feet. Measurement of manhole depth will be from the top of the manhole frame and cover to the manhole invert at the center of the manhole to the nearest foot.

Payment shall include full compensation for materials, labor, and equipment necessary for excavation and disposal of excess materials; preparation of aggregate base; construction of the manhole including installation of the channel, pipe connections, and installation of the frame and cover assembly to finish grade; and acceptance testing.

402.03.02 DROP ASSEMBLIES

Measurement and payment for drop assemblies will be made on a linear-foot basis as shown in the proposal for drop assemblies three feet in height, plus the unit-price-per-foot shown in the proposal for extra height over three feet. No deduction will be made for heights less than three feet. Drop assemblies will be vertically measured from the invert of the pipe at the top of the assembly to the invert of the pipe into the manhole base to the nearest foot.

Payment shall include full compensation for materials, labor, and equipment necessary to construct the drop assembly.

402.03.03 CATCH BASINS AND INLETS

Measurement and payment for catch basins and inlets will be made on a unit-price basis.

Payment shall include full compensation for materials, equipment, and labor necessary for excavation and disposal of excess materials; preparation of aggregate base; and construction of the catch basin or inlet including installation of the pipe connections and the frame and grate assembly to finish grade.

402.03.04 INCIDENTALS

Other materials, labor, and equipment required to complete the work in conformance with the contract documents and not listed as separate pay items in the proposal will be considered incidental to other items of work and no separate payment will be made.

403 WORK ON EXISTING SANITARY SEWERS AND STORM DRAIN STRUCTURES

403.01.00 MATERIALS

Materials used on existing sanitary sewers, storm drains, and related structures shall conform to applicable requirements in Section 205 CONCRETE, ASPHALT, AND AGGREGATE MATERIALS, Section 401 PIPE AND FITTINGS FOR SANITARY SEWERS AND STORM DRAINS, Section 402 MANHOLES, INLETS, AND CATCH BASINS, the contract documents, and additional requirements contained herein.

403.02.00 CONSTRUCTION

403.02.01 EXCAVATION AND BACKFILL

Excavation and backfill shall conform to applicable requirements of Section 204 EXCAVATION, BACKFILL, AND OTHER SITE WORK.

Backfill around manholes, inlets, catch basins, and other appurtenances shall be the same type as the adjacent trench backfill.

The contractor shall be responsible for maintaining flow through existing sewer and storm drain lines at all times in conformance with applicable requirements in Subsection 107.17.00 PUBLIC HEALTH and Section 204 EXCAVATION, BACKFILL, AND OTHER SITE WORK.

403.02.02 MANHOLES CONSTRUCTED OVER EXISTING STRUCTURES

The type of manhole construction will be specified in the contract documents. Cast-in-place manholes shall not be constructed unless specified in the contract documents or approved by the City Engineer.

Precast and cast-in-place manholes shall be constructed in conformance with applicable requirements in Section 401 PIPE AND FITTINGS FOR SANITARY SEWERS AND STORM DRAINS; Section 402 MANHOLES, INLETS, AND CATCH BASINS; the standard details; the contract documents; and to applicable requirements specified herein. The contractor shall take preventive measures to ensure that backfill, concrete, and other construction materials and debris do not enter the existing pipes.

When constructing cast-in-place manholes over clay or non-reinforced concrete pipe, the manhole base shall be constructed prior to opening the pipe. A minimum clear space of six inches shall be obtained under the pipe prior to placing the concrete for the base. The contractor shall take adequate precautions to prevent the pipe from breaking or settling due to removal of underlying material.

After completion of manhole, the top section of the existing pipe shall be sawcut and removed to the full width of pipe and diameter of the manhole. Exposed edges of the pipe shall be trimmed and covered with mortar as necessary to provide a smooth surface.

403.02.03 CONNECTIONS TO EXISTING STRUCTURES

The connection of new pipes to existing manholes, catch basins, inlets, and similar structures shall be in conformance with the contract documents and to applicable requirements specified herein.

The contractor shall take preventive measures to ensure that backfill, concrete, and other construction materials and debris do not enter the existing pipes.

Openings for pipe connections to existing sanitary sewer manholes shall be core-drilled and fitted with flexible, manhole-to-pipe connectors. Pipe connections shall be watertight.

Openings for pipe connections to existing storm drain manholes, catch basins, inlets, and related structures shall be core-drilled. Pipe ends shall be installed flush with the interior surface of the structure. Pipe connections shall be sealed with non-shrink grout. Interior surfaces of the grout seal shall be smooth and free of surface irregularities that may trap debris.

The contractor shall not disturb the base portion of any cast-in-place manhole or similar structure unless such work is specified in the contract documents or approved by the City Engineer. Where pipe connections or other modifications to a cast-in-place base are required and core drilling is not possible, the concrete shall be removed with hand tools, small pneumatic hammers, or other methods that will limit the possibility of damaging the structure beyond that necessary to install the pipe stubout or make the modification. After the stubout is set to specified grade and alignment, non-shrink grout shall be used to fill the annular space between the pipe and the base.

403.02.04 REMOVAL AND ABANDONMENT OF EXISTING STRUCTURES

Manholes, catch basins, inlets, and similar structures shall be completely removed in situations where the structures will not serve any future use. These structures shall be abandoned in place only when such methods are specified in the contract documents or approved by the City Engineer.

Removal and abandonment in place of manholes, catch basins, inlets, and similar structures shall conform to the contract documents and to applicable requirements specified herein.

403.02.04A REMOVAL

The entire structure, including the bases of cast-in-place and precast manholes and similar structures, shall be completely removed and the ends of exposed pipes plugged with concrete. The excavation shall be backfilled with materials as specified in the contract documents or approved by the City Engineer.

403.02.04B ABANDONMENT IN PLACE

Where abandonment in place is specified or approved for manholes and similar structures, the frame and cover assembly, cone, and intermediate riser sections shall be removed to a depth of eight feet below finish surface grade. Exposed pipe ends shall be plugged with concrete and the remainder of the structure filled with ¾-inch or one-inch minus crushed aggregate.

Where abandonment in place is specified for inlets, catch basins, and similar structures, all exposed pipe ends shall be plugged with concrete and the structure filled with ¾-inch minus or one-inch minus crushed aggregate. The top six inches of the structure shall be filled with concrete after removal of the grate and frame assembly. The concrete shall be finished in conformance with applicable requirements in Section 206 CONCRETE STRUCTURES.

Crushed aggregate backfill shall be compacted in conformance with Section 204 EXCAVATION, BACKFILL, AND OTHER SITE WORK.

403.02.05 PERMANENT PLUGS

The interior surfaces of the ends of pipes to be abandoned shall be cleaned prior to constructing permanent plugs.

Concrete plugs shall be constructed in the ends of all pipe 18 inches or less in diameter. Minimum length of concrete plugs shall be eight inches.

For pipe 21 inches and larger, the plugs may be constructed of common brick or concrete block. The exposed face of the concrete block or brick plugs shall be sealed with mortar.

403.02.06 ADJUSTMENT OF EXISTING CONCRETE STRUCTURES TO GRADE

Existing manholes, inlets, catch basins, and similar structures shall be brought to the specified finished grade by methods of construction as specified in Subsection 206.03.10 ADJUSTMENT OF EXISTING CONCRETE STRUCTURES TO GRADE.

403.02.07 CONNECTIONS TO EXISTING SEWER AND STORM DRAIN PIPES

The methods and materials used in tapping existing sanitary sewer and storm drain pipes shall conform to requirements specified in the contract documents and to applicable requirements specified herein.

Tap connections shall not protrude beyond the interior wall surface of the existing pipe.

403.02.07A SANITARY SEWER TAPS

Connections to sanitary sewer pipes shall be made with approved mechanical taps or tees that are compatible with the size and type of pipe being tapped.

Tee installations shall utilize solid-sleeve gasketed couplers compatible with the size and type of pipe being joined.

Core-drilled holes shall be used for mechanical taps in all types of sanitary sewer pipe.

Connections made to sanitary sewer pipe shall be watertight.

403.02.07B STORM DRAIN TAPS

Connections to storm drain pipes shall be made with approved fittings and materials that are compatible with the size and type of pipe being tapped.

Connections to aluminum or steel pipe shall be made by sawcutting a hole in the pipe and installing a prefabricated tapping saddle over the opening in accordance with the manufacturer's recommendations. Stainless steel nuts and bolts shall be used for the installation of these saddles. Bolts shall be installed through the pipe from the inside to avoid unnecessary protrusions on the interior wall of the pipe.

Concrete storm drain pipe shall be sawcut and the pipe wall removed only to the extent necessary to tap the pipe. After the tap is set to specified grade and alignment, grout shall be used to fill the annular space between the pipe and the tap.

Mechanical taps, saddles, or tees shall be used to tap PVC storm drain pipe.

403.03.00 MEASUREMENT AND PAYMENT

403.03.01 MANHOLES CONSTRUCTED OVER EXISTING STRUCTURES

Measurement and payment for manholes constructed over existing sanitary sewer and storm drain pipe will be made in conformance with Subsection 402.03.01 MANHOLES.

Payment shall also include full compensation for materials, labor, and equipment necessary for maintaining flow through the existing pipe and for removal, replacement, or reconstruction of the existing pipe during construction of the manhole.

403.03.01A DROP ASSEMBLIES

Measurement and payment for drop assemblies will be made in conformance with Subsection 402.03.02 DROP ASSEMBLIES.

403.03.02 CONNECTIONS TO EXISTING MANHOLES, INLETS, AND CATCH BASINS

Measurement and payment for connections to existing manholes, inlets, and catch basins will be made on a unit-price-each basis.

Payment shall include full compensation for materials, labor, and equipment necessary for excavation and disposal of excess materials; core drilling and/or sawcutting of the existing structure as specified; preparation of aggregate base; construction of a grout seal or installation of flexible mechanical connectors where required; and installation of the stubout.

403.03.03 CONNECTIONS TO EXISTING SEWER AND STORM DRAIN PIPES

Taps, tees, and similar connections to existing sewer and storm drain pipes will be considered incidental to other appropriate bid items and no separate payment will be made.

403.03.04 ABANDONMENT OF MANHOLES, INLETS, AND CATCH BASINS

Measurement and payment for abandoning manholes, inlets, catch basins, and similar structures will be made on a unit-price-each basis.

Payment shall include full compensation for materials, labor, and equipment necessary for excavation and disposal of excess materials; removal and disposal of abandoned concrete structures where specified; plugging of exposed pipes; backfill and compaction operations; and resurfacing as specified.

403.03.05 INCIDENTALS

Other materials, labor, and equipment required to complete the work in conformance with the contract documents and not listed as separate pay items in the proposal will be considered incidental to other items of work and no separate payment will be made.

**** END OF DIVISION ****