4000 MATERIALS AND CONSTRUCTION - STORM SEWERS

4001 SCOPE. Storm sewer construction shall consist of furnishing all labor, materials, and equipment necessary for the complete installation of storm sewers and appurtenances. Unless otherwise noted within these specifications, the word "sewers" shall refer to pipe sewers, or open channels.

4002 SPECIFICATION MODIFICATION. It is understood that throughout this section these specifications may be modified or deleted by appropriate items in the Special Provisions or notes on the contract drawings.

4003 REVISIONS OF STANDARDS. When reference is made to a standard specification (ASTM, MCIB, etc.), the specification referred to shall be understood to mean the latest revision of said specification as amended at the time of the Notice to Bidders, except as noted on the contract drawings or as provided for in the Special Provisions.

4004 MATERIALS

A. Reinforced Concrete Pipe:

1. Reinforced concrete pipe shall conform to the following ASTM Standards and be of the minimum strength designated herein or such higher strength as may be required by the Plans or Special Provisions:

    a. Round Pipe: ASTM C-76, Class III, Wall B.
    b. Elliptical Pipe: ASTM C-507, Class HE-III.
    c. Arch Culvert Pipe: ASTM C-506, Class A-III.

2. Joints:

    a. Flexible Gasket: Flexible gaskets may be either flat gaskets cemented to the pipe tongue or spigot, O-ring gaskets, or roll-on gaskets. All gaskets shall conform to ASTM C-433.

    b. Plastic Compound: This compound shall be a homogeneous blend of bituminous material, inert filler and suitable solvents or plasticizing compounds thoroughly mixed at the factory to a uniform consistency suitable for sealing joints of concrete pipe. The compound shall conform to the following requirements:

Bitumin, soluble in CS, percent by weight, minimum	.45%
Ash, percent by weight	15-50%
Penetration, standard cone.	150g, 5 seconds, 25 C
Trowel grade, bulk type	110-250mm
Extruded rope or flat tape type	50-120m

c. Preformed Plastic Compound: This compound shall be either rope form or flat tape form conforming to Federal Specification SS-S-210A. Primer, as recommended by the manufacturer, shall be used to maintain the material in position while pipe sections are being joined.

B. Corrugated Metal Pipe:

Pipe, coupling bands, and end sections shall conform to the requirements:

Material:	Galvanized Steel	AASHTO M218 ASTM A 929
	Aluminized Steel Type 2	AASHTO M274 ASTM A 929
	Polymer-Coated Steel	AASHTO M246 ASTM A 742
	Aluminum Alloy	ASHTO M197 ASTM B 744
Pipe:	Steel (Galvanized and Aluminized Steel Type 2, CSP and Spiral Rib)	AASHTO M36 ASTM 760
	Steel (Polymer-Coated, CSP, Spiral Rib, Smooth Interior CSP)	AASHTO M36 AASHTO M245 ASTM A 745
	Aluminum (CMP, Spiral Rib)	AASHTO M196 ASTM A 788

Minimum thickness of the metal after galvanizing shall be as follows:

Circular Culvert Pipe
(2 2/3" x 1/2" corrugations)

Under Roadways or In Street Right-of-Way

Minimum Diameter	Thickness
15-21"	.064"
24-30"	.079"
36-54"	.109"
60-72"	.138"
84"	.168"

Under Railroads

Minimum Diameter	Thickness
12-18"	.079"
21-24"	.109"
30-36"	.138"
42-84"	.168"

Not Under Roadways

Minimum Diameter	Thickness
12-30"	.064"
36-54"	.079"
60-84"	.109"

Circular Culvert Pipe
(3" x 1" corrugations)

Under Roadways or In Street Right-of-Way

Minimum Diameter	Thickness
36-54"	.079"
60-84"	.109"

Not under Roadways

Minimum Diameter	Thickness
36-54"	.064"
60-84"	.079"

Circular Culvert Pipe
(5" x 1" corrugations)

Under Roadways or In Street Right-of-Way

Minimum Diameter	Thickness
36-54"	.079"
60-84"	.109"

Not under Roadways

Minimum Diameter	Thickness
36-54"	.064"
60-84"	.079"

Circular Culvert Pipe
(3/4" x 3/4” x 7 1/2" spiral rib)

Under Roadways or In Street Right-of-Way

Minimum Diameter	Thickness
12”-24"	.064"
30”-42”	.079"
48"-66”	.109"
72"-84”	.138"

Not under Roadways

Minimum Diameter	Thickness
12-42"	.064"
48-60"	.079"
66-84"	.109"

Arch Culvert Pipe
(2 2/3" x 1/2" corrugations)

Equivalent Diameter	Minimum Thickness	Span*	Rise*
15"	.064	17"	13"
18"	.064	21"	15"
21"	.064	24"	18"
24"	.079	28"	20"
30"	.079	35"	24"
36"	.109	42"	29"
42"	.109	49"	33"
48"	.109	57"	38"
54"	.109	64"	43"
60"	.138	71"	47"

*Subject to manufacturing tolerances.

Arch Culvert Pipe
(2 2/3" x 1/2" corrugations)

Equivalent Diameter	Minimum Thickness	Span*	Rise*
36"	.046	40"	31"
42"	.064	46"	36"
48"	.064	53"	41"
54"	.079	60"	46"
60"	.079	66"	51"
66"	.079	73"	55"
72"	.079	81"	59"
78"	.109	87"	63"
84"	.109	95"	67"
90"	.109	103"	71"

*Subject to manufacturing tolerances.

Arch Culvert Pipe
(3/4" x ¾" x 7 ½" spiral rib)

Equivalent Diameter	Minimum Thickness	Span*	Rise*
18"	.064	20"	16"
21"	.064	23"	19"
24"	.064	27"	21"
30"	.079	33"	26"
36"	.079	40"	31"
42"	.079	46"	36"
48"	.109	53"	41"
54"	.109	60"	46"
60"	.109	66"	51"
66"	.109	73"	55"

*Subject to manufacturing tolerances.

Minimum Thickness	Equivalent Nominal Gage
.064	16
.079	14
.109	12
.138	10
.168	8

C. Smooth Interior Corrugated High Density Polyethylene (HDPE) Pipe:

1. Material: Pipe manufactured for this specification shall comply with and be certified to meet the requirements for test methods, dimensions and markings found in ASTM F2306 and AASHTO M-294, current additions. Pipe and blow molded fittings shall be made from virgin PE compounds which conform to the requirements of cell class 435400C in the latest version of ASTM D3350.

2. Pipe Sizes: Nominal sizes for this specification include 12-60 inch diameters designated in AASHTO M294 and ASTM F2306 as full circular cross section with an outer corrugated pipe wall and essentially smooth inner wall (waterway). Pipe corrugations shall be annular.

3. Certification: All high-density polyethylene (HDPE) pipe used for culvert and storm sewer applications shall conform to the requirements of AASHTO M294 and ASTM F2306, current edition. Pipe shall be provided only by manufacturers that are certified through the Plastic Pipe Institute (PPI) or National Transportation Product Evaluation Program (NTPEP) Third Party Certification program.

4. Pipe Usage: High density polyethylene pipe (HDPE) may be used except crossroad applications of collector roadways or higher.

D. Dual Walled Polypropylene Pipe:

Dual wall pipe and fittings 12 inch through 60 inch diameter shall conform to ASTM F2881. Dual wall polypropylene pipe shall have a smooth interior and annular exterior corrugation. Pipe shall be joined with an integral bell and spigot joint on all sizes. The joints shall be watertight in accordance with ASTM D3212. The spigot shall have one gasket meeting the requirements of ASTM F477. The gasket shall be installed by the pipe manufacturer and shall be covered with a removable, protective wrap to ensure the gasket are free from debris. A joint lubricant shall be used on the gasket and pipe bell during assembly. Pipe shall have a reinforced bell with a polymer composite band installed by the manufacturer. Pipe materials shall meet or exceed APWA-KCMO 2600 standards.

4005 CONSTRUCTION DETAILS.

A. Trench Excavation: Trenches shall be excavated to the width and depth as necessary to lay the sewer pipe to the grade line as indicated on the plans. Deviation from plan line and grade will not be permitted except under special circumstances subject to approval of the Engineer. The materials to be excavated are to be deposited on the sides of trenches and excavations, and beyond the reach

of slides, or transported to the spoil banks, or used for backfilling. The length of the trench excavation opened at one time shall be limited depending on the nature of the soil or other safety considerations.

Trenches shall be excavated to a width which will provide adequate working space and pipe clearances for proper pipe installation, jointing and embedment. However, the limiting trench widths must comply with bedding class requirements as shown on the plans. Over excavation shall be replaced with granular bedding material.

1. Unclassified Excavation. Unclassified excavation is defined as the removal of all material encountered regardless of its nature. All material excavated will be considered as Unclassified Excavation unless the Special Provisions specify Classified Materials.

2. Rock Excavation; Rock excavation is defined as the removal of all rock ledges six (6) inches or more in thickness, and detached rock or boulders having a volume of more than one & one half (1 1/2) cubic yards and shale occurring in its natural state, hard and unweathered.

   A rock ledge is defined as a continuous body of rock, which may include interbedded seams of shale or other soft materials. Such interbedded soft material seams less than twelve (12) inches in thickness will be included in the measurement of rock excavation. Such seams twelve (12) inches or greater in thickness will be included only in the measurement of earth excavation. No soft or disintegrated rock which can be removed with a pick or digging machine, no loose, Shaken or previously blasted rock, no broken stones, and no rock which may fall into the trench from outside the limits of excavation will be included. When solid rock is encountered in the trench, it shall be stripped of earth, and the Engineer notified. When blasting is permitted by the Engineer, the Contractor shall use the utmost care to protect life and property. The Contractor shall comply with all laws, ordinances, and applicable safety code requirements and regulations relative to the handling, storage and use of explosives and protection of life and property, and he shall be responsible for all damage thereto caused by his or his subcontractor's operations.

   When blasting is required for rock excavation, all such operations shall conform to the requirements set forth in section 7000 entitled Blasting.

3. Earth Excavation. Earth excavation is defined as the removal of all material not defined as rock.

4. De-watering. The Contractor shall remove any water which may accumulate, or be found in the trenches and other excavations made under the Contract.

   The Contractor shall form all dams, flumes or other works necessary to keep them clear of water while the sewers and their foundation, and other foundations works, are being constructed. All water shall be removed from

such excavation in a manner to not damage property.

5. Cribbing and Sheeting. The Contractor shall furnish, install, and maintain such sheeting, bracing, etc., as may be required to support any excavation and to prevent any movement which could in any way injure or delay the work or endanger adjacent pavement, building or other structures. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed they shall be immediately filled and consolidated.

   For the purpose of preventing injury or property damage, the Contractor may leave in place all sheeting or bracing, etc,. To be embedded in the backfill of the trench. No sheeting or bracing, however, shall be left in place within five (5) feet of the surface without the written permission of the Engineer.

   Whenever timber or other sheeting is driven to a depth below the elevation of the top of the pipe, or whenever any sheeting is driven for protection of trench walls in water bearing soil, the Engineer shall determine whether or not this section of the sheeting may be removed. Should he determine that any portion of this sheeting must be left in place, it shall be considered as Extra Work and will be compensated for on such a basis.

6. Unstable Foundation. Where materials are encountered in the bottom of the trench which are deemed as unsuitable by the Engineer to afford a sufficiently stable pipe foundation, the materials shall be removed to a depth and limits as ordered by the Engineer. Areas undergraded shall be backfilled with approved granular material or materials meeting the approval of the Engineer.

7. Protection of Property. The contractor shall satisfactorily shore, support, and protect any and all structures and all pipes, sewers, drains, conduits, and other facilities, and shall be responsible for any damage resulting thereto. The Contractor shall not be entitled to any damages or extra pay on account of any postponement, interference, or delay caused by any such structures and facilities being on the line of work, whether they are shown on the plans or not; specifically, but not limited to damage due to delay in utility relocation.

B. Laying and Jointing:

1. Handling and Protection: All pipe shall be protected during installation against shock and free fall, and be installed without cracking, chipping, breaking, bending, or damage to coating materials. Damaged pipe materials shall be replaced with new materials except as repair may be permitted by the Engineer.

2. Grade Control. All pipe shall have a continuous slope free from depressions that will not drain. The Contractor shall establish such grade control devices as are necessary to maintain proper alignment and grade.

3. Laying. The laying of pipe in finished trenches shall be commenced at the lowest point and installed with the bell end forward or upstream. All pipe shall be laid with ends abutting and true to line and grade. They shall be carefully centered so that when laid they will form a sewer with a uniform invert.

4. Bedding. The bedding material required shall be as indicated on the plans or standard details. Bedding shall be rodded, spaded, and compacted as necessary to provide firm uniform support for the pipe.

5. Jointing. Preparatory to making pipe joints, all surfaces of the portions of the pipe to be jointed shall be clean and dry. Lubricants, primers, adhesives, etc. that are used shall be compatible with the jointing material recommended or specified. All bell and spigot ends of concrete pipe shall be primed prior to application of trowelable bitumastic plastic compound.

   Trenches shall be kept water-free and as dry as possible during bedding. Laying and jointing, and for as long a period as required to protect the pipe joints and concrete structures.

   As soon as possible after the joint is made, sufficient material shall be placed alongside each side of the pipe to offset conditions that might tend to move the pipe off line and grade.

   a. Concrete Pipe:

      (1) Plastic joint sealant shall be applied to the tongue or spigot prior to the insertion into the bell or groove. A Sufficient amount of sealant shall be used to fill the annular joint space with some squeeze out. Wipe the outside surface of the joint with additional material to assure a complete seal.

      (2) Mortar. When cement mortar is used the joint surface shall be clean and soaked with water immediately before the joint is made. A layer of mortar shall be placed in the loser portion of the bell or groove of the installed pipe and on the upper portion of the tongue or spigot of the pipe section to be installed. The tongue or spigot shall then be inserted into the bell or groove of the installed pipe until the mortar is squeezed out on both the interior and exterior surfaces. The annular joint space shall be completely filled and abutting joint sections flush and even, with excess mortar stuck off .

      (3) Flexible Gaskets. Flat gaskets may be cemented to the pipe tongue or spigot. O-ring gaskets shall be recessed in the groove of the pipe tongue or spigot and confined by the bell or groove after the joint is completed. Roll-on gaskets shall be placed around the tongue or spigot and rolled into

position as the joint is assembled. Flat gaskets and o-ring gaskets shall be lubricated as recommended by the manufacturer.

b. Corrugated and Helical Steel Pipe. Corrugated steel pipes shall be joined with a band type of coupling. The band shall be drawn and secured on the pipe by connecting devices as furnished by the manufacturer. Pipe ends for annular corrugations shall be identical to the rest of the pipe barrel (plain ends), or in the case of helical pipe, the pipe ends at the joint shall be reformed to an annular corrugation or flange (reformed end). Gaskets, if required, shall be furnished in accordance with the plans and Special Provisions.

c. High Density Polyethylene (HDPE): HDPE pipe joints shall consist of in-line integral bell and spigot with rubber gasket that meets specification requirements of ASTM F477. Bell shall span over three spigot corrugations. Joints shall be soil tight as defined by ASTM F2306, paragraph 6.6.3.1, and AASHTO M294. Fittings shall not reduce or impair the overall integrity or function of the pipeline and shall meet the requirements of AASHTO M-294 and ASTM F2306. Fittings may be either molded or fabricated. Common corrugated fittings include in-line joint fittings such as couplers and reducers, branch assembly fittings such as bends, tees, wyes and end caps. Only fittings supplied or recommended by the manufacturer shall be used.

C. Trench Backfill.

1. Compacted backfill shall be required for the full depth of the trench above the embedment where beneath structures, street, road, or highway right-of-way, driveways, walks, parking areas, and at all locations shown on the plans or as directed by the Engineer during the progress of the work.

2. The top portion of the backfill beneath established sodded areas shall be finished with at least twelve (12) inches of topsoil corresponding to, or better than, that underlying adjoining sodded areas. Topsoil shall be approved by the Engineer prior to placement, and unless otherwise directed, shall be material previously excavated and stockpiled for the purpose during excavating and grading operations. Grades on areas to receive topsoil shall be established and maintained as a part of the grading operations. Immediately prior to dumping and spreading topsoil, the surface shall be loosened by discing or scarifying to a depth of two (2) inches to permit bonding of the topsoil to the underlying surface.

3. At the option of the Contractor, compacted backfill may be job-excavated material or material obtained off site, except that all street crossings shall be backfilled with MoDot Type I rock, four (4) feet back of curb to four (4) feet back of curb. Job-excavated material may be used for compacted backfill (outside of Street Right of Ways) when the job-excavated material is finely divided and free from debris, organic material, cinders, or other

corrosive material, and stones larger than three (3) inches in greatest dimension. Large masses of moist, stiff clay shall not be used. Job-excavated material shall be compacted to ninety-five (95) percent of maximum density at optimum moisture content as determined by ASTM D698 when the test is appropriate, or to seventy (70) percent relative density as determined by ASTM D2049 when that test is appropriate.

4. The method of compaction and the equipment used shall be appropriate for the material to be compacted and shall not transmit damaging shocks to the pipe.

   The combination of the thickness of the layer, the method of compaction and the type of compaction equipment used shall be at the discretion of the Contractor subject to obtaining the densities as specified above.

5. Backfill shall not be placed when material contains frost, is frozen, or a blanket or snow prevents proper compaction. Backfill shall not contain waste material, organic material, or debris of any kind.

6. Trench backfill above pipe embedment in locations other than those specified shall be compacted to ninety (90) percent of maximum density at optimum moisture content as determined by ASTM D698, unless otherwise permitted by the Engineer.

7. Uncompacted earth backfill material to be placed above embedments shall be free of brush, roots, more than two (2) inches in diameter, debris, cinders, or other corrosive material, and junk, but may contain rubble and detritus from rock excavation, stones, and boulders in certain portions of the trench depth. Uncompacted backfill material above embedments may be placed by any method acceptable to the Engineer which will not impose excessive concentrated or unbalanced loads, shock, or impact on and which will not result in displacement of installed pipe. Uncompacted backfill shall be placed to the extent necessary to prevent excessive future settlement.

8. Compact masses of stiff clay or other consolidated material more than one (1) cubic foot in volume shall not be permitted to fall more than five (5) feet into the trench unless cushioned by at least two (2) feet of loose backfill above pipe embedment.

9. No un-compacted trench backfill material containing rocks, or rock excavation detritus, shall be placed in the upper eighteen (18) inches of the trench except with specific permission of the Engineer, nor shall any stone larger than eight (8) inches in its greatest dimension be placed within three (3) feet of the top of pipe.

10. HDPE and Dual Wall Polypropylene storm pipe shall be installed in accordance with ASTM D2321. Bedding and backfill material shall be ASTM Classification I or II: crushed rock or coarse sand. When used outside the ROW, the select backfill material shall extend a minimum to ¾

of the pipe diameter. Unless otherwise noted, the backfill material shall be compacted to achieve 90% Standard Proctor. When installed inside the ROW or beneath paved areas, the backfill shall extend to 6" over the top of pipe or to the bottom of the pavement base course material and compacted to 95% Standard Proctor Density.

The inspector may, at his discretion, require the contractor to deflection test as much as 10% of the individual culverts or structure to structure storm sewer lines that have been installed, at no additional cost to the City. If the lines that have been deflection tested pass the deflection test, all of the lines will be accepted. If any of the lines do not pass a 7.5% deflection test, the contractor shall deflection test additional lines to be identified for deflection testing. Lines that do not pass the deflection test must be repaired or replaced at no additional cost to the City. Deflection test shall be conducted by mandrel.

4006 DRAINAGE MAINTENANCE. Trenches across roadways, driveways, walks, or other trafficways adjacent to drainage ditches or water courses shall not be backfilled prior to completion of backfilling the trench on the upstream side of the traffic way, to prevent impounding water after the pipe has been laid. Bridges and other temporary structures required to maintain traffic across such unfilled trenches shall be constructed and maintained by the Contractor. Backfilling shall be done so that water will not accumulate in unfilled or partially-filled trenches. All material deposited in roadway ditches or other water courses crossed by the line of trench shall be removed immediately after backfilling is completed and the original section, grades, and contours of ditches or water courses shall be restored. Surface drainage shall not be obstructed longer than necessary.

4007 DISPOSAL OF EXCESS EXCAVATED MATERIALS. Except as otherwise permitted, all excess excavated materials shall be disposed of away from the site of work at a site as approved by the City Engineer, unless otherwise indicated on the plans.

Broken concrete and other debris resulting from pavement or sidewalk removal, excavated rock in excess of the amount permitted to be and actually installed in trench backfill, junk, and debris encountered in excavation work and other similar waste materials shall be disposed of away from the site of the work.

Excess earth from excavations located in unimproved property shall be distributed directly over the pipe trench and within the pipeline right-of-way to a maximum depth of six (6) inches above the original ground surface elevation at and across the trench and sloping uniformly. Drag with blade machine, or other suitable tool to a smooth, uniform surface without obstructing drainage at any point. Wasting of excess excavated material in the above manner will not be permitted where the line of trench crosses or is within a railroad, public road, or highway right- of-way. The disposal of waste and excess excavated materials, including hauling, handling, grading, and surfacing shall be a subsidiary obligation of the contractor and no separate payment will be made therefore.

4008 SETTLEMENT. The Engineer may perform periodic inspections to insure that no settlement has occurred. The Contractor shall be responsible for all settlement of backfill, fills and embankments which may occur within two (2) years of time after final acceptance of the contract under which the work was performed.

The Contractor shall make, or cause to be made, all repairs or replacements made necessary by settlement within thirty (30) days after notice from the Engineer. Should the Contractor fail to make such repairs the City Engineer may cause repairs to be made and the cost of these repairs shall be the responsibility of the Contractor.

4009 ACCEPTANCE TESTS FOR STORM SEWERS.

A. Visual Inspection

1. Contractor shall clean pipe of excess mortar, joint sealant and other dirt and debris prior to inspection.

2. Sewer shall be inspected by running a T.V. camera the full length of the line and recording on audio/visual media compatible with WinCan software or approved equal, recording shall be retained by the City. Correct defects as determined by T.V. inspection including the presence of any misaligned, displaced, or broken pipe and the presence of visible infiltration or other defects.

3. Correct defects as required. Any section with defects shall be re-inspected as set forth in paragraph 2.