

**SECTION 4**  
**SANITARY SEWER**

**12/08/2015**



**STANDARD CONSTRUCTION SPECIFICATIONS**

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**4.00 SCOPE** – The work covered by this section of the specification consists of furnishing all plant, labor, equipment, appliances, and materials, and for performing all operations in connection with the construction of the sewers including appurtenant structures complete in accordance with this section of the specifications and the applicable drawings.

**4.10 GENERAL** – The Contractor shall remove paving, as may be required, excavate the trenches and pits to the required dimensions; excavate bell holes; construct and maintain all bridges for traffic control; sheet, brace and support the adjoining ground or structures where necessary; handle all drainage valves, hydrants and accessories; backfill and consolidate the trenches and pits; restore the roadway surface unless otherwise stipulated; supply required or remove surplus excavated material; and clean the site of the work. The latest revisions of the standard specifications referred to herein prevailing at the time of the bid opening shall prevail.

Although such work is not specifically shown or specified, all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure, complete and compatible installation shall be furnished and installed as part of this work. The drawings show sizes and general arrangements of all pipes and appurtenances. Responsibility for handling and/or cutting exact lengths of the various sizes of pipe for proper make-up rests with the Contractor.

#### **4.20 MATERIALS**

**4.21 GRAVITY SEWERS** – The Contractor shall furnish the Owner with certified records of the tests required herein made by the manufacturer or by a reliable commercial laboratory. Unless otherwise noted, all gravity sewer shall be bed with Class B Bedding, a minimum of 4" of gravel bedding below the pipe and to the top of the sewer main. Bedding material shall meet the gradation limits of coarse aggregate per specification 12.20. Bedding shall be incidental to the sewer main bid price unless otherwise noted on the bid form.

**A. VITRIFIED CLAY SEWER PIPE** – Vitrified Clay sewer pipe shall conform to the requirements of American Society for Testing and Materials (ASTM) Designation C-700 for extra strength clay sewer pipe. Sewer pipe shall be furnished in standard lengths. Vitrified clay sewer pipe and materials shall be capable of meeting the tests outlined in ASTM Designation C-301. Vitrified clay pipe joints shall conform to ASTM Standard Specification of Compressive Joints for Vitrified Clay Bell-and-Spigot Pipe, Designation C-425 or ASTM Standard Specification C-594. Clay Bell-and-Spigot are preferred joints, for 12" and smaller reinforced type 2 band seal ® with corrosion resistant shear ring can be used.

**B. DUCTILE IRON PIPE** – Ductile iron pipe shall conform to the requirements of American Water Works Association (AWWA) Standard Specification C-150 and C-151. Unless otherwise specified, pipe shall be Class 52. All ductile iron pipe shall have a lining equal to Sewer Coat as manufactured by Lafarge Calcium Aluminates. Thickness of the lining shall be a minimum of 0.125 inch for pipe diameters 6 inches to 12 inches and 0.1875 inch for sizes larger than 12 inches. A seal coat shall be applied to the lining.

The pipe shall be tested in accordance with AWWA Standard Specification C-151. Before lining, the inside of the socket, including a portion of the gasket cavity and a portion of the pipe barrel, shall be coated with a minimum of 8 mils of epoxy. Cracks and/or crazing shall not be acceptable. Loose areas of cement lining are not allowable. The outside bituminous coating shall conform to bituminous paint AWWA C-151. Joints for ductile iron pipe shall conform to the requirements of AWWA Standard Specification C-111, Rubber Gasket Joints for Cast-Iron and Ductile Iron Pressure Pipe and Fittings.

## **4.22 PRESSURE SEWERS**

**A. DUCTILE IRON PIPE AND FITTINGS** – Ductile iron pipe and fittings shall conform to Section 4.21 Fittings, of this specification.

**B. GATE VALVES** – Valves shall be resilient seal valves and shall comply with the requirements of the AWWA Standard Specification C-509 or C-515. Valves shall have hub ends to fit the pipe for which they are to be used. An adjustable valve box of sufficient length for the depth of trench shall be furnished complete. All gate valves shall have a clear waterway of the full diameter of the valve and shall be opened by turning to the left. The operating nut shall have cast thereon an arrow indicating the direction of the opening. Each valve shall be designed for a maximum working pressure of 200 psi (14 kg/sq. cm). Prior to shipment from the factory, each valve shall be tested by hydraulic pressure equal to twice the working pressure. Unless otherwise specified, valves shall be resilient seat non-rising stem. Valves shall have “O” Ring packing and a 2 inch (5.1 cm) operating nut. Valve disc and entire inside of valve body shall be coated with two part thermosetting epoxy coating, complying with AWWA C550.

**C. PLUG VALVE** – Valve shall be comprised of cast-iron body (ASTM A126, Class B), ductile iron plug (ASTM A536 65-45-12), plug shall be resilient faced with Buna-N resilient seating surface, permanently lubricated stainless steel or bronze shaft bearing bushings, valve seats with welded-in overlay of 90 percent nickel (minimum 1/8” thick) and stem seal with nitrile butadiene packing or Buna-N dual U-cups.

Valves shall have sleeve type metal bearings and shall be of stainless steel or bronze permanently lubricated type. Grit excluder seals shall be provided in upper and lower journals to isolate the bearings. All valves shall be supplied with standard 2” wrench nut for operation. Pressure rating of valve shall be 175 psi working pressure. Keystone/Henry Pratt and DeZurik, or an approved equal will be acceptable for plug valve installation.

**D. VALVE BOXES** – Valve boxes shall be constructed of cast iron or metal with a 3/16 inch (0.05 cm) minimum thickness at any point. Two piece, Buffalo Type valve boxes shall be equivalent to Mueller screw Type H-10360. Valve boxes shall be screw type size 666-S or approved equal. The cover shall have cast thereon the word “SEWER and shall be Tyler domestic or equal”.

## **4.30 CONSTRUCTION METHODS**

**A. EXCAVATION, TRENCHING AND BACKFILLING** – Sanitary sewers shall conform to the requirements of section 6, “Excavation, Trenching, Bedding and Backfilling”.

**B. PIPE INSTALLATION** – Vitrified Clay Sewer Pipe shall be installed in compliance with ASTM Standard Specification Designation C-12 or with the manufacturer’s recommendations and approval of the Engineer. Pipe installation shall be in Class B bedding unless otherwise specified. Pipe laying shall proceed upgrade so that the spigot ends point in the direction flow. All pipes shall be laid with ends abutting and true to line and grade. The pipe shall be matched so that when laid, they will form a sewer with a smooth, uniform invert. Sockets shall be carefully cleaned before pipes are lowered into trenches. All joints shall be watertight, root resistant, durable, and any leaks or defects discovered shall be immediately repaired. Any pipe which has been disturbed after being laid shall be taken up, the joints cleaned and the pipe properly relaid.

**C. PLUGGING OF PIPE DURING INSTALLATION** – Each time pipe laying work is stopped; the sewer shall be closed with a suitable plug to exclude water, foreign material and other objects. If any water, mud or foreign material should enter the new sewer, or any existing sewer connected thereto, the Contractor shall remove same at his expense and he shall be liable for any damage that may result thereby. Mud, water, etc.; to be removed, shall be pumped out of the sewer and shall not be flushed down into another sewer line or municipal utility.

**D. DEWATERING IN PIPE INSTALLATION** – The Contractor shall furnish all necessary equipment, labor and materials for pumping or otherwise removing any water that may enter or accumulate in the trenches or other excavations and keep them free from water until work is constructed and set for sufficient time so water will not damage the work in any way. Water shall not be allowed to flow through any sewer until joints are sufficiently set and the trench backfill is made to a point where pipe settlement will not occur. Also water shall not be allowed to flow through any sewer where the flooding of basements or other damage is possible.

**4.40 SEWER APPURTENANCES** – All sewer appurtenances shall be of the same type of material as the sewer pipe used and specified. All appurtenances shall conform to the drawings.

**A. MANHOLES** – Manholes shall be installed at the location shown on the drawings or as located and directed by the Engineer. Standard manholes shall be constructed in accordance with the City of Kearney “Standard Manhole Detail, while drop manholes when required shall be constructed in accordance with the City of Kearney “Standard Drop Manhole Detail. All manholes shall be constructed with covers. Manholes above foundations, unless otherwise required by the drawings, shall be constructed of precast concrete rings shall be in accordance with ASTM Standard Specification, Designation C-478. Precast concrete sections shall be jointed tightly using mastic joint sealing compound or other methods approved by the Engineer. Epoxy coating will be required for the inside of all. The eccentric section of manholes shall not extend above the proposed top of subgrade for pavement. A PCC concrete pad shall be poured, 6.0’ x 6.0’ x 0.67’ with the opening of the manhole eccentric centered within this pad. This shall allow the street paving to move with thermal

expansion and contraction and not be tied directly to the manhole, see the City of Kearney Standard Manhole Detail.

Manhole ring and cover shall be Deeter 1030, or approved equal. If the manhole is not in PCC paving (street or driveway), the manhole ring and cover shall be centered in a 6.0' x 6.0' x 8" PCC pad. When located in asphaltic paving the pad shall be set to the grade of the proposed paving. If the pad is located in a gravel street or in an agricultural area the pad shall slope 1 inch per foot away from the ring and cover. Rim elevations shall be 1.5 feet below the gravel surface of the street or 3.0 feet below the existing grade in agricultural areas, see the City of Kearney Standard Manhole Detail. When manholes are built in residential, commercial, and industrial areas the manhole lid shall be constructed to the proposed finished surrounding grade. Manhole inverts shall be carefully constructed to maintain the proper velocities through the manhole, and in no case shall the invert sections through the manhole be greater than the outgoing pipe. The shape of the invert shall conform to the lower half of the pipe it connects. Pipes joining the main sewer shall be connected with as large a radius of curve as practicable. City specified PCC section # 12 Portland Cement Concrete Pavement.

The main sewer shall be carried through manholes by split pipe whenever practicable. The sewer should be laid continuously through the manhole locations with a pipe joint just outside the manhole whenever grade and alignment permit and the manhole built later. The foundation shall be laid and carried up approximately to the center of the pipe. From the center of the pipe to the walls of the manhole the floor shall have a minimum slope of 1 inch per foot (8.33 cm/m). After the manhole is built, the upper half of the pipe shall be cut out. Cement mortar, if required shall be used to provide a smooth clean surface.

Where it is not practicable to use split pipe through manholes because of breaks in grade or elevation of incoming sewers, the sewer invert shall be made of concrete deposited between forms. The shape of the invert shall exactly conform to the lower half of the pipe in connects. Inverts shall be plastered with cement mortar if required to provide a smooth clean surface.

**B. WYE BRANCHES AND TEES** – Wye branches and tees shall be installed at the location designated by the drawings. Where not immediately connected to service sewers the fittings shall be closed with a stopper lightly cemented or sealed in place. Install service at minimum grade of ¼ inch per foot from sewer main to back of curb under paving. Continue to install service line at minimum slope of ¼ inch per foot to property line if bury depth is less than 10 feet or install to a minimum bury depth of 10 feet below top of finished curb grade at property line. Install a 1 inch inside diameter schedule 40 PVC pipe extending from the end flowline of the sanitary sewer service to the top of finished grade at the property line. Install plastic caps on the bottom and top ends of the 1 inch PVC pipe, do not glue the top cap so that the flowline depth of the sanitary sewer service can be measured. Install a 2 foot length of standard steel fencing tee post driven directly behind PVC pipe for locating purposes. See the City of Kearney Standard Details. The Contractor shall record accurately the location of all sealed fittings with double ties and the record shall be submitted to the Engineer.

**C. SERVICE CONNECTIONS** – Service connections shall be located as shown on the drawings. Connections shall be constructed in accordance with the City of

Kearney Standard "Standard Service Connection Detail." Slope of the service mains shall be ¼ inch per foot from sewer main to back of curb under paving. Continue to install service at minimum slope of ¼" per foot if bury depth is less than 10.0 feet or install service to a minimum depth of 10.0 feet bellow finished grade of back of curb paving at property line.

**D. ANCHORAGE FOR PLUGS, CAPS, WYES, TEES AND BENDS** – Plugs, caps, wyes and bends for pressure sewers shall be provided with a reaction backing in accordance with the Standard Blocking Detail. Reverse concrete anchor and tie backs are acceptable. Blocking shall be placed between solid ground and the fitting to be anchored; the area of bearing on the pipe and on the ground, in blocking. Temporary wood blocking may be used as directed by the Engineer.

All forming for concrete thrust blocks and anchors will be done by bulkheading around the shape of thrust block or anchor with burlap or reinforced paper sacks which have been filled with sand or earth, or other Engineer approved forming method. Filled sacks used to form concrete blocks will be left in place in the trench and backfill will be placed around and over them in the usual manner. Any bolt head or fitting must be left accessible when pouring concrete around them.

**E. RELATION OF WATERMAINS TO SEWERS** – Sewers shall be separated from water mains according to "Recommended Standards for Sewage Works", by the Committee of the Great Lakes-Upper Mississippi River Board of State Sanitary Engineer, (10 State Standard). Horizontal separation shall be 10 feet (3.05 m) measured from edge to edge. Vertical separation where a sewer crosses a water main shall not be less than 18 inches (45.7 cm), clear.

**F. ADAPTOR COUPLINGS** – All connections to existing sewer, new sewers, stubouts, dissimilar types of new and old pipes shall be by means of a properly sized Mission Flex Seal ARC coupling or equal as approved by the city's Utilities Department.

**G. EPOXY TOPCOAT** – All sanitary sewer manholes shall have an 80-100 mil epoxy coating applied to the interior of the manhole from the bench to the top lid in accordance to these specifications. Epoxy topcoat shall not be a separate bid item but shall be included in the manhole bid price.

1. Epoxy Topcoat- Corrosion resistant, rapid curing epoxy resin that will cure at low temperatures and in the presence of water. This material shall have the following properties:

Acceptable Materials:

- 1) Strong Seal Epoxy Top Coat
  - 2) Neopoxy NPR-5303 Epoxy
  - 3) Raven 405 Epoxy
  - 4) Tnemec Perma-glaze Series 435
  - 5) Approved Equal
2. Epoxy Spraying Equipment- Specifically designed for application of epoxy and approved for use by the epoxy manufacturer. The equipment shall consist of

a temperature controlled, plural component sprayer capable of either high-pressure, low-volume airless (HPLV) or low-pressure, high-volume air assisted (HPLV) spraying.

3. Mixing – Epoxy shall be mixed automatically by the spraying equipment in accordance with the epoxy manufacturer’s requirements.
4. Epoxy Application Procedure:
  - A) Epoxy topcoat shall be applied over the grout liner material after the grout has cured for a minimum of 24 hours. Contractor shall inspect the grout to insure it has properly cured.
  - B) Epoxy shall be sprayed in one continuous coating with a minimum thickness of 100 mils. During application, a wet film thickness gauge shall be used to insure that the minimum thickness is being applied.
5. Epoxy shall not be applied to frozen surfaces or during temperatures below 40° F.
6. Epoxy shall be protected from direct sunlight during the application process to prevent early setup/cure.
7. After the coating product(s) have set in accordance with manufacturer instructions, all surfaces shall be inspected for holidays with high voltage holiday detection equipment. Reference NACE RPO 188-2006 for performing holiday detection. All detected holidays shall be marked and be repaired by abrading the coating surface with grit disk paper or other hand tooling method. After abrading and cleaning, additional coating can be hand applied to the repair area. All touch-up/repair procedures shall follow the coating manufacturer’s recommendations. Documentation on areas tested, results and repairs made shall be provided to the City by the contractor or engineer.
8. Visual inspection shall be made by the project engineer and/or construction observer. Any deficiencies in the finished coating shall be marked and repaired by the contractor according to the procedures set forth herein.
9. All work shall be carried out in strict compliance with all applicable OSHA standards. Particular attention is drawn to those safety requirements involving entering and working in confined spaces.

#### **4.70 QUALITY ASSURANCE**

##### **4.71 TESTING GRAVITY SEWERS**

**A. FIELD QUALITY CONTROL** – All work performed under this specification shall be inspected, tested and approved. Tests shall be made in the presence of the Engineer. The Contractor shall provide all necessary equipment and shall perform all work required in connection with the tests at the expense of the Contractor.

**B. LIGHT TEST** – A light test shall be performed on all lines as follows. A light held in a pipe at one manhole shall be visible from the next manhole as a full circle of light. Sewer line sections not meeting the above test shall be relaid and the test repeated.

**C. INFILTRATION AND AIR TEST** – All lines shall be tested for tightness by one of the following methods. If the ground water table is at least two feet above the top of the pipe, the infiltration test shall be used. Otherwise, the air test shall be used. In all cases if leakage is above the specified amount, the sewer line or manhole shall be repaired and retested at the expense of the Contractor.

**D. AIR TEST** – This test will be performed according to ASTM C828 for VCP and ASTM 1417 for PVC pipe, stated procedures and under the supervision of the Engineer for gasket type joint pipe. If leakage is above the specified amount, the sewer shall be repaired, replaced and retested at the expense of the Contractor.

Equipment used shall meet the following minimum requirements: a) Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be tested. b) Pneumatic plugs shall resist internal testing pressure without requiring external bracing or blocking. c) All air used shall pass through a single control unit. d) These individual hoses shall be used for the following connections: (1) From control unit to pneumatic plugs for inflation (2) From control unit to scaled line for introducing low pressure air (3) From sealed line to control unit for continually monitoring the air pressure inside the pipe being tested. Procedures: All pneumatic plugs shall be seal tested before being used in the actual test installation. One length of pipe shall be laid on the ground and sealed at both ends with the pneumatic plugs to be checked. Air shall be pressurized to 25 psig. The sealed pipe shall be pressurized to 5 psig. The plugs shall hold against this pressure without movement of the plugs out of the pipe.

After a manhole to manhole reach of the pipe has been backfilled to final grade and cleaned and the pneumatic plugs are checked by the above procedures, the plugs shall be placed in the line and inflated to 25 psig. Low pressure air shall be introduced into this sealed line until the internal air pressure reaches 4 psig greater than the average back pressure of any ground water that may be over the pipe. At least two minutes shall be allowed for the air pressure to stabilize.

After the stabilization period (3.5 psig minimum pressure in the pipe), the air hose from the control unit to the air supply shall be disconnected. The portion of the line being tested shall be termed “acceptable” if the time required in minutes for the pressure to decrease from 3.5 psig to 2.5 psig (greater than average back pressure of any ground water that may be over the pipe) shall not be less than the time shown for the given diameters in the following table:

<i>Pipe Diameter in Inches</i>	<i>VCP</i>
	<i>Time (Minutes)/100 (Feet)</i>
4	0.3
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
21	3.0
24	3.6
27	4.2

30	4.8
36	6.0
42	7.3

In areas where ground water is known to exist, the Contractor shall determine in the water elevation prior to running the test. The height of water over the invert of the pipe shall be divided by 2.3 to establish the pounds of pressure that will be added to all readings. (For example, if the height of the water is 11 ½ foot, then the added pressure will be 5 psig. This increases the 3.5 psig to 8.5 psig, and the 2.5 psig to 7.5 psig. The allowable drop of one pound and the timing will remain the same.

If the pressure drops more than 1.0 psi during the test time, the line is presumed to have failed. The Contractor shall, at his own expense, determine the source of leakage. He shall then repair or replace all defective materials and/or workmanship. Air testing shall then be performed on the repaired line to meet the above specifications.

**E. TELEVISION INSPECTION** – Television inspection shall be required for the following:

1. Televiser sewer new construction only – for review purposes.
2. Televiser sewer rehabilitation/replacement to determine if any defects exist prior to acceptance.
3. Televiser sewer after all other infrastructure has been constructed and prior to finalizing project. The inspector may televise the sewer at any time to determine if main has been damaged and to see if it is clear of all mud, concrete, and debris.

A minimum of 14 days shall lapse between completion of rehabilitation/replacement and television inspection. All other infrastructure shall be constructed and project ready for final inspection before the new main has televised inspection. In all cases the existing sewer shall be cleaned prior to any televising event. The cleaning shall be accomplished with a high-pressure stream to move debris to the downstream manhole.

Debris shall be vacuumed and removed from the downstream manhole of each run to be televised and not allowed to flow into the existing main. The Contractor shall provide public notification to each resident affected by the cleaning event, a minimum of 24 hours prior to cleaning. Mobile closed circuit television inspection equipment shall be used to televise sewer lines between manholes. The camera shall be pulled through the line. Push type cameras are not acceptable. Robotic type camera equipment shall be used to televise stubouts.

The television camera used for the inspection shall be a color camera specifically designed and constructed for such inspection. Lighting for the camera shall be suitable to allow a clear picture for the entire periphery of the pipe. Picture quality and definition shall be satisfactory to determine characteristics and defects of sewer being televised. Inspection operations shall cease if the quality of the image on the screen is unsatisfactory. A continuous image for viewing shall be produced. A system, which displays the camera location in feet on the monitor with respect to the starting

manhole's centerline, shall be used. This system shall automatically update the camera location display as the camera is pulled forward or backward through the sewer line.

Measurement for location of observations to be recorded shall be made at the ground level by means of a meter device. Measurements shall be accurate to one-half (0.5) foot. Measurements shall be referenced from the center of the manhole where the camera is started to the center of the manhole where observations are terminated. The measurements shall be verified at the completion of the observations by measuring the distance between manhole centers at the ground level. The observed measurements shall correspond to within plus or minus one foot. Surface measurements shall be made by the contractor in the presence of the Engineer's representative.

The television camera shall be moved through the line at a uniform slow rate. During the inspection the camera shall be stopped at the points where one or more of the following conditions are observed and distances recorded.

1. Service line tees, wyes or taps.
2. Infiltration/inflow source.
3. Structural defects, including broken pipe, collapsed pipe, cracks, punctures, settling, etc.
4. Abnormal joint conditions, such as horizontal and vertical misalignment, open joints, joints not fully sealed, etc.
5. Unusual conditions.

Photographs of all questionable conditions shall be taken for subsequent review. The photographs shall be color and shall be taken from the image on the TV monitor with approved methods. The TV camera shall be positioned so the optimum view can be obtained. The image size of photographs shall be no smaller than three inches by four inches. All photographs shall be identified by location, date taken, and names of the owner's and Contract representative. The location of all photographs shall be identified by recording the distance from each defect or point of interest to the center of the reference manhole. All photographs shall be submitted as specified.

A CD, DVD, or VHS with a clear and audible voice narrative of the entire TV monitoring shall be furnished. Each video will be delivered to the Engineer in charge. Each report shall be titled on the screen with the date, manhole numbers, pipe size, and district or project number. The camera shall be set to begin at the center of the manhole and the footage zeroed out. The title shall change at each manhole and the footage zeroed out again before starting a new pull when more than one section of sewer is televised in succession. Defects in the sewer line shall be repaired or replaced by the Contractor, as directed by the Engineer, at no cost to the Owner. If the sewer is televised in a location where no construction has been completed, no repairs shall be required. Two bound copies of the final inspection report shall be submitted to the Engineer. Included in the report shall be a map showing the work area, a wye locations report, a television inspection report, video and all pictures.

#### **4.72 TESTING PRESSURE SEWERS**

**A. HYDROSTATIC TEST** – A pressure of 100 psi (7.0 kg/sq. cm) at the lowest elevation shall be applied for not less than 4 hours. No acceptance shall be granted until the leakage is less than 7 gallons per diameter inch per mile of pipe (6.5 liters per centimeter diameter per kilometer of pipe). Water shall be added and gauged continuously throughout the duration of the test under supervision of the Engineer, to maintain the required test pressure.

If the installation fails to meet this requirement, the Contractor shall, at his expense, determine the source of leakage. He shall repair or replace the defective materials and/or workmanship. The repaired line shall then be retested to meet the above requirements.

**B. PRESSURE AND LEAKAGE TESTS** – The pipeline shall be subjected to pressure and leakage tests as specified herein and as directed by the Engineer.

The required pressure and leakage tests shall be made after all pipe laying and backfilling work has been completed. All concrete reaction blocks and bracing or restraining facilities shall be in place at least 7 days before the initial filling of the line, except where tension joints are used at bends. The pressure and leakage tests shall be applied to the entire line and end plugs. The Contractor shall be solely responsible for any and all damage to the pipeline, and to public and private property, which results from defective material or workmanship.

The section of the line to be tested shall slowly be filled with water and all air expelled from the pipe. Care shall be taken that all air valves are installed and open in the section being filled, and that the rate of filling does not exceed the venting capacity of the air valves.

**C. TEST EQUIPMENT AND FACILITIES** – The Contractor shall perform the necessary work to fill the pipeline with test water, as specified. The Contractor shall furnish all pumping equipment, water meter, pressure gauge, and all equipment, materials, and facilities required for the tests.

Test pressures shall be applied by means of a force pump of such design and capacity that the required pressure can be applied and maintained without interruption for the duration of each test. The water meter and pressure gauge shall be accurately calibrated and shall be subject to the approval of the Engineer.

**D. PRESSURE TEST** – The low point in the forcemain for each test section shall be subjected to a test pressure of 100 psi (7.0 kg/sq.com). Test pressure shall not exceed the rated pressure of the valves, pipe or appurtenances when the pressure boundary of the test section includes closed, resilient-seated gate valves.

After the section of the line to be tested has been filled with water, the specified test pressure shall be applied and maintained for a period of not less than 2 hours and for whatever longer period as may be necessary for the Engineer to complete the inspection of the line under test or for the Contractor to locate any and all defective joints and pipeline materials. If repairs are needed, such repair shall be made, the line refilled, and the test pressure applied as before; this operation shall be repeated until the line and all parts thereof withstand the test pressure in a satisfactory manner.

**E. LEAKAGE TESTS** – After the specified pressure test has been completed, the line being tested shall be subjected to a leakage test under a hydrostatic pressure of 100 psi (7.0 kg/sq.com). The pressure shall be maintained constant (within a maximum variation, plus or minus, of 5 psi) during the entire time that line leakage measurements are being made, so that the allowable leakage rate may be determined accurately from the leakage rate formula.

Leakage shall not be started until a constant test pressure has been established. Compression of air trapped in un-vented pipes or fittings will give false leakage readings under changing pressure conditions. After the test pressure has been established and stabilized, the line leakage shall be measured by means of a water meter installed on the line side of the force pump.

Line leakage is defined as the total amount of water introduced into the line as measured by the meter during the leakage test. The forcemain, or tested section thereof, will not be accepted if and while it has a leakage rate in excess of that rate determined by the following formula:

$$L = \frac{SD}{133,200} (P)^{1/2} \quad \text{in which:}$$

L = Maximum permissible leakage rate, in gallons per hour.

S = Length of pipe tested, in feet.

D = Nominal internal diameter of the pipe, in inches.

P = Average test pressure, in pounds per square inch (gauge).

Where the leakage test shows a leakage rate in excess of the permissible maximum, the Contractor shall make all necessary surveys in connection with the location and repair of leaking joints to the extent required to reduce the total leakage to an acceptable amount.

All joints in piping and closed valves shall be watertight and free from visible leaks during the prescribed tests. Each and every leak which maybe discovered at any time prior to the expiration of one year from and after the date of final acceptance of the work by the Owner shall be located and repaired by and at the expense of the Contractor, regardless of any amount that the total line leakage rate during the specified leakage test may be below the specified maximum rate.

#### **4.90 MEASUREMENT AND PAYMENT**

**A. Measurement and payment** - The following methods of measurement and payment to the Contractor will be used on all projects Owned and let by the City of Kearney unless otherwise specified in the Detailed Specifications. Items not specifically listed in the Bid or defined by this specification shall be considered subsidiary to construction and direct payment will not be made for these items.

**B. Sewer Pipe** – Sewer pipe will be measured on the surface of the ground along the centerline of the sewer. Measurement on sewer line will be continuous through manholes, fittings, etc. but not continuous through special water and sewer crossing. A 20 L.F. deduct shall be made for these crossings. Payment will be made at unit price as set forth in the BID for the measured number of lineal feet of complete

sanitary sewer in place. Costs for jointing all pipe shall be included in the BID for the applicable type of pipe. No additional payment will be made for underground pipes or other utility structures encountered.

**C. Standard Manholes** – Standard manholes shall be paid at the unit price per each.

**D. Drop Manholes** – Drop manholes shall be measured and paid at the unit price per each.

**E. Wye Branches and Tees** – Wye branches and tees will be counted and paid for at the unit price as set forth in the BID. The price for each unit shall be considered as the price for the spur only. The cost of straight run of pipe from the wye fitting shall be measured and paid for as set forth in the BID of sanitary sewer in place.

**F. Cleanouts** – Cleanouts will be paid for at the unit price as set forth in the BID constructed complete in place.

**G. Service Connections** – New service connections will be measured from the wye branch to top of riser and shall be paid for per lineal foot of pipe in place under until price as set forth in the BID.

**H. Special Foundations** – Where a specially prepared foundation for support of the sewer pipe is constructed on direction of the Engineer, an adjustment will be made unless item is included in the BID.

**I. Connections to Existing Manhole** – Connections to existing manholes will not be measured but shall be paid at the lump sum price as set forth in the BID.

**J. Service Reconnections for Water and Sewer** – All new services, relocation and/or restoration of existing services encountered along the route of the Contractor's work shall be the responsibility of the Contractor. No direct payment for existing service reconnections or relocations will be made. All incidental work shall be considered subsidiary to the total BID.

**K. Water and Sewer Crossing** – Water and sewer crossing will be counted and paid for at the unit price as set forth in the BID. The price for each shall include all material and labor necessary. It shall include all bends, neoprene coupling, concrete, pressure pipe, etc. The nominal length of the crossing shall be 20 feet.

**L. Adaptor Couplings** – Unless adaptor couplings are specified in the BID, no separate payment will be made for adaptor couplings, as it will be included in the BID for pipe installation.

**M. Forcemain Cleanout** – Forcemain cleanouts including the wye fitting, valve, bends, ring and cover, with appurtenances will be counted and paid for the unit price for each as set forth in the BID, Forcemain Cleanout, complete in place.