

SECTION 500

EXCAVATION AND TRENCHING FOR SANITARY SEWERS

500.1. Description. This section covers excavation and trenching work and shall include the necessary clearing, grubbing, and preparation of the site; removal and disposal of all debris; excavation and trenching as required; the handling, storage, transportation, and disposal of all excavated material; all necessary sheeting, shoring, and protection work; preparation of subgrades; pumping and dewatering as necessary or required; protection of adjacent property; backfilling; pipe embedment; surfacing and grading; site restoration; and other appurtenant work.

500.2. General Requirements. Excavation shall provide adequate working space and clearance for the work to be performed therein. In no case shall excavation faces be undercut.

Subgrade surfaces shall be clean and free of loose material of any kind when concrete is placed undercut.

Backfilling and construction of fills and embankments during freezing weather shall not be done except by permission of the Engineer. No backfill, fill, or embankment materials shall be installed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill, fill, or embankment. All rock which cannot be handled and compacted as earth shall be kept separate from other excavated materials and shall not be mixed with backfill or embankment materials except as specified or directed by the Engineer.

500.3. Classification of Excavated Materials. No classification of excavated materials will be made for payment purposes except for rock excavation as specifically noted in the project proposal. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the Contract work, regardless of the type, character, composition or condition thereof except for rock excavation. Payment for rock excavation shall be based upon the depth of rock encountered and standard details 9A and 9B. Payment for rock excavation at manholes or other structures shall be based on the outside diameter or dimensions plus 4 feet to allow a working space of 2 feet beyond each exterior wall.

500.4. Site Preparation. All sites to be occupied by permanent construction or embankments shall be cleared of all logs, trees, roots, brush, tree trimmings, and other objectionable materials and debris. All stumps shall be grubbed. In addition, subgrades for fills and embankments shall be cleaned and stripped of all surface vegetation, sod, and organic topsoil. All waste materials shall be removed from the site and disposed of by the Contractor and at his expense. Topsoil shall be stripped and stockpiled for reuse as specified herein.

500.5. Clearing. The Contractor shall do all clearing necessary for access, stringing of pipeline materials, and construction of the pipelines and appurtenant structure.

Contractor shall do all clearing necessary for performance of his work and shall confine his operations to that area provided through easements, licenses, agreements and rights-of-way. The contractor's entrance upon any lands outside of that area provided by easements, licenses, agreements or public rights-of-way, shall be at the Contractor's sole liability.

Property owners shall be notified by the contractor at least two (2) weeks prior to the proposed construction starting date. The notification will allow property owners to remove any small plants or flowers they desire to save.

Clearing along creek banks, ditches, swales, etc. shall be kept to a minimum as necessary for sewer or force main installation, to minimize bank erosion prior to riprap installation.

500.6. Use of Explosives. The Contractor shall comply with all laws, ordinances, applicable safety code requirements, and regulations relative to the handling, storage, and use of explosives, and the protection of life and property. The Contractor shall be responsible for all damage caused by his blasting operations. Suitable methods shall be employed to confine all materials lifted by blasting within the limits of the excavation or trench.

All rock which can't be handled and compacted as earth shall be kept separate from other excavated materials and shall not be mixed with backfill or embankment materials except as specified or directed.

500.7. Unauthorized Excavation. Except where otherwise authorized, shown, or specified, all materials excavated below the bottom of concrete walls, footings, slabs on grade, and foundations shall be replaced, by the Contractor and at his expense, with concrete placed at the same time and monolithic with the concrete above.

500.8. Dewatering. The Contractor shall provide and maintain adequate dewatering equipment to remove and dispose of all surface and ground water entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure is to be built, or the pipe to be installed herein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

All excavations for concrete structures or trenches which extend down to or below ground water shall be dewatered by lowering and keeping the ground water level beneath such excavations 12 inches or more below the bottom of the excavation.

Surface water shall be diverted or otherwise prevented from entering excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.

The Contractor will be held responsible for the condition of any pipe or conduit which he may use for drainage purposes, and all such pipes or conduits shall be left clean and free of sediment.

500.9. Sheeting and Shoring. If any sheeting or shoring is to be done an engineered plan shall be submitted to Public Works. The plan will be reviewed for loadings on the pipe. The plan must be approved by the Engineer prior to beginning work. Except where banks are cut back on a stable slope, excavation for structures and trenches shall be sheeted, braced, and shored, as necessary, to prevent caving or sliding.

Trench sheeting shall not be pulled before backfilling unless the pipe strength is sufficient to carry trench loads based on trench width to the back of sheeting, nor shall sheeting be pulled after backfilling. With the concurrence of the Engineer, sheeting shall be left permanently in the trench.

Where trench sheeting is left in place, such sheeting shall not be braced against the pipe, but shall be supported in a manner which will preclude concentrated loads or horizontal thrusts in the pipe. Cross braces installed above the pipe to support sheeting may be removed after pipe embedment has been completed.

500.10. Stabilization. Subgrades for concrete structures and trench bottoms shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud and muck; and shall be sufficiently stable to remain firm and intact under the feet of the workmen.

Subgrades for concrete structures or trench bottoms, which are otherwise solid, but which become mucky on top due to construction operations, shall be reinforced with one (1) or more layers of crushed rock or gravel. The stabilizing material shall be spread and compacted to a depth of not more than 4 inches, which shall be furnished and installed as specified for granular fills. Not more than 1/2-inch depth of mud or muck shall be allowed to remain on stabilized trench bottoms when the pipe bedding material is placed thereon. The finished elevation of stabilized subgrades for concrete structures shall not be above subgrade elevations indicated on the drawings.

All stabilization work shall be performed by and at the expense of the Contractor.

500.11. Topsoil Removal and Replacement. In all areas of the construction easement for sanitary sewers, in all areas to be graded or where fills or embankments are to be constructed and any other areas of the project where the original topsoil will be covered, damaged, or disturbed, the topsoil shall be removed, stockpiled, and replaced.

Topsoil shall be removed to a minimum depth of 6 inches or to the actual depth of the topsoil where greater than 6 inches, and shall be carefully segregated and stockpiled for replacement after construction has been completed. No mixing with other excavated materials or waste granular bedding materials will be permitted.

500.12. Trench Excavation. The Contractor shall not open more trench in advance of pipe laying than is necessary to expedite the work. The trench shall be backfilled at the end of each day except as may be required to begin the next day's work. Trenches in the road shall be plated with steel sheets or patched with cold patch overnight. The maximum length of open trench on any line under construction shall be 300 feet.

Except where tunneling is indicated on the drawings, or is permitted by the Engineer, all trench excavation shall be open cut from the surface.

- a. Alignment and Minimum Cover. The alignment of each pipeline shall be fixed and determined from offset stakes. Vertical and horizontal alignment of pipes, and the maximum joint deflection used in connection therewith, shall be in conformity with requirements of the section covering installation of pipe. Establish required uniform line and grade in trench from benchmarks identified by City Engineer. Maintain this control for minimum of 100 feet behind and ahead of pipe-laying operation. Use laser beam equipment to establish and maintain proper line and grade of work.

- b. Limiting Trench Widths. Trenches shall be excavated to a width which will provide adjacent working space and sidewall clearances for proper pipe installation, jointing, and embedment and shall follow the minimum trench width (payline) shown on standard details 9A and 9B.
1. Minimum Sidewall Clearance. Minimum permissible sidewall clearance between installed pipe and each trench wall, expressed in inches, shall be the outside diameter of the pipe divided by six (6) ($D_o/6$).

The stipulated minimum sidewall clearance is not minimum average clearance, but is minimum clear distances which are required.

2. Maximum Trench Widths. The maximum trench width for sanitary sewer pipe is shown on standard details 9A and 9B.

Where necessary to reduce earth load on trench banks to prevent sliding and caving, the banks may be cut back on slopes and shall not extend lower than 1 foot above the top of the pipe.

- c. Unauthorized Trench Widths. Where, for any reason, the width of the lower portion of the trench as excavated at any point exceeds the maximum permitted in the foregoing specifications: either; pipe of adequate strength, special pipe embedment, or arch concrete encasement, as required by the loading conditions and with the concurrence of the Engineer, shall be furnished and installed by the contractor and at his expense.
- d. Mechanical Excavation. The use of mechanical equipment will not be permitted in locations where its operation would cause damage to trees, buildings, culverts, other existing property, utilities, or structures above or below ground. In all such locations, hand excavation methods shall be used.

Mechanical equipment used for trench excavation shall be of a type, design, and construction, and shall be such operated, that the rough trench excavation bottom elevation can be controlled, that uniform trench widths and vertical sidewalls are obtained at least from an elevation of one foot above the top of the installed pipe to the bottom of the trench, and that trench alignment is such that pipe when accurately laid to specified alignment will be centered in the trench with adequate clearance between the pipe and sidewalls of the trench. Undercutting the trench sidewall to obtain clearance will not be permitted.

- e. Cutting Asphalt or Concrete Pavement. Cuts in asphalt or concrete pavement or sidewalks shall be not larger than necessary to provide adequate working space for proper installation of pipe and appurtenances. Cutting shall be started with a concrete saw in a manner which will provide a clean groove at least 1-1/2 inches deep along each side of the trench and along the perimeter of cuts for structures.

Pavement over trenches excavated for pipelines shall be removed so that a shoulder not less than 12 inches in width at any point is left between the cut edge of the pavement and the top edge of the trench. Where necessary, trench banks may be

sloped back as needed, and the width of pavement removed shall be adjusted accordingly. Trench width at the bottom shall not be greater than at the top and no undercutting will be permitted. Pavement cuts shall be made to and between straight or accurately marked curved lines that, unless otherwise required, shall be parallel to the centerline of the trench. Temporary pavement patches shall contain a minimum of 3 inches of cold mix as noted in the Street and Storm Sewer Specification Standard Details–Pavement Replacement (120.01).

- f. Excavation Below Pipe Subgrade. Except where otherwise required, pipe trenches shall be excavated below the underside of the pipe, as shown on the Pipe Embedment Detail 9A, and 9B, to provide for the installation of granular embedment pipe foundation material.
- g. Artificial Foundations in Trenches. Whenever so ordered by the Engineer, the Contractor shall excavate to such depth below grade as the Engineer may direct and the trench bottom shall be brought to grade with crushed stone foundation material, or such material as the Engineer may order installed. All timber, concrete, or other foundations made necessary by unstable soil shall be installed as directed by the Engineer. Compensation for extra excavation and timber, concrete, or other foundations, except where provided by contract unit prices, shall be made in accordance with the contract provisions for extra work.

Where crushed stone artificial foundations in trenches are required, the material shall be placed on suitably prepared subgrades and compacted by vibration, and shall be crushed rock or gravel free from dust, clay, or trash, graded 1-1/2 inches to No. 4 as defined in ASTM C33.

- h. Bell Holes. Bell holes shall provide adequate clearance for tools and methods used in installing pipe. No part of any bell or coupling shall be in contact with the trench bottom, trench walls, or granular embedment when the pipe is jointed.

500.13. Pipe Embedment. Embedment materials for the sanitary sewer, both below and above the bottom of the pipe, classes of embedment to be used, and placement and compaction of embedment material shall conform to the requirements shown on the Pipe Embedment Details 9A and 9B and to the following supplementary requirements. RCP, VCP, and DIP shall be considered rigid pipes. HDPE and CMP shall be considered flexible pipe however, HDPE and CMP are not acceptable for sanitary sewer uses.

Embedment material shall contain no cinders or other material which may cause pipe corrosion.

- a. Placement and Compaction. Granular embedment material shall be spread and the surface graded to provide a uniform and continuous support beneath the pipe at all points between bell holes or pipe joints. It will be permissible to slightly disturb the finished subgrade surface by withdrawal of pipe slings or other lifting tackle.

After each pipe has been graded, aligned, and placed in final position on the bedding material and shoved home, Category I (loosely placed uncompacted bedding

material shall be placed under the center of the pipe a distance of $D_o/3$ before the pipe is placed). Category I bedding material shall be deposited and compacted to 95% on either side of the loosely placed bedding material and around each side of the pipe up to the springline and back of the bell or end thereof to hold the pipe in proper position and alignment during subsequent pipe jointing and embedment operations.

- b. RCP, VCP and DIP. Pipe shall be bedded according to the Type 3 installation as recommended by the American Concrete Pipe Association and details bound in this manual.
- c. PVC pipe shall be bedded according to the details for flexible pipe bound in this manual.

500.14. Trench Backfill. All trench backfill above the springline of the pipe embedment shall conform to the following requirements.

Classification of backfill materials. Backfill materials in these specifications shall conform to the Standard Installation Direct Design (SIDD) categories per the chart below.

SIDD Soil	USCS	Standard AASHTO
Gravelly Sand (Category I)	SW, SP, GW, GP	A1, A3
Sandy Silt (Category II)	GM, SM, ML, Also GC with less than 20% passing #200 sieve	A2, A4
Silty Clay (Category III)	CL, MH, GC, SC	A5, A6

If concrete arch encasement is required, a layer of backfill material not more than 8 inches deep may be placed over concrete arch encasement after the concrete has reached its initial set, to aid curing. No additional backfill shall be placed over arch encasement until the concrete has been in place for at least three (3) days.

- a. Compacted Backfill. Compacted backfill will be required for the full depth of the trench above the embedment in the following locations:
 1. Where beneath pavements, surfacings, driveways, curbs, gutter, walks, or other surface construction, or structures.
 2. Where in street, road, or highway shoulders.
 3. In established lawn areas.

At the option of the Contractor, compacted backfill may be: (1) suitable job excavated material; or (2) graded gravel as described below:

b. Trench Backfill

1. Materials. All materials which are to be compacted by tamping or rolling, including all tamped embedment, shall be free from sticks, large roots, or other organic matter coarser than grass roots, stones, hard lumps, and clods, and shall have a moisture content such that optimum compaction is obtained when properly tamped or rolled.

Granular material for replacement of unsuitable foundation material removed from trench bottoms shall consist of coarse sand, lime gravel, and shall be free from dust, clay, and other materials which would cause the materials to crack or cake. When tested with square mesh laboratory sieves, not less than ninety-five percent (95%) shall pass a three-eighths (3/8) inch sieve and not more than five percent (5%) shall pass a No. 10 sieve.

Flowable backfill shall be a Controlled Low Strength Material (CLSM). CLSM shall be composed of Portland cement, fly ash (optional), fine aggregate, coarse aggregate (optional), water, and a shrinkage compensator. Cement shall be either Type I or Type II Portland cement. Mixing water shall be potable. Air entrainment admixture shall consist of an organic compound which will result in air contents as prescribed by ASTM C 173 or C 231. Fine aggregate shall be washed and consist of clean, hard, durable and uncoated particles of natural or manufactured sand or a combination thereof, with or without mineral filler. Aggregate shall be free of injurious amounts of salt, alkali, vegetable matter or other objectionable material. Coarse aggregate shall be sound, durable, clean rock or broken concrete (2 inch to 8 inch square) to minimize the quantity of CLSM. The CLSM shall be placed to a depth of 2 feet then coarse aggregate may be added to the CLSM mixture until the top of the CLSM and top of aggregate are approximately equal. The process may be repeated until the fill is completed. CLSM shall be removable (less than 100 PSI) and comply with the following mix design:

Cement	144 lbs
Water	396 lbs
Sand	2,698 lbs
Air entrainment	13%

Where CLSM is being placed over or adjacent to crushed stone backfill, a layer of filter fabric shall be installed between the two materials.

Inundated sand backfill is not acceptable.

2. Compaction. All backfill shall be thoroughly compacted by pneumatic tampers, or other approved methods, to the original state of consolidation of the soil encountered. Backfill shall be placed in uncompacted lifts not to exceed 6 inches and each lift shall be thoroughly and adequately compacted. Care shall be exercised not to disturb the pipe when placing backfill. The compacted earth backfill shall be brought to an elevation of approximately 6 inches below the finished surface grade

and then surface grade or paving constructed. Testing shall be similar to that required at embankments per 500.15 except that tests shall be taken once for every 300 linear feet of trench or fraction thereof for every other lift. Backfill using ¾" clean aggregate does not require testing.

After backfill and compaction is complete trenches shall be leveled off and grading shall be performed as is necessary to restore yards or other grassed or sodded areas to their original condition or better.

Backfill under pavements shall be flowable fill. Flowable fill shall be placed from a maximum of 1 foot above top of utility to the underside of pavement base course. If pavement does not have a base course, stop flowable fill 6 inches below bottom of pavement and provide 6 inch cushion course of 1 inch clean aggregate.

- c. Responsibility of Contractor for Backfill Settlement. The Contractor shall be responsible for the satisfactory compaction and maintenance thereof, of all trenches and structural excavation of any description required under this Contract. Contractor shall warrant their work for at least the correction period from the date of acceptance. If prior to the expiration of this warranty, any trenches or other excavations are found to have settled they shall immediately be reworked by the Contractor and restored to the specified grades. Any sod, paving, or other surfacing damaged by settlement of trenches shall be replaced by the Contractor and at his expense.
- d. Topsoil Replacement. Topsoil removed and stockpiled in advance of trench excavation shall be replaced after trench backfilling operations are completed and initial settlement has taken place. Trench backfill shall be completed to such elevation as required to allow settlement and to permit the replacement of all topsoil which had been removed and stockpiled.

500.15. Fill and Embankments. Where filling is required to raise the subgrade under areas to be paved or surfaced, all fill materials shall consist of earth or other approved material. All organic or other undesirable material shall be removed. Where embankments, regardless of height, are placed against hillsides or existing embankments, either of which have a slope steeper than 1 vertical to 4 horizontal, the existing slope shall be benched or stepped in approximately 24 inch rises as the new fill is brought up in 8 inch maximum layers or lifts. The material bladed out, the bottom of the area cut into, and the embankment material being placed, shall be compacted to the required density. Material cut out, bladed into place and compacted shall not be measured and paid for directly but will be considered as incidental work.

All fill under paved surfaces such as streets and parking lots shall be compacted by a power roller or other approved equipment and the subgrade brought to a reasonably true and even plane. Earth used for fill shall be placed in layers not more than 8 inches thick, an uncompacted measurement, and shall be compacted as specified before the next layer is placed. Each layer shall be wetted or dried as necessary, and shall be compacted to the required density. Regardless of the type of equipment used, the roadway shall be compacted

uniformly and the surface kept reasonably smooth at all times. If large pieces of heavy clay are encountered, the material shall be broken down by suitable manipulation to permit satisfactory embankment construction. If shale is encountered, the shale shall be broken down as much as practical and compacted at or above optimum moisture.

Each layer shall be uniformly spread, moistened as required, and then compacted to 90% of maximum density, obtained at the optimum moisture content, as determined by AASHTO Method T-99-38. The top 18 inches shall be compacted to 95% of maximum density. The field density of the lift will be determined in accordance with AASHTO T 191 or T 205, using the total material or T238, Method B Direct Transmission, for wet density. If nuclear density methods are used, moisture content will be determined in accordance with AASHTO T239. One test shall be taken for every 1,000 linear feet or fraction thereof for each lift. Testing is to be done by a third party independent testing agency or by the Contractor if the Contractor has demonstrated to the Engineer that Contractor employs qualified persons and maintains qualified equipment to conduct density testing. Test results shall be furnished on forms acceptable to Engineer. Costs of all testing and retesting are the responsibility of the Contractor.

500.16 Structural Backfill. Backfilling of all structures shall be permitted only after an adequate curing time, as determined by the Engineer, has elapsed.

All excavations shall be backfilled to the lines and grades shown on the drawings. In no instance shall backfill be dumped, bull-dozed, or otherwise deposited in bulk upon the newly-constructed structure. After the required curing time, the excavation shall be backfilled by depositing, entirely without shock and with careful pneumatic tamping, suitable earth, sand, or other acceptable material in lifts not to exceed 6 inches in compacted thickness. Backfill shall be deposited at approximately the same elevation on opposite sides of the structure and shall be compacted in place to a density equal to or greater than ninety-five percent (95%) of maximum density as determined by the Standard AASHTO Method T-99-38. Inundated sand backfill shall not be used.

No trench backfill material containing rock, or debris from rock excavation, shall be placed in the upper 18 inches of the excavation except with the specific permission of the Engineer. Large stones may be placed in the remainder of the trench backfill only if well separated and so arranged that no interference with backfill compaction will result.

Any deficiency in the quantity of material for backfilling the excavation, or for filling depressions caused by settlement, shall be supplied by the Contractor. All excavated material in excess of that necessary to fill the trench to the grade shown on the drawings shall be removed and disposed of by the Contractor.

500.17. Final Grading. After other outside work has been finished, and backfilling and embankments completed and settled, all areas on the site of the work which are to be graded shall be brought to grade at the indicated elevation, slopes, and contours. Use of graders or other power equipment will be permitted for final grading and dressing of slopes, provided the result is uniform and equivalent to hand work. All surfaces shall be graded to secure effective drainage. Unless otherwise shown, a slope of at least one percent shall be provided.

Topsoil removed and stockpiled as part of site preparation work shall be used to surface and finish all fills and embankments which do not require gravel surfacing.

Grading and surfacing shall be completed to the satisfaction of the Engineer.

500.18. Tests. As stipulated in the quality control section, all tests required for preliminary review of materials shall be made by an acceptable independent testing laboratory at the expense of the Contractor. A gradation test shall be made for each type of embedment or backfill material and one additional gradation test shall be made for each additional 500 tons of each material. Contractor shall furnish test reports by a third party certified testing agency which is acceptable to the City. Tests shall be taken once for every 300 linear feet or fraction thereof for each lift. Costs of all tests and retesting shall be borne by the contractor.

500.19. Tunnel Excavation. Pipelines shall be constructed in tunnels of the type designated on the contract plans, in conformity with the following requirements: Before starting work on any tunnel, detailed drawings, specifications, and other data covering the lines to be used shall be submitted in accordance with the submittals section.

The minimum clear inside diameter of the tunnel liner shall not exceed the outside diameter of the carrier pipe joints or couplings by 4 inches unless specifically indicated on the drawings.

- a. Casing Pipe. New, smooth, wall, welded steel pipe fabricated from ASTM A36 plate or ASTM A 570 sheet with a minimum yield point of 36,000 psi conforming to AWWA C200. The casing pipe shall have a wall thickness as follows:

Wall Thickness

Casing Diameter inches	Under Highways inches	Under Railroads Inches
Under 14	0.188	0.250
14 to 16	0.188	0.281
18	0.250	0.312
20	0.250	0.344
22	0.250	0.375
24	0.281	0.406
26	0.281	0.438
28 to 30	0.312	0.469
32	0.312	0.500
34	0.312	0.531
36	0.344	0.531
38 to 42	0.344	0.563

- b. Coatings and Linings. The casing pipe shall be cleaned and coated both inside and outside with two (2) coats of coal tar paint, Kippers “Bitumastic Super Service Black”, Mobil “High-Build Bituminous Coating 35-J-10”, or Tnemec “46-449 Heavy Duty Black”.

- c. Joints. All joints in steel pipe casings shall be field welded to conform to API 1104 or AWWA C206.
- d. Casing Installation. The casing shall be installed by jacking into place . Earth displaced by the conduit shall be removed through the interior of the conduit by hand, by auger, or by other acceptable means. Sections of the casing pipe shall be welded together to form a continuous conduit capable of resisting all stresses, including jacking stresses. The casing pipe conduit in its final position shall be straight and true in alignment and grade, as required on the drawings. There shall be no space between the earth and the outside of the casing.
- e. Casing spacers. Type 1 or Type 2 casing spacers shall be used in bores where sanitary sewer pipe is 15 inches in diameter and smaller, length of bore is 250 linear feet or less.

Type 2 casing spacers shall be used in bores where the sanitary sewer pipe diameter is larger than 15 inches or longer than 250 linear feet.

1. Type 1 Casing Spacers. Casing spacers shall be non-metallic, molded in segments for field assembly without any special tools. The casing spacers shall have minimum compression strength of 3,000 psi and minimum impact strength of 1.5 ft-lbs/inch. The casing spacers shall have full length, integrally molded skids designed to provide a minimum of 0.75 inches of clearance between the carrier pipe's greatest outside diameter and the casing pipe's inside diameter. The skids shall be beveled with high abrasion resistance and a low friction coefficient. Metal, Type 304 (18-8) stainless steel bolts may be used to secure the segments together. Acceptable manufactures and models are: PSI Ranger II, Advance Products & System Model CI.
 2. Type 2 Casing Spacers. The casing spacers shall have a bolt on shell made in two (2) sections. All metal components shall be Type 304 (18-8) Stainless Steel. It shall have an elastomeric liner to isolate the shell from the carrier pipe. It shall have runners attached to the shell and be designed to provide a minimum of 0.75 inches clearance between the carrier pipe's greatest outside diameter and the casing pipe's inside diameter. The chock runners shall be beveled with high abrasion resistance and a low friction coefficient. Acceptable manufacturers and models are: PSI S8G-2 and PSI S12G-2, Power Seal #4810, Cascade CCS series and Advance Products & Systems Model SSI.
- f. End Seals. Both ends of each tunnel liner shall be closed seamless pull-on-type synthetic rubber end seals. The end seals shall be secured to the casing and carrier pipe with T-304 stainless steel banding straps with a 100% non-magnetic worm gear mechanism. The end seal installation shall not require any special tools. Acceptable manufacturers and models are: Advance Products & Systems Models AC & AM, PSI Models C & S.
 - g. Boring and Jacking Pipe. After dewatering as required, the casing pipe shall be installed by boring and simultaneously jacking the pipe in place. There shall be no

annular space between the outside of the casing pipe and the undisturbed earth. If necessary to reduce friction and ensure that the entire length of casing pipe can be jacked in place, bentonite slurry or a suitable chemical gel shall be pumped to the head of the bore to lubricate the exterior casing pipe walls.

500.20. 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 trafficway, 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.

500.21. Protection of Trench Backfill in Drainage Courses. Where trenches are constructed in ditches or other water courses, backfill shall be protected from surface erosion. Where the grade of the ditch exceeds one (1) percent, ditch checks shall be installed. Unless otherwise indicated on the drawings, ditch checks shall be concrete. Ditch checks shall extend not less than 2 feet below the original ditch or water course bottom for the full bottom width and at least 18 inches into the side slopes and shall be at least 12 inches thick.

500.22. Disposal of Excess Excavated Materials. Insofar as needed, suitable excess excavated materials shall be used in fills and embankments indicated on the drawings. Except as otherwise permitted, all excess excavated materials shall be disposed of away from the site of the work.

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.

Earth from excavations located in unimproved property shall be distributed directly over the pipe trench and within the pipeline right-of-way in such a way that the finish grade of the replaced topsoil will be 6 inches above the original ground surface elevation at and across the trench and sloping uniformly each way. Material thus distributed shall be carefully finished with a drag, blade machine, or other suitable tool to a smooth, uniform surface without obstructing drainage at any point. At previous natural drainage ways crossing the sewer alignment, the mounded finish grade shall be sloped to form a drainage swale suitable to allow runoff to drain and shall not cause ponding. Placement of excavated material in the above manner will not be permitted where the line of trench crosses or is within a 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 there for.

500.23. Settlement. The Contractor shall be responsible for all settlement of backfill, fills, and embankments which may occur within the correction period stipulated in the General Requirements Section 5.9.

The Contractor shall make, or cause to be made, all repairs or replacements, including reseeding or resodding as required, made necessary by settlement within 30 days after notice from Engineer or Owner.

500.24. Erosion Control. To prevent erosion of creek banks at points where the sewer crosses, the removal of trees and vegetation along the creek banks shall be minimized.

At each creek crossing, where indicated on the plans, a one-foot high and 4-foot wide berm shall be constructed adjacent and parallel to the top of each bank, so runoff will flow along the berm and be deflected to undisturbed vegetated areas before entering the creek.

At each creek crossing, where indicated on the plans, the restored creek bank shall be protected by 2 feet of riprap on top of 6 inches of filter blanket rock which shall be placed on top of a 4-foot thick ground water barrier. The riprap and filter blanket rock shall cover an area from the bottom of the channel to the top of the berm and extend 5 feet into undisturbed earth on each side. The ground water barrier shall cover an area from the bottom of the sewer trench to the top of the berm for the full trench width.

- a. Materials. The material for riprap shall consist of a predominantly one-sized, durable stone, shot rock or broken concrete. Acceptance by the engineer may be made by visual inspection. Riprap material shall be either Type 1, or 2, per below.

Type 1 Riprap shall consist of at least 40 percent of the mass being pieces having a volume of one cubic foot or more.

Type 2 Riprap shall consist of at least 60 percent of the mass being pieces having a volume of one cubic foot or more.

A geotextile material shall separate the subgrade from the riprap. Geotextile material shall be AASHTO M288-96 Class 2 with a minimum permittivity of 1.0 sec^{-1} and an apparent opening size of 0.22 mm MARV. Lap seams per manufacturers recommendations.

Riprap shall be placed to the approximate shape and thickness shown on the plans for the specified ditch or as directed by the Engineer. The rock shall be dumped on a subgrade of reasonably uniform density and left in a rough condition meeting the approval from the Engineer.

Grouted riprap shall not be allowed unless approved by the Engineer.

- a. Filter Blanket Rock. The material shall be durable and may be either crushed stone or gravel of a combination of both. The rock shall be reasonably well graded with a maximum size of 4 inches in diameter and an average size of one inch in diameter.

- b. Placement. The ground water barrier shall be placed and compacted in one-foot layers for the total thickness below the filter blanket rock. The geotextile is to be placed on top of grade. The filter blanket rock shall be carefully dumped in place so as to prevent damage to the filter blanket layer. The completed riprap shall form a uniform 2 foot thick layer with a tight surface. Each layer need not be compacted, but shall be graded in a manner to ensure that the larger fragments are uniformly distributed and that the smaller fragments serve to fill the voids between the larger fragments. Hand placement of fragments or compaction will be required only to the extent necessary to obtain the required results. A trench at the toe of the slope shall be excavated to the depth shown on the plans, or to a depth of 2 feet if not otherwise shown on the plans.

All costs in connection with erosion control, including ground water barrier, filter blanket, and riprap shall be included in the cost of sewer pipe in place.

- c. Ground Water Barrier. Ground water barriers shall impede passage of water through the pipe embedment material. Barrier material shall meet soil classification GC, SC, CL, or ML-CL, and shall be compacted to 95% of maximum density. Material may be finely divided suitable job excavated material, free from stones, organic matter and debris. Ground water barriers shall be compacted soil the full depth of granular material plus 1 foot above the granular material, the full trench width, at least 4 feet long with a minimum depth of 4 feet.
- d. Stream Crossing Cleanup. Cleanup of stream crossings shall begin immediately after sewer construction and backfilling can be completed. Exposed disturbed areas in stream crossings shall not remain unprotected for more than seven (7) days.

500.25. Cleanup Work. The Contractor shall provide sufficient labor forces and equipment to maintain cleanup operations closely behind pipe laying operations. Every advantage shall be taken of periods of good weather for general cleanup, grading, topsoiling, seeding, sodding, etc. Items of work such as manhole construction, road cuts, pavement replacement, and all other restoration work shall not be allowed to lag behind the pipe installation. Special attention shall be given to maintaining road crossings. Streets to be opened to local traffic at the end of the day's operation shall be cleaned of dirt and mud. Streets which are not open to traffic shall be cleaned regularly to be kept free of dirt and mud. Street sweeping equipment shall capture and contain dust and debris. Powered broom attachments shall be of the pick-up type. All equipment and material stockpiles shall be secured for safe passage of vehicles and pedestrians. Traffic control in conformance with the Manual of Uniform Traffic Control Devices shall be in place prior to opening the road to traffic.

All temporary pavement patches must be kept flush with adjacent paved surfaces between asphalt paving seasons. Ruts and other depressions caused by settling, vehicular traffic, etc., shall be continuously filled and graded for maintenance of a smooth traveled surface and minimum inconvenience to the public. All material stockpiles shall be secured for safe passage of vehicles and pedestrians. If, in the opinion of the Engineer, cleanup and miscellaneous items of work and

construction are allowed to lag, the Contractor will be required to stop pipe installation until such work is caught up.

A percentage of the unit and lump sum prices will be withheld from payments for pipe installation, manhole construction, etc., in areas where cleanup and restoration have not been completed. This percentage will be in excess of the specified 10% retained for completed work.

SECTION 505

SANITARY SEWER PIPE

505.1. Description. This section covers sanitary sewer pipe and fittings to be furnished complete with all jointing materials and appurtenances.

Pipe shall be installed and tested in accordance with Section 515 - Sewer Pipe Installation and Testing.

505.2. Materials for Public Sewer Lines. Pipe and fittings, jointing materials, and appurtenant materials shall be shown on the drawings and as specified herein.

- a. PVC PIPE - PVC pipe and fittings shall be permitted for sewers up to 27 inches in diameter. The use of PVC pipe for sewers larger than 27 inches in diameter will be considered on a case by case basis. PVC pipe shall meet either the sewer pipe specifications or the pressure pipe specifications listed below depending upon the depth of sewer installed.
 1. Gravity Sewers Up to 15 Feet Deep. At a minimum the gravity sewer pipe shall be SDR 35 PVC. Pipe up to 15 inches in diameter shall conform to ASTM D-3034. Pipe with a diameter 18 inches or larger shall conform to ASTM F-679. The use of pipe conforming to ASTM F-794 and ASTM F-1803 will be considered on a case by case basis for pipe sizes 12 inches to 27 inches in diameter. Joints shall comply with the specifications below. Pipe embedment and backfill shall be in accordance with the Pipe Embedment Standard Detail 9A and 9B.
 2. Gravity Sewers Between 15 Feet but Less Than 30 Feet Deep. At a minimum the gravity sewer pipe shall be SDR 26 heavy wall gravity sewer pipe. Pipe up to 15 inches shall conform to ASTM D-3034 (latest revision). Pipe with a diameter 18 inches or larger shall have a minimum stiffness of 115 psi and conform to ASTM F-679 (latest revision)

PVC pressure rated pipe shall be permitted as follows. PVC pipe shall meet AWWA C-900, or AWWA C-909, or AWWA C-905, or ASTM D-2241 SDR-26.

Joints shall comply with the specifications below. Pipe embedment and backfill shall be in accordance with the Pipe Embedment Standard Detail 9A and 9B.

3. For Gravity Sewers Installed Deeper Than 30 Feet Deep. Gravity sewers installed deeper than 30 feet deep shall only be approved on a case by case basis.

Jointing Materials

Ordinary joints	ASTM D3212, integral bell punch-on type elastomeric gasket joints
Field cut joints and connections to other piping materials	Can-Tex "C-T Adapters"; Dickey "Plastic Pipe Adapters"; "Flexible Couplings"; Mission "Eastern Standard Band-Seal Couplings" with stainless steel shear rings; Nashua Pre-Cast Corporation "Flex-O-Joint," "Mega Lug"; or equal Fernco "PVC Donuts" by approval of Engineer only.

- b. Ductile iron pipe (DIP). DIP shall be used for sanitary sewer in areas where the minimum 30 inches of cover over the top of pipe cannot be met, under creek crossings, deep gravity sewer applications, or as specified on the Contract plans. Pipe embedment and backfill shall be in accordance with the Pipe Embedment Standard Detail 9A and 9B.

<u>Pipe</u>	Ductile iron, ANSI A21.51; ASTM A536, Grade 60-42-10; thickness, class 52
-------------	---

Fittings

Material	Gray iron, ANSI A21.10. 250 psi pressure rating, except shorter laying lengths will be acceptable or ductile iron, ASTM A536, Grade 80-60-03 or 70-50-05, ANSI A21.10, 350 psi pressure rating All gasketed fittings 4" through 15" must be injection-molded and comply with the ASTM D3034 and F1336 standards and must be certified by a third party testing agency to an industry standard.
----------	---

<u>Push-on Joints</u>	ANSI A21.11, except gaskets shall be neoprene or other synthetic rubber. Natural rubber will not be acceptable
-----------------------	--

<u>Flanged Joints</u>	ANSI A21.15
-----------------------	-------------

Flanges	ANSI B16.1, 125 lb or U.S. Pipe "Flange-Tyte"
Bolts	ASTM A 307, chamfered or rounded ends projecting 1/4 to 1/2 inch beyond outer face of nut
Nuts	ASTM A307, Hexagonal, ANSI B18.2, heavy semi finished pattern
Gaskets	ASTM D1330, Grade I rubber, ring type, 1/8-inch thick; or U.S. Pipe "Flange-Tyte", 1/8-inch thick

<u>Mechanical Joints</u>	ANSI A21.11
--------------------------	-------------

Mechanical joint with waterstop and tapped holes, single

Wall Castings casting or fabricated cast iron Midwest Pipe Fabricators "Adjustable Wall Pipe." All holes shall be plugged with plastic plugs.

Plastic Plugs Protective Closures "Caplug Series WW"

Mechanical Joints with Tie Rods

Tie Rods	ASTM A307
Steel Pipe	ASTM A210, standard weight
Washers	ANSI B27.2, plain steel

Mechanical Couplings

Couplings	Dresser Style 38 or Rockwell/Smith-Blair 441 or 411 Flexible Coupling; without pipe stop
Gaskets	Oil-resistant synthetic rubber

Shop Coating and Lining

Cement Lining	ANSI A21.4
Bituminous Coating	Manufacturer's standard
Rust-Preventative Compound	Houghton "Rust Veto 344" or Rush-Oleum "R9"

Field Coating Heavy coal tar paint, MIL-C-18480; Koppers "Bitumastic No. 50", or Mobil "35-J-10 Hi-Build Bituminous Coating"

c. Reinforced Concrete Pipe (RCP). RCP shall be permitted for gravity sewers with a diameter of 30 inches and larger. RCP shall conform to ASTM C76 (latest revision) Class III, Wall B. Pipe embedment and backfill shall be in accordance with the Pipe Embedment Standard Detail 9A and 9B.

1. Joints ASTM C361, Bell and Spigot compressive type with resilient seals embedded in both ends and joined with O Ring rubber gaskets.
2. All rubber and rings shall be extruded or molded and cured in such a manner that any cross section will be dense, homogeneous, and free of porosity, blisters, pitting and other imperfections. The basic polymer shall be EPDM hydrocarbon. The compound shall conform to the following requirements:
The rubber EPDM material shall meet ASTM C-443 with the exception of the 40-60 duro hardness.
For resilient interlocked end seals the hardness duro A shall be 40 to 70 ± 5.

3. Each concrete pipe section shall be tested at the site with low pressure air or equivalent vacuum test. The test shall be conducted in a manner using a cap, plug and gasket of the type and size to be used in the field to include the tongue and bell sealing surface. End to end testing using foam plates is not acceptable. Pipe passing the test shall be clearly marked "Air Tested."

505.3. Materials for Private Service Laterals. Pipe and fittings, jointing materials, and appurtenant materials shall be shown on the drawings and as specified herein. Private service laterals shall be a minimum of 4 inches in diameter.

- a. Pipe and fittings for private service laterals that connect to the public sewer main at a depth of 15 feet or less shall at a minimum be SDR 35 solid wall PVC sewer pipe and shall conform to ASTM D-3034.
- b. Pipe and fittings for private service laterals that connect to the public sewer main at a depth deeper than 15 feet but less than 20 feet shall at a minimum be SDR 26 heavy wall PVC gravity sewer pipe and conform to ASTM D-3034.
- c. Private service laterals shall not be connected to public sewers deeper than 20 feet.
- d. Service connections shall not be within five (5) feet of a manhole or lamphole (cleanout) or directly into a lamphole (cleanout).
- e. Individual service connections shall be separated horizontally by a minimum of two (2) feet.
- f. Service connections shall not be connected to a manhole. Food service establishments may connect directly to a manhole with written permission from the City of Columbia; however, these will be approved on a case by case basis.
- g. PVC hub to conform to ASTM Specification D-3034 (latest revision). Rubber sleeve and gasket shall conform to ASTM Specification F477 (latest revision).

505.3. Manhole Connections. The Contractor shall use precast manhole base sections with integral circular flexible gasket as specified in the sewer manholes section of these specifications, plain end pipe shall be installed through the gasket in accordance with the manufacturer's instructions.

When a new sewer line is being connected to an existing manhole the invert is to be modified by acceptable methods of adding or removing concrete to ensure an acceptable amount of fall (0.2'-1.5') through the manhole.

505.4. Drawings and Data. Drawings and data shall be submitted in accordance with the submittals section. Drawings and data shall include but not limited to the following:

Details of joints

Gasket material
Pipe length
Certification

505.5. Affidavit of Compliance. An affidavit shall be submitted to the Engineer certifying that pipe, fittings, and jointing materials are in compliance with the governing standards and specifications.

SECTION 510

SEWER MANHOLES

510.1. Description. This section covers standard and drop manholes. Manholes shall be constructed complete with covers, steps, vents, fittings, and other appurtenances, in accordance with the details and these specifications.

All doghouse manholes, inside drop manholes or any other material or construction practice that is not covered on the construction plans or these specifications shall request a variance in writing to the Sanitary Sewer Engineer of the City of Columbia. Such changes, as are authorized under this provision, shall be made without additional cost to the City of Columbia. The City of Columbia reserves the right to receive an equitable adjustment in contract price or contract time as a consideration for authorizing such change.

All standard and drop manholes shall be constructed of precast concrete sections. Only concentric precast concrete cones will be acceptable. When flat top manholes are used, the frame casting shall be cast into the center of the manhole top.

Only manholes which are required to have outside pipe and fittings for dropping wastewater into the lower line will be designated as drop manholes.

510.2. Materials.

<u>Concrete</u>	Materials, handling, forms, finishing, curing, and other work as specified in concrete section, except that only calcareous materials shall be used. Granitic materials shall not be used.
<u>Precast Section</u>	Circular precast concrete; ASTM C478, except as modified
Minimum Barrel Diameter	48" for pipe diameters less than 24" 60" for pipe diameters of 24" to 36"
Minimum Wall Thickness	5" minimum
Reinforcement	As indicated on the Standards
<u>Portland Cement</u>	ASTM C150
<u>Hydrated Lime</u>	ASTM C207, Type S
<u>Sand</u>	Concrete sand (fine aggregate) sieved through 8 mesh screen
<u>Shrinkage-Correcting Aggregate</u>	Master Builders "Embeco", Sika "Kemox", Sonneborn "Ferrolith G-DS", or equal One part Portland cement, 1/2 part hydrated lime, 3

<u>Mortar</u>	parts sand
<u>Non-shrinking Mortar</u>	Premixed or job mixed; job mixed shall be one part shrinkage-correcting aggregate, one part Portland cement, one part sand
<u>Gaskets</u>	
Mastic	Fed Spec SS-S-210; K.T. Snyder "Ram-Nek", Hamilton-Kent "Kent-Seal No. 2" Bidco "C-56", Conseal "CS-102" or equal
Rubber	Neoprene or other synthetic, 40 (plus or minus 5) hardness when measured by ASTM D2240, Type A durometer
<u>Coal Tar Paint</u>	Koppers "Bitumastic Super-Service Black", Polyguard "CA-14 Coating", Tnemec "46-449 Heavy Duty Black", or equal
<u>Castings</u>	Manhole and cleanout castings shall conform to ASTM A48, class 35 B. Manhole and cleanout casting dimensions shall conform to the Standard Details. Manhole lid shall have a minimum weight of 135 lbs. Manhole lid plus manhole frame shall have a total minimum weight of 350 lbs. Cleanout lid plus cleanout frame shall have a total minimum weight of 90 lbs.
<u>Sealing System</u>	Infi-Shield Uni Band or approved equal
<u>Joint Sealant</u>	Infi-Shield Seal Wrap or approved equal. Seal wrap to be made of high quality EPDM rubber. EPDM shall meet ASTM D2240, D412, D395, and D634
<u>Steps</u>	Neenah R-1980-J, Clay & Baily 2102 or approved equal

510.3. Precast Concrete Sections. Precast sections shall conform in all respects to applicable requirements of Details of Standard Manholes as indicated in the standard details and shall contain reinforcing steel as required to prevent cracking during handling.

- a. Delivery. Precast concrete sections shall not be delivered to the job until representative concrete cylinders have attained strength of at least 80% of the specified minimum.

- b. Handling. Precast concrete sections shall be handled carefully and shall not be bumped or dropped. Hooks shall not be permitted to come in contact with joint surfaces. Use of lifting holes will not be permitted. Lift notches that are not deeper than one half of the wall thickness will be allowed. Lifting notches shall be repaired by cementing a properly shaped concrete plug in place with epoxy cement, or by other methods acceptable to the Engineer.
- c. Inspection. Precast concrete sections shall be inspected when delivered and all cracked or otherwise visibly defective units rejected.

510.4. Precast Concrete Base. The requirements of precast concrete sections shall apply to precast concrete bases. Precast bases shall be furnished with "A-Lok" continuous flexible gaskets for connecting piping. Part of the concrete invert fill may be furnished with the precast unit; however, a rough surface must be provided to improve bond with the final invert fill. At least the top 2 inches of the concrete invert fill must be installed in the field and shall conform exactly to the invert elevations of the connecting piping after installations. Surface shall be free of all dust, deleterious matter, and moisture prior to placing fill.

The connecting pipe shall be plain end, bevel cut spigots and shall not protrude more than 1 inch inside the manhole wall. A clear distance of at least 1 inch from the end of each connecting pipe and around the pipe shall be provided when the concrete invert fill is installed. This shall be provided under the pipe by a boxout with sides which are at right angles with each other. After completion of the manhole, the boxout shall be filled with suitable asphalt or mastic Dow Great Stuff or approved equal, completely filling the space beneath the pipe and extending to at least the springline. The asphalt or mastic fill material shall provide a smooth, uniform surface between the inside diameter of the pipe and the manhole invert. The void space shall be filled with closed cell urethane foam such as Dow Great Stuff or approved equal. After the spray foam has been applied it shall be trimmed to make a flush edge with the inside of the manhole as shown on the Manhole Gasket Standard Detail 7.

As shown on the plan or in extenuating circumstance where it is not possible to use "A-Lok" or approved equal continuous flexible gaskets and with the approval of the Engineer, precast bases may be furnished with suitable horseshoe shaped or circular boxouts with roughened or grooved surface to improve mortar bond for connecting piping, the space between connecting pipes and the wall or precast sections shall be completely filled with non-shrinking mortar.

When precast manhole sections with horseshoe shaped boxouts are used, the following items shall apply:

- a. For PVC. Pipe water stops as recommended or supplied by the pipe manufacturer shall be installed at the center of the manhole walls and grouted in place as specified in Section 510 - Sewer Manholes.
- b. For VCP and DIP. Pipe shall be flush at manhole walls and grouted in place as specified in Section 510 - Sewer Manholes.

510.5 Cast-in-Place Concrete Bases. Cast-in-place concrete manhole bases shall be allowed when it is required to construct a new manhole over an existing sanitary sewer line as

shown on the Doghouse Manhole Standard Detail. When a cast-in-place concrete base is utilized the remainder of the manhole shall consist of precast manhole sections. When precast manhole sections with horseshoe shaped boxouts are used, 510.4 a. and 510.4 b. shall apply. The cast-in-place concrete base shall be constructed in accordance with the Doghouse Manhole Standard Detail.

510.6. Construction. All mortar shall be used within 40 minutes after mixing. Mortar which has begun to take initial set shall be discarded and shall not be mixed with additional cement or new mortar.

In no case shall the invert section through a manhole be greater than that of the outgoing pipe. The shape of the invert shall conform exactly to the lower half of the pipe it connects. Side branches shall be connected with as large radius of curve as practicable. All inverts shall be troweled to a smooth clean surface.

Circular precast sections shall be provided with a rubber or mastic gasket to seal joints between sections. Where mastic gaskets are furnished, the written installation recommendations of the manufacturer shall be available at the site of the work, and shall be strictly followed. For manhole risers, mastic gaskets with a nominal cross section as shown in the following table shall be furnished unless a different cross section is recommended in writing by the manufacturer.

<u>Minimum Manholes Diameter</u> (inches)	<u>Nominal Cross Section</u> (inches)
48	1 x 3
60	1 x 3
72	1 x 3-1/2

510.7. Damproofing. The outside surfaces of each manhole shall be painted with one heavy coat of coal tar paint. Surfaces to receive paint shall be dry. Damproofing may be applied to precast units in the shop. If the shop coating is damaged during construction, a touch-up coat of paint as required shall be applied and allowed to dry prior to backfilling.

Where manholes are required to extend above finish grade, damproofing shall be terminated 6 inches below the finish grade line. All exposed surfaces of manholes above grades shall be plain concrete.

510.8. Shallow Manholes. Shallow manholes shall conform in all respects to the applicable requirements of Standard Shallow Manhole Standard Detail.

510.9. Drawings and Data. Drawings and data covering precast concrete sections or cast-in-place concrete manholes shall be submitted in accordance with the submittals section.

510.10 Manhole Seals. Each manhole joint shall be sealed with a 6 inch wide external rubber sleeve similar to the Infi-Shield Seal GatorWrap as manufactured by Sealing Systems, Inc, or approved equal. The seal shall be made of a Stretchable, Self-Shrinking, Intra-Curing Halogenated Based Rubber with a minimum thickness of 30 mils. The entire back side of each seal wrap shall be coated with mastic. The mastic shall be non-hardening butyl rubber sealant, with a

minimum thickness of 30 mils. The seal shall be designed to stretch around the substrate then overlapped creating a cross link and fused bond between the rubber and butyl adhesive. The application shall form a continuous rubber seal that applies inward pressure on the protected area for the life of application. The butyl adhesive and the inward pressure exerted on the substrate shall prevent the intrusion of water and soil through the joint sections of the manhole. This seal shall be provided in addition to the joint sealing requirements outlined in the Standard Specifications.

510.11 Manhole Rings and Covers. The rings and covers of all manholes shall be set at the elevation shown on the drawings and solidly built into place. Concrete rings shall be grouted with cement mortar.

Plastic adjusting rings shall be injection molded recycled HDPE as manufactured by LADTECH, Inc. or approved equal and installed as per manufacturer's recommendations

The manhole adjusting rings shall be molded from high density polyethylene as defined in ASTM Specification D-4976. The annular space between the rings and cone basin, the rings, and cover frame shall be sealed utilizing an approved butyl sealant. The contractor shall utilize flat and sloping units to match the required slope and or grade of the structure

The manhole lids shall clearly have cast into "Sanitary" on the top of the manhole lid. Manhole lids are to be water tight. Manhole covers are to be bolt down type in all floodplains.

SECTION 515

SEWER PIPE INSTALLATION AND TESTING

515.1. Description. This section covers installation and testing of all sewer pipe. Except where modified by specific requirement in this section, the written installation recommendations of the sewer pipe manufacturer shall be strictly followed. Sewer pipe materials are specified in other sections.

515.2. Handling. Pipe fittings and appurtenance shall be transported, stored, and handled in a manner which prevents damage. Hooks shall not be permitted to contact joint surfaces. Plastic pipe shall be shaded if necessary to prevent curvature due to thermal expansion. Damaged pipe shall be removed from the site.

515.3. Cleaning. The interior of all pipe and fittings shall be thoroughly cleaned before installation and shall be kept clean until the work has been accepted. All joint surfaces shall be kept clean until the joint is completed.

Every precaution shall be taken to prevent foreign material from entering the pipe during installation. No debris, tools, clothing, or other materials shall be placed in the pipe.

Whenever pipe laying is stopped, the open end of the pipe shall be closed with a manufacturers cap drilled with holes closely fitting the end of the pipe to keep sand and earth out of the pipe. The cap shall have several small holes near the center to permit water to enter the pipe and prevent flotation in the event of flooding of the trench.

No connection shall be made to the downstream system until the new system has been completed or the Engineer has approved the connection. If the connection is made the low end shall be plugged properly using a manufacturers cap drilled with holes.

515.4. Alignment. Piping shall be laid to the lines and grades indicated on the drawings.

Laser beam equipment or surveying instruments shall be utilized to determine and maintain proper pipe line and grade. Establish required uniform line and grade in trench from benchmarks identified by the Engineer. Maintain this control for a minimum of 100 feet behind and ahead of pipe-laying operation.

515.5. Laying Pipe. Lateral displacement of the pipe shall be prevented during embedment operations. Pipe shall not be laid in water, or under unsuitable weather or trench conditions.

Pipe laying shall begin at the lowest elevation with all ends facing the direction of laying except when reverse laying is permitted by the Engineer.

Core holes in concrete pipe shall be repaired by cementing a properly shaped concrete plug in place with epoxy cement or by other methods acceptable to the Engineer.

Vertical clearance between sewer and water mains shall be a minimum of 2 feet.

515.6. Jointing. All joint preparation and jointing operations shall comply with the instructions and recommendations of the pipe manufacturer. Immediately before joints are pushed together, all joint surfaces shall be coated with the lubricant furnished with the pipe. The position and condition of each rubber gasket (unbonded gaskets) shall be checked with a feeler after the joint is completed.

515.7. Concrete Encasement. Concrete encasement shall be installed where and as shown on the drawings. Concrete and reinforcing steel shall be as specified in the Section 250 – Concrete Structures. All pipe which is to be encased shall be suitably supported and blocked in proper position and shall be anchored against flotation.

515.8. Acceptance Tests. Each manhole and reach of sewer shall meet the requirements of the following acceptance tests. All defects shall be repaired to the satisfaction of the Engineer. Contractor shall furnish, at no additional cost to the owner, all necessary equipment and appurtenances to perform the acceptance tests.

- a. Lamping. Unless otherwise indicated on the drawings or directed by the Engineer, each section of sewer line between manholes shall be straight and uniformly graded. The Engineer may lamp any or all sections of sewer line at his discretion. The Contractor shall furnish suitable equipment and assistants to help the Engineer.
- b. Air Testing. An air test shall be conducted on each reach of sewer pipe between manholes or structures. For each type of pipe to be installed in the work, the first line between manholes or structures shall be tested before backfilling and before any sewer pipe is installed in the remainder of the work. Thereafter, air testing shall be done after backfilling and individual or multiple reaches may be tested at the option of the Contractor. Air testing shall be used for all types of pipe except large diameter pipes where air testing is not practical. Air testing shall comply with ASTM C828.

Leakage shall not exceed 0.003 cfm per square foot of internal pipe wall at an average pressure of 3 psi. The time elapsed for a one psi drop in air pressure shall not be less than:

$$t = 0.472d; \quad \text{where: } t = \text{time in minutes} \\ d = \text{pipe in diameter in inches}$$

Leaks shall be located by air testing short sections of pipe. Leaks shall be repaired and the reach of sewer retested.

- c. Exfiltration. Exfiltration tests are not an acceptable acceptance test for manholes. An exfiltration test may be used in lieu of air testing for large diameter sewer pipe where air testing is not practical. Exfiltration tests shall be conducted by blocking off all manhole or structure openings, except those connecting with the reach being tested, fill the line, and measuring the water required to maintain a constant level in the manholes or structures.

During the exfiltration test, the average water level in the manholes or structures shall be at least at the elevation of the ground surface. The maximum depth at the lower end shall not exceed 25 feet, and the minimum depth at the upper end shall be at least 5 feet above the crown of the pipe or 5 feet above the ground water elevation, whichever is higher.

The total exfiltration shall not exceed 200 gallons per inch of nominal diameter per mile of pipe per day for each reach tested. For purposes of determining maximum allowable leakage, manholes shall be considered sections of 48 inch pipe. The exfiltration tests shall be maintained on each reach for at least 2 hours and as much longer as necessary, in the opinion of the Engineer, to locate all leaks.

The Contractor shall provide, at his own expense, all necessary piping between the reach to be tested and the source of water supply, together with equipment and materials required for the tests. The methods used and the time of conducting exfiltration tests shall be acceptable to the Engineer.

- d. Infiltration. If at any time prior to expiration of the correction period stipulated in the General Conditions infiltration exceeds 200 gallons per inch of nominal diameter per mile of sewer per day, the Contractor shall locate the leaks and make repairs as necessary to control the infiltration.
- e. Deflection. Not less than 30 days after backfilling is complete, and prior to acceptance of the work, all flexible pipe shall be tested, by the use of a mandrel or other approved device, to insure that no pipe deflection has occurred greater than five (5) percent of the inside diameter of the pipe. These tests shall be performed without mechanical pulling devices and without additional cost to the Owner. Pipe with a deflection exceeding five (5) percent of the inside diameter shall be uncovered, and the bedding and backfill replaced to prevent excessive deflection. Repaired pipe shall be retested. Ductile iron pipe will not require a deflection test unless otherwise noted on the plans or specifications.
- f. Vacuum Test. A vacuum test shall be performed on each manhole to assure watertightness in accordance with the following procedures:
 - 1. Each manhole shall pass two (2) tests; the first test shall be after assembly but prior to backfilling and the second test shall be after backfilling.
 - 2. The vacuum test shall include testing of the seal between the cast iron frame and the concrete cone, slab or grad rings.
 - 3. Plug all pipes entering the manhole at least 8 inches into the sewer pipe. The plug must be inflated at a location past the manhole/pipe gasket.
 - 4. Brace all plugs to prevent the plug or pipe from being dislodged and drawn into the manhole.

5. A vacuum of at least 10-1/2 inches of mercury shall be drawn on the manhole. Shut valve on vacuum line to manhole and disconnect vacuum line. Open the vacuum line valve and adjust vacuum to 10 inches of mercury.
6. The pressure gage shall be liquid filled having a 3.5-inch diameter face with a reading from 0 to 30 inches of mercury. The test equipment shall be capable of having 2 gages connected. The gage supplied with the test equipment shall match the reading of a gage furnished by the Public Works Department. The gage reading is to be verified on each project.
7. The time elapsed for the vacuum reading to drop from 10 inches of mercury to 9 inches of mercury must not be less than the following times for the manhole to be considered as passing the vacuum test:

<u>Manhole Depth</u>	<u>Time (minutes)</u>
10 feet or less	2
10.1 to 15 feet	2.5
15.1 to 25 feet	3

8. If a manhole fails the vacuum test the manhole shall be uncovered and patched on the exterior of the manhole; retested prior to backfilling when the leak has been patched and then retested after backfill is completed.

g. Video Inspection. All sanitary sewers including pipes, manholes, cleanouts, service connections, service laterals, etc. shall be inspected using a video camera. Immediately prior to video inspection all sewers must be flushed with clean water. The contractor shall provide and run a video camera to check for the presence of sags or other evidence of improper construction. The video shall show the restoration of all surface areas disturbed during construction as well as document that the tops of all manholes and cleanouts are properly adjusted to grade.

1. Furnish one copy of the video to Public Works department. Video shall comply with the following requirements:
 - a. Full color (Not black and white)
 - b. Date and time of inspection
 - c. Manhole labels
 - d. Real time stationing of camera in pipe
 - e. Inspection of all joints, fittings, and lateral connections
 - f. Locations of observed deficiencies (i.e. bad joints, breaks, leaks, infiltration, etc.)
 - g. Pipe ponding in excess of 3/4" identified by location
 - h. Minimum resolution of 800x600 pixels
 - i. Single sided DVD or CD utilizing MPEG compression
 - j. DVD/CD and box shall be labeled with manhole numbers, project title, and date

2. The City of Columbia reserves the right to reject sewer lines based upon the

video inspection, and complete own video inspection.

3. Faulty sections of sewer lines or manholes rejected by the City shall be repaired or replaced at the Contractors expense to produce a like new product in a manner acceptable to the Engineer.
4. The Contractor shall provide the City a video inspection to document the repair or replacement of any rejected work.
5. Camera Speed shall not be greater than 30 feet per minute.

515.9 Payment. There will be no direct payment for testing and inspections. The cost and expense of such work to the Contractor must be included in the price of the bid for sanitary sewers and concrete structures.

- a. The City of Columbia may complete a video inspection at no cost to the Contractor for the first video inspection.
- b. All subsequent inspections completed by the City of Columbia will have a fee associated with it.

SECTION 530

GROUTING

530.1. Description. This section covers grouting miscellaneous base plates and other uses of grout as indicated on the drawings. Unless otherwise specified, all grouting shall be done with non-shrinking grout.

530.2. Materials.

Non-shrinking Grout: Master Builders "Masterflow LL-713 Grout", Sauereisen Cements "F-100 Level Fill Grout", U.S. Grout "Five Star Grout", or USM "Upcon", or equal.

Water: Clean and free from deleterious substances.

530.3. Non-shrinking Grout. Non-shrinking grout shall be furnished factory premixed so only water is added at the job site. Grout shall be mixed in a mechanical mixer. No more water shall be used than is necessary to produce a flowable grout.

- a. Preparation. The concrete foundation to receive non-shrinking grout shall be saturated with water for 24 hours prior to grouting.
- b. Placement. Grout shall be placed in strict accordance with the direction of the manufacturer so all spaces and cavities are completely filled without voids.
- c. Edge Finishing. The grout shall be finished smooth in all locations where the edge of the grout will be exposed to view after reaching its initial set.
- d. Curing. Non-shrinking grout shall be protected against rapid loss of moisture by covering with wet rags or polyethylene sheets. After edge finishing is completed, the grout shall be wet cured for at least seven (7) days.

Holes shall be prepared for grouting as recommended by the grout manufacturer.

