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Sewer System – Standards and Extensions

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SECTION A – PREFACE *(A-1 to A-2)*

A-1. The Design and Construction Standards presented in Sections B and C are the minimum standards to be followed by the Loudoun County Sanitation Authority, hereinafter referred to as the "Authority", in the design and construction of the local component sewer systems of the integrated sewer system for Loudoun County. They are not intended to be used as a substitute for actual construction specifications and design computations.

A-2. The Rules and Regulations Governing Extensions within Specified Areas presented in Section D prescribe the procedure to be followed by developers desiring sewerage service for certain specified areas or tracts that can be served by the Authority.

SECTION B - GENERAL DESIGN STANDARD *(B-1 to B-12)*

B-1. Tributary Population:

- (a) Sewer systems, including pumping facilities, shall be based on the Authority's current Sewer Utility Master Plan taking the following into consideration:
 - (1) The general design factors noted in the Commonwealth of Virginia Sewage Collection and Treatment regulations and the estimated tributary population for a period of fifty years hence, and
 - (2) The entire watershed shall be assumed to be built-out according to current residential, commercial, or industrial uses, or allowable land use.
 - (3) The current Sewer Utility Master Plan shall be defined as the approved Authority Sewer Utility Master Plan, as currently revised based on appended Area Facility Plans and Technical Memoranda.
 - (4) Allowable land use shall be defined as uses consistent with the Loudoun County Revised Comprehensive Plan and comprised of permissible residential densities and Commercial and Industrial development. Future Commercial and Industrial development shall be based on an equivalent population of 30 and 40 people per acre; respectively.
- (b) Sewer systems shall be designed in accordance with the current Sewer Utility Master Plan.
 - (1) Sewer systems shall be sized to provide for the entire watershed in accordance with the current Sewer Utility Master Plan.
 - (2) Trunk sewers within the Suburban Area of the County Revised General Plan shall be designed on a basis of population density of not less than ten (10) persons per acre. Design provisions in excess of this minimum shall be made where the engineer and Authority deems it necessary based on land use trends and patterns.
 - (3) Collectors and trunk sewers within the Transition Policy Area shall be designed on the Allowable land use.
 - (4) Supporting data shall be included in the Design Analysis, prepared on the form shown in Figure IV, attached hereto, entitled "Design of Sanitary Sewers". Design Analysis shall be provided for all trunk and sub-trunk sewers and when required by the Authority for collecting sewers.

B-2. Capacities:

- (a) In determining the required capacities of sanitary sewers, the following factors shall be considered:
 - (1) Maximum hourly quantity of domestic sewage.
 - (2) Additional maximum sewage or waste from industrial plants and commercial areas.
 - (3) Ground water infiltration.
- (b) New sewer systems shall be designed on the basis of an average per capita flow of sewage from the equivalent population served of not less than 100 gallons per day. On this basis, lateral and collector sewers shall be designed with capacities, when running full, in accordance with the peak flows indicated in Figure I, entitled "Design Flow for Sewers", attached hereto.
- (c) The 100 gallons per capita per day figure is assumed to cover normal infiltration.
- (d) Evidence may be presented to the Authority to justify higher flows from commercial or industrial areas at ultimate development.
- (e) In cases where the above criteria are not applicable, an alternate design procedure may be submitted to the Authority for approval. A description of the procedure used and justification for the modifications shall be included with the Design Analyses and plans submitted for approval.

B-3. Sewer Locations and Depth:

- (a) In general, sewers will be located on legally established streets or rights-of-way and shall be equidistant from property lines or curb lines wherever possible. The horizontal distance between sewers and existing or projected water mains shall be not less than ten (10) feet, except where the water mains are located at a higher elevation (1.5 feet above top of sewer minimum) than the top of the sewer, in which case, a minimum horizontal distance of six (6) feet will be permissible.
- (b) Sewers shall generally be installed with a minimum cover of six (6) feet below the finished street surface or ground. In isolated instances where only a few houses are served and where the required six (6) feet or greater depth would excessively increase construction costs, shallower depths at the upper end may be permitted. Sewers at shallow depths shall be protected against possible damage by superimposed loads or effects of traffic.
- (c) Where approved by the Authority, sewers with less than three (3) feet of cover shall be encased in concrete or be ductile iron pipe.

- (d) Sewers located in relation to streams, lakes and reservoirs shall meet the following requirements:
- (1) The tops of all sewers entering or crossing streams shall be at a sufficient depth below the natural bottom of the streambed to protect the sewer line. In general, one (1) foot of suitable cover shall be provided where the stream is located in rock and three (3) feet of suitable cover in other material. Less cover will be considered if the proposed sewer crossing is encased in concrete and will not interfere with future improvements to stream channel. Reasons for requesting less cover shall be given in the application. In paved channels, the top of the sewer lines should be placed below the bottom of the channel pavement.
 - (2) Sewers and their appurtenances located along streams shall be protected against the 100-year flood. Sewers located along streams shall be located outside of the streambed wherever possible and sufficiently removed therefrom to provide for future possible channel widening. Reasons for requesting sewer lines to be located within streambeds shall be given in the application.
 - (3) Sewers crossing streams shall be ductile iron from manhole to manhole. The pipe and joints shall be tested in place, shall exhibit zero infiltration, and shall be designed, constructed and protected against anticipated hydraulic and physical, longitudinal, vertical and horizontal loads and erosion and impact.
 - (4) Sewers laid on piers across ravines or streams shall be allowed only when it can be demonstrated that no practical alternative exists. Such sewers on piers shall be constructed in accordance with the requirements for sewers entering or crossing under streams. Construction methods and materials of construction shall be such that sewers will remain watertight and free from change in alignment or grade.

B-4. Manholes:

- (a) Manholes for access to sewers shall be provided at all intersections with other sewers, at all points of change in alignment, at all changes in grade and at the terminal of the line. In addition, access manholes shall be provided at intervals not exceeding 400 feet on all sewers 15 inches in diameter or less and not more than 500 feet apart on sewers 18 inches in diameter or larger.
- (b) Manholes shall be designed in detail incorporating the features shown in Figures VIII to XII, inclusive, where applicable.

- (c) At sewer junctions where the invert of the inlet sewer is more than 24 inches higher than the invert of the outlet sewer, a drop connection shall be provided. Where the difference is less than 24 inches, the base of the manhole shall be so filleted as to prevent solid deposition.
- (d) Sewer manholes for sewers up to 24-inch diameter shall not be less than four (4) feet-0 inch inside diameter. Manholes for sewers larger than 24 inches and up to 48 inches shall have an inside diameter of not less than five (5) feet-0 inches.
- (e) The flow channel through the manholes shall be made to conform in shape and slope to that of the sewer.
- (f) Manholes shall extend above the maximum known stage of floodwaters one (1) foot, unless improvements, such as street grades, will not so permit. In such cases, watertight manhole covers shall be used wherever the manhole tops may be flooded by street runoff or high water.
- (g) All manholes of brick or segmental block shall be waterproofed on the exterior with a one-half (1/2)-inch coating of cement mortar, protected against loss of moisture while curing. A bituminous waterproof coating shall be applied to the outer walls of all manholes to the top of the manhole. Coat each manhole joint with bituminous waterproofing material before setting adjacent manhole section. After setting, smooth extruded material on exterior and interior walls. Parge all inside manhole joints with grout.
- (h) Ventilation of gravity sewers shall be provided where continuous watertight sections greater than 1,000 feet in length are incurred.

B-5. Minimum Sewer Size: No public sewer shall be less than eight (8) inches in diameter.

B-6. Sewer Connections: Connections to sewer lines 18 inches in diameter or larger shall only be made at manholes.

B-7. Inverted Siphons: Inverted siphons shall be used sparingly and only after all alternate designs have been determined as impracticable. An inverted siphon of minimum size (six (6)-inch) should not serve a population of less than 3,000. Inverted siphons shall have not less than two (2) barrels with a minimum pipe size of six (6) inches and shall be provided with necessary appurtenances for convenient flushing and maintenance; the manhole shall have adequate clearance for rodding; and in general, sufficient head shall be provided and pipe sizes selected to secure velocities of at least 3.0 feet per second for average flows. The inlet and outlet details shall be so arranged that the normal flow is diverted to one (1) barrel and in such a manner that either barrel may be cut out of service for cleaning.

B-8. Hydraulic Design Criteria: The hydraulic design and determination of sewer sizes shall be based on the following conditions:

- (a) Sewers shall have a uniform slope and straight alignment between manholes. Horizontally curved sewers shall not be used unless specifically approved by the Authority.
- (b) At all junctions where a smaller diameter sewer discharges into a larger one and at all locations where the sewer increases in size, the invert of the larger sewer shall be lowered so that the energy gradients of the sewer at the junction are at the same level. Generally, this condition will be met by placing the crowns of the two (2) sewers at the same elevation.
- (c) Sewers shall be designed to be free flowing with the hydraulic grade below the crown and with hydraulic slopes sufficient to provide an average velocity when running full of not less than 2.25 feet per second (f.ps.). Computations of velocity of flow shall be based on the following values of "n", as used in the Kutter or Manning formula for velocity of flow. For pipe sizes eight (8) to 24 inches in diameter, laid in lengths up to five (5) feet, "n" shall equal 0.013. For pipe sizes eight (8) to 27-inch diameter, laid in lengths of six (6) feet long, or longer, "n" shall equal 0.012. For pipe sizes 30-inch diameter and up, laid in lengths of four (4) feet or more with tongue and groove type joints made carefully smooth, "n" shall equal 0.012.
- (d) For sewage flow depth less than one-fourth (1/4) full, allowance shall be made for increased value of "n" and in no case shall velocities of less than 1.3 f.ps. be permitted. The improved velocities shall be accomplished by steeper grades and not by increasing pipe diameter.
- (e) The maximum permissible velocity at average flow (before applying peak flow factor) shall be 15 feet per second. Suitable drop manholes shall be provided to break the steep slopes to limit the velocities in the connecting sewer pipes between manholes. Where drop manholes are impracticable for reduction of velocity, the sewer shall be of ductile iron or other abrasion resistant material.

- (f) In general, the following are minimum slopes in feet per hundred feet to be provided for pipes flowing full depth to one-fourth (1/4) of full depth:

Sewer Size	Pipe Lengths up to 5 feet	Pipe Lengths 6 feet or more
8-inch	0.47	0.42
10-inch	0.34	0.31
12-inch	0.26	0.24
15-inch	0.18	0.17
18-inch	0.14	0.13
21-inch	0.113	0.11
24-inch	0.088	0.088
30-inch	0.062	0.062
36-inch	0.048	0.048
42-inch	0.040	0.040

Terminal sections of sewers discharging into lift stations, sewage treatment plants, plant effluent into streams, etc., will require a minimum slope of double that indicated in above table.

- (g) Miscellaneous head losses at manholes and junctions shall be allowed for as follows:

- (1) At manholes on straight runs allow head loss of 0.05 feet.
- (2) Turns made inside manholes, where the radius of turn is less than two (2) pipe diameters, allow a head loss of 0.50 Velocity head. If the radius of turn is greater than two (2) pipe diameters, allow 0.25 Velocity head. "Velocity head" is defined as the velocity (in feet per second) squared, divided by 64.4. In no case shall total allowance be less than 0.05 feet.

- (3) At transitions and intersections of sewers larger than 24-inch diameter, each case shall be investigated separately and the hydraulic analysis shall be submitted to the Authority for approval.
- (h) In general, the pipe diameter of sub-trunk sewers shall be continually increasing, with increase in tributary flow. Where steep ground slopes make possible the use of a reduced pipe size and a substantial economy of construction cost can be derived, the pipe size may be reduced; but due hydraulic allowances shall be made for head loss at entry, increased velocity and the effect of velocity retardation at the lower end where the flow will be on a flatter slope. In no case shall pipe sizes be thus reduced below 12-inch diameter.

B-9. Structural Design:

- (a) General: The structural design of sewers shall conform with the methods given in the ASCE Manual No. 37 for the Design and Construction of Sanitary and Storm Sewers, except as modified hereinafter.
- (b) Working Strength: The working strength for rigid pipes shall be the minimum ultimate three edge bearing strength divided by a factor of safety of 1.5.
- (c) Allowable Load: The allowable load shall be the working strength times the load factor shown below:

- (1) In trench condition:

Type Bedding	Load Factor
Class A (Concrete Cradle or Arch)	2.5
Class B	1.9
Class C	1.5

- (2) In embankment condition:

Same as listed above for Trench Condition: (See C-2 (b)).

- (d) Dead Load:

- (1) In trench condition: Figure II may be used for determination of Coefficient Cd and dead load computed from formula given. Unless more specific data is available, the dead load shall be computed using the following values:

Backfill Weight= $w=130$ pounds per cubic foot

$K_u=K_u'=0.130$ (ordinary clay curve)

- (2) In embankment condition: Formula and curves are given in Manual 37.

Backfill Weight= $w=130$ pounds per cubic foot

- (e) Live Load: The load on the pipe due to surface wheel loads shall be determined from the graph of Figure III. The minimum wheel load equivalent to a H-20 loading (16,000 lb. wheel load) shall be applied to all sewers under existing and/or future streets, roads, drives and highways. An allowance of 50 percent (50%) of the design wheel load shall be added for impact. A minimum wheel load of 10,000 pounds per wheel shall be applied to all other sewers.
- (f) Bearing Strength: Minimum ultimate three edge bearing strengths for the various types and classes of pipe that may be approved by the Authority are tabulated in Figure V. Severe loads under unusual conditions may be accommodated by using cast iron pipe which is heavier than the minimum allowed. In such a case, the ultimate minimum three edge bearing strength shall be determined by the following formula:

$$W = \frac{t R}{0.0795 (d+t)}$$

where t = average barrel thickness at pipe in inches, minus 0.20 inches for corrosion and factory tolerance

R = modulus of rupture (31,000 psi for pit cast iron)
(40,000 psi for centrifugally cast iron)

d = average internal diameter of pipe in inches

w = value of equivalent three edge bearing strength

- (g) Bedding of Pipe: All sewer pipes shall be bedded by one of the methods shown in Figure VII. The bedding used in design shall be compatible to that obtainable in the field.

B-10. Pipe Materials for Public Sewers: The Authority reserves the right to select the type of material which shall be used in sewer installation from the following list of materials:

- (a) Clay Pipe:

- (1) Design Specification: 24-inch diameter or less; ASTM C700 (extra strength only), plain end. (Bell and spigot not permitted.)
 - (2) Joints: ASTM C425 (compression joints).
 - (3) Gaskets: ASTM C425 (neoprene or other synthetic material).
 - (4) Installation: ASTM C-12 (Class A or B bedding only) and in accordance with LCSA Standards for public sewers.
- (b) Reinforced Concrete Pipe:
- (1) Design Specification: 18-inch diameter and greater; ASTM C76 (Class III, Class IV, and Class V only) with the following exceptions:
 - (a) Portland cement shall be ASTM C150, Type II.
 - (b) Concrete shall have a minimum compressive strength of 6,000 psi at 28 days.
 - (c) Water absorption of not more than seven percent (7%) by Method A, ASTM C497.
 - (2) Joints: 18-inch through 27-inch diameter: rubber and concrete, ASTM C443 (with continuous ring, multiple seal, compression type gasket); 30-inch diameter and larger: rubber and steel, AWWA C301 (O-ring gasket) with two-coat epoxy coating of steel joint elements.
 - (3) Gaskets: ASTM C443 or AWWA C301 of neoprene or synthetic material.
 - (4) Lining: One of the following:
 - (a) Three-fourths (3/4)-inch sacrificial concrete.
 - (b) Approved coal tar epoxy (minimum 16 mils dry film thickness).
 - (c) Approved plastic lining over upper 300-degree segment of pipe.
 - (5) Installation: In accordance with LCSA Standards for public sewers.
- (c) Ductile Iron Pipe:
- (1) Design Specification: 12-inch diameter and greater; ASTM A746 with the following exceptions:

- (a) Maximum allowable deflection of three percent (3%).
- (b) Net calculated thickness shall include standard casting tolerances plus 0.02-inch additional tolerance.
- (c) Select standard class thickness above total calculated thickness.
- (2) Joints: ANSI A21.11/AWWA C111 (push on or mechanical).
- (3) Gaskets: ANSI A21.11/AWWA C111 (neoprene or other synthetic material).
- (4) Lining: approved coal tar epoxy (minimum 16 mils dry film thickness) or ASTM D1248 (polyethylene) or ANSI 21.4 (high-alumina cement mortar).
- (5) Coating: ANSI A21.11/AWWA C111 (manufacturer's standard).
- (6) Encasement: ASTM A674 (polyethylene).
- (7) Installation: In accordance with LCSA Standards for public sewers.
- (d) Polyvinyl Chloride (PVC) Small Diameter Plastic Pipe:
 - (1) Design Specification: 12-inch diameter or less, AWWA C900 (DR 25).
 - (2) Joints: ASTM D3139 (push on/joint).
 - (3) Gaskets: ASTM F477 (neoprene or other synthetic material).
 - (4) Installation: ASTM D2774 or D2321 (Class I, II, or III bedding) and in accordance with manufacturer's recommendations.
- (e) Polyvinyl Chloride (PVC) Large-Diameter Plastic Pipe:
 - (1) Design Specification: 14-inch through 36-inch diameter, AWWA C905:
 - (a) Maximum installed deflection of five percent (5.0%).
 - (b) Earth load computed as the prism load.
 - (c) Maximum modulus of soil reaction, $E' = 300$ in soil and $E' = 2,250$ in rock.
 - (d) Bedding angle equal or less than 90 degrees.

- (e) Minimum pipe stiffness of 46 psi.
 - (2) Joints: ASTM D3139.
 - (3) Gaskets: ASTM F477 (neoprene or other synthetic material).
 - (4) Installation: ASTM D2321 (Class I or II bedding) and in accordance with manufacturer's recommendations.
- (f) Polyethylene (PE) Large-Diameter Profile Wall Plastic Pipe:
- (1) Design Specification: 18-inch through 36-inch diameter; ASTM F894 with the following design conditions:
 - (a) Maximum installed deflection of five percent (5.0%).
 - (b) Earth load computed as the prism load.
 - (c) Maximum modulus of soil reaction, $E' = 300$ in soil and $E' = 2,250$ in rock.
 - (d) Bedding angle equal or less than 90 degrees.
 - (e) RSC (Ring Stiffness Constant) required resulting in a pipe stiffness of 46 psi or more.
 - (2) Joints: ASTM F894 and ASTM D3212 (push on gasket).
 - (3) Gaskets: ASTM F477 (neoprene or other synthetic material).
 - (4) Installation: ASTM D2321 (Class I or II bedding) and in accordance with manufacturer's recommendations.
- (g) Prestressed Concrete Cylinder Pipe:
- (1) Design Specification: 18-inch diameter and larger: AWWA C301 with ASTM C150, Type II cement.
 - (2) Joints: AWWA C301 (O-ring gasket) with two-coat epoxy coating of steel joint elements.
 - (3) Gaskets: AWWA C301 (neoprene or other synthetic material).
 - (4) Lining: Approved coal-tar epoxy (minimum 16 mils dry film thickness).

- (5) Installation: AWWA Manual M9 and in accordance with LCSA Standards for public sewers.

B-11. Pipe Materials for Building Sewers: The Authority reserves the right to select the type of materials which shall be used in sewer installation from the following list of materials:

- (a) Cast Iron Soil Pipe:
 - (1) Design Specification: 15-inch diameter or less, ASTM A74 (extra heavy).
 - (2) Joints: CISPI (Cast Iron Soil Pipe Institute)-HSN.
 - (3) Gaskets: CISPI-HSN (neoprene compression type).
 - (4) Coating: ASTM A74.
 - (5) Installation: In accordance with LCSA Standards for public sewers.
- (b) Ductile Iron Gravity Sewer Pipe:
 - (1) Design Specification: ASTM A746 and ANSI A21.51.
 - (2) Joints: ANSI A21.11/AWWA C111 (mechanical or push on).
 - (3) Gaskets: ANSI A21.11/AWWA C111 (neoprene or other synthetic material).
 - (4) Lining: ANSI A21.4 (double thickness cement-mortar).
 - (5) Coating: ANSI A21.6 (bituminous).
 - (6) Installation: In accordance with LCSA Standards for public sewers.
- (c) Polyvinyl Chloride (PVC) Sewer Pipe:
 - (1) Design Specification: 15-inch diameter or less, ASTM D3034 (SDR 35).
 - (2) Joints: ASTM D3212 (push on/gasket).
 - (3) Gaskets: ASTM F477 (neoprene or other synthetic material).
 - (4) Installation: ASTM D2321 (Class I, II, or III bedding) and in accordance with manufacturer's recommendations.

- (d) Polyvinyl Chloride (PVC) Pressure Pipe:
 - (1) Design Specifications: 12-inch diameter or less, AWWA C900 (DR 25).
 - (2) Joints: ASTM D3139 (push on/joint).
 - (3) Gaskets: ASTM F477 (neoprene or other synthetic material).
 - (4) Installation: ASTM D2774 or D2321 (Class I, II, or III bedding) and in accordance with manufacturer's recommendations.
- (e) Clay Pipe:
 - (1) Design Specification: 15-inch diameter or less; ASTM C700 (extra strength only) plain end. (Bell and spigot not permitted.)
 - (2) Joints: ASTM C425 (compression joints).

B-12. Force Mains: The hydraulic design of force mains shall be based on the following conditions:

- (a) Force mains shall be designed for a minimum velocity of two (2.0) feet per second and a maximum velocity of eight (8.0) feet per second.
- (b) The minimum size of force mains shall be four (4) inches in diameter, except for grinder pumps which shall be provided with a minimum diameter of two (2) inches.
- (c) An air release valve shall be placed at the necessary high points in the force main to relieve air locking.
- (d) Force main piping and fittings shall be cement-lined ductile iron pipe and shall be designed to meet the maximum pressure of the system.
- (e) Force mains shall enter a gravity sewer system at a manhole or special junction chamber. The force main shall enter the termination structure with its centerline horizontal and at a point no more than one (1) foot above the flow line of the receiving gravity sewer. Design of the force main termination structure shall ensure a smooth flow transition to the gravity flow section to prevent turbulence and release of gases. All interior walls of the force main termination structure shall be coated with coal-tar epoxy.
- (f) Force mains shall be sufficiently anchored throughout the line length. The number of bends shall be as few as possible. Thrust blocks, restrained joints, and/or tie rods shall be provided where restraint is needed.

- (g) All force mains shall be tested at a minimum pressure of at least 50 percent (50%) above the design operating pressure, for at least 30 minutes. Leakage shall not exceed the amount given by the formula contained in the most current AWWA Standard C-600.

SECTION C - CONSTRUCTION REQUIREMENTS (C-1 to C-17)

C-1. Excavation:

- (a) **Clearing:** The site of all excavation shall be first cleared of all lumber, stumps, trees, brush and rubbish which shall be removed or disposed of in a satisfactory manner.
- (b) **General:** During excavation operations, material suitable for backfill shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated material not suitable and/or required for backfill shall be removed and disposed of in an approved manner. Such grading shall be done as may be necessary to prevent water from flowing into trenches or other excavations, and any water accumulating therein shall be removed by approved methods. All excavation shall be made by open cut unless otherwise specified.
- (c) **Trench Excavation:** The trench shall not be opened for a distance exceeding 300 feet at any time, when located along streets or highways. The width of the trench at any point below the top of the pipe shall not exceed the structural design assumption width. The width of the trench above the top of the pipe may be as wide as necessary for sheeting and bracing and the proper performance of the work. All trench walls shall be kept as nearly vertical as possible. Excavation at manholes and similar structures shall be sufficient to leave at least 12 inches clear between their outer surface and the embankment or sheeting. Minimum clearance between side of trench and pipe shall be six (6) inches. The trench shall be excavated to a uniform sub-grade as required for installation of pipe bedding material.

C-2. Pipe Foundation:

- (a) **Pipe Installed in Trenches:** Pipe to be located at elevations below the existing ground level shall be installed in trenches with Class A, B or C pipe bedding as shown in Figure VII. Granular material under and around the pipe shall be placed in six (6)-inch layers and compacted by rodding, spading or with approved vibratory equipment to obtain not less than 80 percent (80%) relative density as determined by ASTM Method D2049.

- (b) Pipe Installed in Embankment: Pipe to be located at elevations above the existing ground level shall be installed in trenches excavated after embankment has been constructed to a minimum elevation of one (1) foot above the proposed top of pipe.
- (c) Pipe Bedding Material: The pipe shall be bedded from the trench sub-grade to the pipe springline in granular material consisting of gravel, crushed gravel, or crushed stone meeting the requirements of ASTM Designation C33, Gradation 67 (3/4 inch to No. 4).
- (d) Foundation in Poor Soil: Whenever the soil at the trench sub-grade elevation is soft, unstable, or saturated with water, such unsuitable material will be removed and the trench sub-grade stabilized with a granular stabilization material. Maximum size of granular material shall be two (2) inches. Depth of stabilization shall be as required to construct a firm sub-grade for pipe bedding material. Concrete cradle shall be provided when necessary to bridge highly unstable soils.

C-3. Backfill:

- (a) All material used for backfill of trenches shall be free of excessive amounts of deleterious materials such as all organic matter, frozen clods and sticky masses of clay and gumbo which are difficult to properly compact. Backfill to be placed within 12 inches of the installed pipe in any direction shall not contain earth clods or rock material greater than one (1) inch in greatest dimension. Backfill to be placed greater than 12 inches from the top of pipe shall not contain earth clods or rock material greater than four (4) inches in greatest dimension. Material as specified for pipe bedding may be substituted for backfill material defined above from top of pipe bedding to 12 inches above top of pipe.
- (b) Backfill shall be placed in six (6)-inch layers from top of pipe bedding to a point at least 12 inches above the top of pipe. Above this point, backfill shall be deposited in layers of a thickness that will permit compaction to a density as specified hereinafter.
- (c) The layers of material shall be compacted to a density of at least 90 percent (90%) of the maximum density as determined by the AASHO Standard Test (AASHO Designation T99) wherever the pipe is installed in open fields or areas which carry no vehicular traffic. The top portion of the backfill areas that are to be re-sodded shall be composed of topsoil at least six (6) inches in depth and corresponding to that of the adjoining sodded areas.
- (d) The layers of material shall be compacted to a density of at least 95 percent (95%) of the maximum density at optimum moisture content as determined by the AASHO Standard Test (ASSHO Designation T99) under all pavements and for future pavements. Pavement shall not be restored over trenches until the backfill

material has been tested and determined as satisfactory according to the tests. Figure VI is a detail of pavement patching.

C-4. Sheeting and Bracing: All trenches and excavations shall be properly sheeted and braced for the safety of personnel and/or protection of the work; and/or to maintain the maximum trench widths permitted; and/or to prevent the disturbance or settlement of adjacent foundations or structures. When so required by the Authority, sheeting shall be left in place by cutting off no higher than one (1) foot below finished surface grade and no lower than one (1) foot above the top of the pipe. The requirement of sheeting and/or bracing left in place shall not obligate the Authority in any manner.

C-5. Blasting: Blasting, where required, shall be done with care in accordance with all applicable Federal, State and local laws, ordinances and regulations, and shall not be done within a distance of 25 feet from a previously laid pipe line or a previously installed structure if, in the opinion of the Authority, the safety or soundness of existing facilities is in any manner endangered.

C-6. Pipe Materials: Sewers shall be constructed of pipe materials as shown in approved plans and specifications for construction.

C-7. Jointing: All joints of pipe and fittings shall be of the type that has been certified by an independent laboratory to resist internal water pressure of ten (10) feet head (4.3 psi) for one (1) hour without failure or development of visible leakage. The following joints have been tested and are approved.

- (a) Lead and Oakum or Hemp Joints for Use on Cast-iron Soil Pipe for House Service Lines: The oakum or hemp shall be firmly compacted in joint. The lead shall conform to Federal Specification QQ-C-40 and shall be poured to a depth of not less than one (1) inch. Lead shall be run in one pouring and caulked tightly.
- (b) Rubber Gasket Joints: Rubber gasket joints shall be used with cast-iron water mains, guaranteed by the manufacturer and assembled as recommended by the manufacturer.
- (c) Flexible Compression Joints: Flexible compression joints conforming to ASTM Designation C425 of latest revision shall be assembled as recommended by the manufacturer.
- (d) Joints with Round Rubber Gaskets ("O" Ring Type): The joints shall be of the round rubber gasket type and conform to AWWA C302 of latest revision, Section 3.3 and Section 3.4. The joints shall be assembled as recommended by the manufacturer.

C-8. Building Sewer Connections:

- (a) No building sewers shall be connected directly to public sewer of sizes larger than 15 inches inside diameter. All branch connection locations shall be accurately recorded on drawings by station number from nearest downstream manhole, and by direct reference to the property boundaries. The branch shall be installed in the exact location shown. Revised "as-built" drawings shall show any field changes.
- (b) Branch outlets for building sewers may be installed in sewer line while under construction providing:
 - (1) Branch is plugged and blocked with a plug and joint capable of sustaining without failure or leakage an internal water pressure head of ten (10) feet (4.3 psi).
- (c) Branch connections may be installed after public sewer has been completed and tested by the use of saddles furnished and installed as required in the Loudoun County Sewer Ordinance, providing:
 - (1) Saddle actually strengthens lateral sewer at connection.
 - (2) Saddle and joint are capable of sustaining without failure or leakage an internal water pressure head of ten (10) feet (4.3 psi).
- (d) Building spurs may be installed from sewer lateral to property lines during construction of sewer lateral providing:
 - (1) All joints and connections to lateral are capable of sustaining without failure or leakage an internal pressure head of ten (10) feet (4.3 psi).
 - (2) All spurs are constructed of extra heavy cast-iron soil pipe with lead and hemp joints or other material approved by the Authority.
 - (3) Ends of spurs are properly sealed to sustain pressure of tests provided in Section C-15 of these standards.
 - (4) Spurs are located accurately on drawings.
 - (5) Spurs are laid to grades provided in Loudoun County Sewer Ordinance.
 - (6) Pipe is properly bedded and backfill properly compacted as provided herein for sewers.

C-9. Concrete:

- (a) Classification:

- (1) Concrete for manhole bases and roof slab, concrete driveways and sidewalks shall be Class A.
 - (2) Concrete for cradle and encasement shall be Class B.
 - (3) Concrete for replacement of pavements on public thoroughfares shall conform to the requirements of the governmental agency having jurisdiction.
- (b) Materials:
- (1) Cement shall be Portland cement conforming to ASTM Designation C-150, Type II.
 - (2) Fine Aggregate shall conform to ASTM Designation C33 as specified for concrete subject to abrasion.
 - (3) Coarse Aggregate shall be gravel, crushed gravel, or crushed stone conforming to ASTM C33 as specified for concrete subject to severe exposure, size 57.
 - (4) Water for concrete shall be clean, clear and free from oil, acid, alkali or other injurious substances in any appreciable amounts.
- (c) Strength: Concrete shall be proportioned and mixed for the following strength:

Class	Minimum Allowable Compressive Strength of 28 Days
A	3000
B	2000

- (d) Proportioning: Concrete shall be composed of cement, fine aggregate, coarse aggregate and water so proportioned and mixed as to produce a plastic, workable mixture in which the minimum cement content and maximum water content for the respective classifications shall not exceed the following:

Class	Minimum Cement Content	Maximum Water Content
A	6 Bags Per Cu. Yd.	5.25 Gals. Per Bag Cement
B	5 Bags Per Cu. Yd.	6.75 Gals. Per Bag Cement

The exact proportions of all materials entering into the concrete shall be in accordance with good concrete practice. The Applicant shall provide all equipment necessary to positively determine and control the actual amounts of all materials entering into the concrete. The proportions will be changed whenever in the opinion of the Authority such change becomes necessary to obtain the specified strength and the desired density, uniformity and workability.

- (e) Forms: Forms shall be of wood and other approved materials. Forms shall be mortar-tight and sufficiently rigid to prevent displacement. Responsibility for their adequacy shall rest with the Applicant. Form surfaces shall be smooth and free from irregularities, dents or holes. Form removal shall be accomplished in such a manner as will prevent injury to the concrete.
- (f) Reinforcement: All reinforcement bars for concrete shall conform to the requirements of ASTM Designation A615. All bars #4 or larger shall be Grade 60. Ties and all #3 bars shall be Grade 40. All welded wire fabric reinforcement shall conform to ASTM Designation A185 using bright basic wire meeting requirements of ASTM Designation A82. Wire gauges #11 or smaller shall be galvanized. All reinforcement shall be, when surrounding concrete is placed, entirely free from rust, scale, grease or other coating which might destroy or reduce its bonds with concrete.
- (g) Mixing:
 - (1) The concrete shall be mixed until there is a uniform distribution of the materials and shall be completely discharged before the mixer is recharged.
 - (2) Machine-mixed at Site: For concrete batched on the job, the mixer shall be operated in accordance with the manufacturer's recommendation. The minimum time of mixing for each batch shall be 1 1/2 minutes.
 - (3) Ready-mixed Concrete: Concrete furnished in truck-mixers shall be mixed at the site of the work. No water shall be added to the batch until the work is ready to receive the concrete. The mixer shall be operated in accordance with manufacturer's recommendations and the minimum mixing time shall be 1 1/2 minutes.
- (h) Placing: Concrete shall be conveyed from mixer to forms by a method which will prevent segregation or loss of ingredients. Concrete that has attained its initial set, or has contained its water content for more than one (1) hour, shall not be used in the work. All concrete shall be thoroughly compacted by suitable means during placing, and shall be thoroughly worked around reinforcement, pipe and embedded items and into the corners of the forms. Surfaces shall be finished as specified. Concrete shall be kept in moist condition for five (5) days after placing.

Whenever the temperature is below 40 degrees F, all concrete placed in the forms shall have a temperature of between 70 degrees F and 80 degrees F, and adequate means shall be provided for protecting the concrete.

C-10. Concrete Cradle and Arch:

- (a) Concrete for cradles or arches, where required, shall be Class B as specified in Article C-9 herein.
- (b) Dimensions shall conform to those shown in Figure VII.
- (c) Concrete shall be placed carefully around pipe to avoid displacement of pipe. Trench shall be de-watered before placing concrete. Backfill shall not be placed over concrete cradle or arch until 24 hours after pouring unless otherwise authorized.

C-11. Manholes:

- (a) Manhole Bases: Manhole bases shall be poured of Class A concrete and reinforced as shown in Figures IX and X.
- (b) Roof Slabs: Roof slabs of shallow manholes shall be Class A concrete and reinforced as shown in Figure No. IX.
- (c) Invert Channels: Invert channels shall be smooth and semi-circular in shape conforming to the inside of the connecting sewer section. Changes in direction of flow shall be made with a smooth curve of as large a radius as the size of the manhole will permit. Changes in size and grade of the channels shall be made gradually and evenly. The invert channel shall be formed as shown in Figures IX and X. The floor of the manhole outside the channels shall be smooth and shall slope toward the channels.
- (d) Masonry Walls: Manhole walls shall be constructed of brick or concrete blocks.
 - (1) Brick shall conform to ASTM Designation C-32 and shall be Grade SS.
 - (2) Concrete block shall conform to ASTM Designation C-139 for Concrete Masonry Units for Construction of Catch Basins and Manholes. The unit shall be so designed and laid that the interior surfaces are cylindrical for the vertical sides and conical for the top four (4) courses with no offsets. Where steps as shown in Figure VIII are to be installed, the blocks shall be recessed to allow for the installation thereof.
 - (3) Mortar shall be made of one (1) part of cement to two (2) parts of sand. The proportions shall be based on one (1) bag of cement to 1.8 cubic feet of

sand. If directed by the Engineer, lime shall be added to the mortar in an amount not to exceed ten percent (10%).

- (e) Laying Masonry: All masonry shall be laid in a careful and workmanlike manner by skilled workmen.
 - (1) Masonry units shall be thoroughly wetted before being laid. Each masonry unit shall be laid with push joints in a full bed of mortar and close joints must be obtained. The mortar must fully cover the bottom and ends of the unit and surplus mortar on inside face shall be removed. All mortar joints on the inside face shall be well rubbed before initial set with a suitable pointing iron and the joints shall be left with a smooth hard finish. Brick shall be laid in stretcher courses with every sixth course a header.
 - (2) The top of the manhole shall be brought accurately to the dimensions of the flange of the manhole frame.
 - (3) Adequate precautions shall be taken in freezing weather to protect the masonry from damage by frost.
 - (4) The outside surface of all manhole walls shall be plastered with mortar to a thickness of not less than one-half (1/2) inch, troweled to a smooth hard finish. Backfill will not be allowed until the mortar has thoroughly hardened. The inside surface of all manhole walls shall be plastered with mortar to a thickness of not less than one-half (1/2) inch, troweled to a smooth hard finish. All mortar shall be protected against loss of moisture while curing by use of a plastic membrane, wet burlap or other means satisfactory to the Authority. Bitumastic waterproofing shall be provided to a level one (1) foot above highest ground water table, or flood stage.
- (f) Watertight Work Required: The entire work of constructing manholes must be carried on in a manner to insure watertight work as provided in B-4, and any leaks in manholes shall be caulked, repaired, or the entire work removed and rebuilt. Attention is particularly called to the necessity of keeping water level below all parts of the masonry or concrete foundations and walls until the mortar and concrete has obtained an adequate set.
- (g) Frames and Covers: Manhole frames and covers shall be gray cast iron free from cracks, holes and cold shuts and conforming to ASTM Designation A-48. Castings shall conform to the drawings in Figure XI in all essentials of design. Bearing surfaces shall be machined to provide even bearing surfaces. Castings shall be coated with coal tar pitch varnish.
 - (1) Covers shall have two (2) one (1)-inch vent holes, two (2) notch holes in the perimeter, and the word "SEWER" cast in the center.

- (2) Frames shall be set level on a full bed of mortar to the proper grade.
- (h) Manhole Drop Connections: The contractor shall install drop connections at manholes in accordance with the provisions of B-4.(c). Drop connections shall conform to the details as shown in Figure X. The drop pipe and fittings shall be either vitrified clay conforming to ASTM Specification C-13 of latest revision for Standard Strength Clay Sewer Pipe or concrete conforming to ASTM Specification C-14 of latest revision for Concrete Sewer Pipe. The pipe and fittings shall be jointed as specified in the section on Pipe Sewers. The drop pipe and fittings and part of inlet sewer shall be encased in Class B concrete as shown on the drawings.
- (i) Manhole Stubs: Where shown on the drawings or ordered by the Authority, the contractor shall place a vitrified clay or concrete stub in the wall of the manhole. The stub shall be a bell-and-spigot piece at least 36 inches in length. Before installing stub, a vitrified clay or concrete stopper shall be placed in the bell end. Stopper shall be capable of withstanding ten (10) feet (4.3 psi) internal pressure without leakage.

C-12. Acceptance Tests:

- (a) The Authority shall be permitted access to the construction work at any time for inspection of the work and construction methods. Work not conforming to the requirements of these standards shall be adequate basis for rejection of project until corrected to the satisfaction of the Authority.
- (b) Sewers will be checked by the Authority to determine whether any displacement of pipe has occurred. The test will be as follows: A light will be flashed between manholes by means of a flashlight or reflection of sunlight with a mirror. If illuminated interior of the pipe shows poor alignment, displaced pipe or any other defects, the defects shall be remedied before acceptance by the Authority.
- (c) All completed sewers shall be tested for leakage by (1) ex-filtration (i.e. outward leakage, trench dry) or (2) infiltration (i.e. inward leakage, trench wet). Leakage shall not exceed 100 gallons per inch of diameter of sewer per mile per day. Sewers crossing streams shall exhibit zero infiltration.

The leakage test shall be conducted on the first section of pipe laid by each crew before backfill and before the crew is permitted to continue pipe installation. If, however, the contractor desires to backfill prior to testing, he may do so at his own risk, and shall be responsible for uncovering and repairing any section which does not meet the standards outlined above.

The leakage test shall be conducted on all other sections of the system, as completed, in a manner acceptable to the Authority.

All expenses connected with the test shall be borne by the contractor.

Leakage test shall be performed as follows:

- (1) Ex-filtration Test: Wherever possible, in the judgement of the Authority, the sewer shall be subjected to the ex-filtration test. The exception shall be where ground water level would be higher than the internal pressure head developed by this test. All outlets and/or inlets shall be plugged and secured in a manner to resist the internal pressure of this test without leakage or failure. The test section shall be filled with water to an elevation up to the top of the manhole at the upstream end to provide an internal pressure head of four (4) feet at any point in the pipe and a maximum head of ten (10) feet at the lowest point of the section being tested. Test sections shall be selected such that internal pressure heads do not exceed ten (10) feet. Where grades between adjacent manholes would develop more than ten (10) feet of pressure head within the pipe, the contractor shall test in segments or test at the higher pressure at his risk. This level of water shall be maintained as long as necessary to determine acceptability of sewer being tested, but not less than two (2) hours. Measurements shall be made of the rate of leakage (ex-filtration) from the sewer by determining the amount of water required to maintain the initial level at the upstream end of the pipe. Water will be furnished to the contractor or developer at cost from an approved source provided with a meter.
- (2) Infiltration Test: Where the aforesaid ex-filtration test cannot be run because of high ground water level, the sewer shall be tested by measuring the actual infiltration. A V-notch weir shall be installed at the lower end of the section to be tested and the maximum flow determined shall be the rate compared to the standards provided herein, and shall apply only to that length of pipe submerged at least six (6) inches below the ground water table. The amount of submergence shall be measured by the use of well-points driven into backfill material adjacent to the pipe at or near manholes in sections being tested, or by use of other vertical well casings with perforations that will exclude the backfill material installed during construction, or by other methods approved by the Authority. The submergence shall be determined and recorded at each end of the section being tested as well as at any intermediate points deemed necessary by the Authority.
- (d) All completed manholes shall be tested for leakage. Manholes may be tested for leakage at the same time that gravity sewer lines are being hydrostatically tested for leakage. For manholes greater than four (4) feet in depth whose entire depth was not included in the hydrostatic testing of the sewer line, the manholes shall be used to plug all lines into and out of the manhole being tested. The manhole shall

be filled with water to the top of the rim. A maximum 12-hour soak shall be allowed. Leakage shall not exceed one-half (1/2) gallon per hour.

C-13. Repairs: Sewer lines, structures, facilities or appurtenances thereto not meeting the requirements of these standards shall be replaced or repaired in a manner approved by the Authority. Defective materials, pipe or fittings shall be completely removed and replaced with new materials in a manner approved by the Authority. Evidence of excessive leakage, or unsatisfactory alignment, or poor workmanship shall be justification for the Authority to require complete removal of the entire line between manholes and its reconstruction in accordance with the plans and specifications and the standards of the Authority.

C-14. Protection of Existing Improvements: During construction operations, care should be exercised to protect, brace, support and maintain all underground pipes, conduits, drains and other underground structures uncovered or otherwise affected by the construction work being performed. All pavement, surfacing, driveways, curbs, walks, buildings, utility poles, guy wires and other surface structures, together with all sod and shrubs in yards and parkings crossed by or adjacent to the sewer under construction, shall be maintained and if removed or otherwise damaged, shall be replaced or restored to the original condition thereof. All replacements of such underground and surface structures or parts thereof shall be made with new materials. All damage resulting from construction operations to streets, roads, highways, shoulders, ditches, embankments, culverts, bridges or other public or private property or facility, regardless of location or character, which may be caused by construction and/or moving, hauling or otherwise transporting equipment, materials or men to or from the work or any part of site thereof, shall be the responsibility of the applicant, his contractor or subcontractor. Satisfactory arrangements shall be made without delay with the owner or owners of, or the agency or authority having jurisdiction over, the damaged property, surface, structure or facility concerning its repair or replacement and payment of cost incurred in connection with said damage.

C-15. Safety of Public:

- (a) Maintenance of Traffic: Construction operations shall be scheduled so as to interfere as little as possible with public travel, whether vehicular or pedestrian. Whenever it is necessary to cross or interfere with roads, driveways and walks, whether public or private, suitable and safe bridges, detours or other temporary expedients for the accommodation of public and private travel shall be provided and maintained. Reasonable notice shall be given to owners of private drives before interfering with them.
- (b) Barricades and Lights:
 - (1) All streets, roads, highways and other public thoroughfares which are closed to traffic, under the authority of a proper permit, shall be protected by means of effective barricades on which shall be placed acceptable warning signs; such barricades being located at the nearest intersecting

public highway or street on each side of the blocked section of such public thoroughfare.

- (2) All open trenches and other excavations shall be provided with suitable barriers, signs and lights to the extent that adequate protection is provided to the public against accident by reason of such open construction. Obstructions, such as material piles and equipment shall be provided with similar warning signs and lights.
- (3) All barricades and obstructions shall be illuminated by means of acceptable warning lights at night, and all lights used for this purpose shall be kept burning from sunset to sunrise. Materials stored upon or alongside public streets, roads and highways shall be so placed, and the work at all times shall be so conducted, as to cause the minimum obstruction and inconvenience to the traveling public.
- (4) All barricades, signs, warning lights and other protective devices shall be installed and maintained in conformity with applicable statutory requirements and, where within public thoroughfare rights-of-way, as required by the authority having jurisdiction thereover.

(c) Operations Along Streets and Highways:

- (1) No equipment, pipeline or excavated materials shall be stored on the pavement, or on shoulders of uncurbed roads, or in ditches or at other locations obstructing traffic or drainage.
- (2) Construction operations shall be confined to no more than 1,000 feet under construction with a maximum open trench of 300 feet. "Under Construction" shall include all operations between start of excavation of the trench to final tamping of backfill and/or restoration of pavement to public use. Traffic shall not be obstructed in more than one (1) lane during construction operations. The length of one-lane traffic shall be limited to 300 feet. Two(2) flagmen shall be provided to control traffic. Advance warning signs shall be provided. All obstructions shall be removed and the pavement cleaned at all road crossings at the end of each day's operation.
- (3) All pipe strung along the right-of-way shall be blocked to prevent movement.

C-16. Permits for Construction on State Highways and Streets: The Virginia Department of Transportation requires a permit for work to be performed on State Highways. Provisions for obtaining such permits are set forth in the "Manual on Permits, Virginia Department of Transportation, Richmond, Virginia," of latest revision. No work will be accepted by the

Authority that has not been accepted or approved as satisfactory by the Department of Transportation.

C-17. Cleanup and Restoration: All debris, rock or other waste shall be removed and deposited at approved locations and covered with 12 inches of earth, where required by the Authority.

- (a) The Authority will not accept any construction wherein public or private property has not been restored to a condition at least equal to its condition before commencement of construction.
- (b) All streets, roads and highways shall be restored as required by the Virginia Department of Transportation.
- (c) Work performed on private property shall be confined to the easements obtained and the area shall be seeded or sodded, landscaping restored, fences restored and all damaged improvements replaced or restored.
- (d) A condition precedent to acceptance by the Authority shall be a release from each Owner, upon whose property work was performed, stating that the property has been restored to the satisfaction of such Owner.

SECTION D - RULES AND REGULATIONS

GOVERNING EXTENSIONS WITHIN SPECIFIED AREAS (D-1 to D-11)

D-1. General: Under special contract agreements, the Authority may permit (a) an extension of its sewerage system to be installed within a specified area, or (b) the installation of a local sewerage system within a specified area, said local system to be eventually connected to and served by the sewers of the integrated sewerage system of the Authority. In either case, the installation shall be in accordance with the standards presented in Sections B and C hereof, shall be made by and at the expense of the Applicant desiring to secure sewer services for said area, and, upon acceptance by the Authority, shall be dedicated to the Authority for ownership, operation and maintenance. No such installation shall be made until a written application for a permit and detailed plans and specifications have been filed with the Authority and written permit therefore, including approval of said plans and specifications, have been obtained from the Authority, all as hereinafter provided.

D-2. Application: Application for such installation shall be made in writing and submitted in duplicate in accordance with the following instructions:

- (a) The application shall state the location and size of the area to be served; shall state in detail the number, nature, and location of connections to be served (including dwelling units, schools and other public buildings, and commercial and industrial establishments, together with probable number of employees of each such establishment); and shall be accompanied by two (2) copies of a preliminary plat

(measuring 23 inches by 36 inches) drawn to scale and showing the following information:

- (1) The upper half of the drawing shall show the sewer location in plan and the lower half shall show the profile of the sewer and of the ground surface.
 - (2) All manholes shall be located in plan and on the profile.
 - (3) In addition to the sewers, the plan shall show the location of existing structures, houses, etc., en route, plus location of proposed or existing underground utilities, curbs, property lines, railroad crossings, culverts, bridges, etc. crossing the sewer line.
 - (4) The horizontal scale for profiles shall be the same as that used for the plan, which shall in no case be smaller than 100 feet to the inch. The vertical scale shall in no case be smaller than ten (10) feet to the inch.
 - (5) Sewer sizes manhole numbers and stationing shall be shown on the plan and repeated on the profile.
 - (6) Sewer grade, invert elevations at manholes, elevation of top of manhole casting, type of pipe, location of cradle, etc., maximum level or flood stage at manholes, and existing and proposed street grades shall be shown on the profile.
 - (7) A vicinity map at a scale not smaller than 4,000 feet to the inch shall be used as a cover sheet for all plans where the proposed installation is on more than one (1) street.
 - (8) The following note shall be placed on the cover sheet for all plans: "Sanitary sewers shall be constructed in strict compliance with current standards of the Loudoun County Sanitation Authority for the construction of Sanitary Sewers in Loudoun County, Virginia."
- (b) The application shall include such other pertinent information as the Authority may require, and shall indicate in full detail the manner in which the Applicant proposes to meet the standards set forth in Sections B and C hereof. Said plat shall be prepared and certified by an engineer duly authorized by the State of Virginia to perform such work. Said application shall be accompanied by a certificate from the Loudoun County Zoning Administrator that the area to be served by the proposed installation has been officially zoned for the particular type or types of land use described in the application and shown on the accompanying plat.

D-3. Review of Application: In making its review of the application and accompanying preliminary plat, the Authority reserves the right to require such changes, including changes in pipe sizes, as it may consider necessary in order (1) to meet the requirements of the standards presented in Sections B and C and (2) to permit future extensions where circumstances so indicate.

D-4. Plans, Specifications and Cost Estimates: In case the Authority finds the proposed installation to be practicable from both the engineering and economic standpoints and to be in accordance with the standards presented in said Sections B and C, the applicant shall submit to the Authority, in triplicate, complete plans and specifications for the project, together with an estimate of cost, all prepared and certified by an engineer duly authorized by the State of Virginia to perform such work. Said plans and specifications shall be in complete conformity with the design and construction standards presented in Sections B and C.

D-5. Contract Agreement: After the Authority has approved said plans and specifications, and before a permit can be issued, the Applicant shall enter into a contract agreement with the Authority wherein he covenants and agrees as follows:

- (a) That the installation shall conform to said plans and specifications and shall be subject to inspection by the Authority at any time as work progresses.
- (b) That construction of the installation shall be undertaken not later than a specified date and carried through to completion in an expeditious and proper manner.
- (c) That where the project or any part thereof is being installed on private property or in a private street, the owner thereof shall provide, free of cost to the Authority, an easement and a free unobstructed and uninterrupted right-of-way for inspection, operation, maintenance, enlargement, replacement, alteration and extension of the installation.
- (d) That in the event the construction work is to be done by contract, the Applicant shall, upon letting such contract or contracts, advise the Authority as to the total cost thereof.
- (e) That the Applicant shall be responsible for all damages, loss or injury to persons or property that may arise or be incurred in or during the progress of the work incident to said project without regard to whether or not the Applicant, his agents, employees or contractors have been negligent, and that the Authority shall be by the Applicant held and kept free and discharged of and from any and all responsibility and liability therefor of any sort or kind; that the Applicant shall assume all responsibility for risks or casualties of every description; that the Applicant shall make good any damages that may occur in consequence of the work or any part thereof, and shall assume all blame, loss and responsibility of whatsoever nature by reason of neglect or violation of any Federal, State, County or local laws, regulations and ordinances.

- (f) That the Applicant will not commence work on this project until he has obtained all insurance required under this paragraph and such insurance has been approved by the Authority and that the Applicant will not allow any contractor or subcontractor to commence work on this project until all similar insurance has been obtained and approved.
 - (1) Workmen's Compensation Insurance for all employees employed at the site of the project.
 - (2) Public Liability Insurance during the life of this contract agreement in an amount not less than \$150,000 for injuries, including wrongful death, to any one person and subject to the same limit for each person, in an amount not less than \$500,000 on account of one accident.
 - (3) Property Damage Insurance in an amount not less than \$50,000 for damages as a result of any one accident and in an amount not less than \$250,000 as a result of all accidents.
- (g) That this contract agreement shall continue in full force and effect until the project has been completed and turned over to and accepted by the Authority.
- (h) That ownership of the completed installation shall, upon acceptance by the Authority, be in the Authority, its successors and assigns.
- (i) That all materials and/or equipment and work performed are guaranteed to be free of defects in material and workmanship, and further agrees to provide all maintenance, repairs or reconstruction of defective construction, materials, and/or workmanship, including all shrinkage or settlement or other faults arising therefrom at his own expense, promptly when notified in writing to do so by the Authority and to the satisfaction of the Authority for a term of one (1) year from date of acceptance by the Authority. The guarantee shall be secured by a bond of a surety company acceptable to the Authority, in the amount of five percent (5%) of the estimated construction cost of work, for faithful performance of the guarantee.

D-6. Performance Bond: Simultaneously with his delivery of the executed contract agreement, the Applicant shall deliver to the Authority an executed performance bond in the amount of One Hundred Percent (100%) of the estimated cost of the project, including a contingency item, the amount of said bond to be satisfactory to the Authority, conditioned upon the fulfillment of the contract agreement and upon payment of all persons supplying labor and furnishing materials on the construction of the work, and having as surety thereon such surety company or companies approved by the Authority. In event the Applicant has the work done by contract and the contract price is greater than the estimated cost of the project, the amount of the performance bond shall be increased accordingly.

D-7. Issuance of Permit: Upon delivery to the Authority by the Applicant of the executed contract agreement and performance bond, as herein before provided, the Authority will issue the official permit for the installation of the project. The Applicant is hereby placed on notice that any installation work he may do on the project prior to the issuance of said permit is done entirely at his own risk.

D-8. Notice of Construction: The holder of a permit hereunder shall notify the Authority of the actual installation of any sewer or other facilities covered by said permit at least 48 hours prior to the covering up of such sewer or facility in order to permit inspection and testing thereof.

D-9. As-Built Drawings:

- (a) As-built drawings, on linen or a polyester film type base (Mylar or equal), original or reproducible, showing the facilities as actually built and deed book references of sanitary sewer easements prepared by a surveyor or engineer duly authorized by the State to prepare same, shall be submitted to the Authority as a condition precedent to the use of the facilities.
- (b) Drawings shall meet all requirements of Section D-2. (a)., Parts (1). through (7). of these standards. Any branches and dead ends that may require location at a future date shall be located by references and dimensions.
- (c) When the As-built information differs from the approved construction plans, a Design Analysis for the existing conditions may be required.

D-10. Extension of Sewerage System by Authority: Nothing contained herein shall be construed as limiting or preventing the Authority from extending its sewerage system whenever and wherever it may determine that circumstances so warrant.

D-11. Resident Supervision of Construction: Installation of all sewer mains, laterals, manholes, and appurtenances shall be under the direct supervision of a Resident Engineer. The Resident Engineer shall be (1) a registered professional engineer duly authorized in the State of Virginia to perform such work, (2) approved by the Authority, (3) employed by the Applicant.

D-11.1. Resident Engineer shall be specifically authorized to inspect or cause to be inspected by his subordinates all phases of construction and installation included in the permit issued by the Authority, for compliance to these standards, approved specifications and plans, and the terms of any contract or agreement between the Authority and Applicant.

D-11.2. Resident Engineer shall report in writing daily to the Authority on progress of work and any problems as to compliance as specified in paragraph D-11.1. He shall have the Authority to stop work of any contractor or subcontractor failing to comply with requirements, withhold payments until corrections are made to satisfaction of Authority, and/or to require discharge of any employee not producing satisfactory workmanship.

D-11.3. Resident Engineer shall be free of intimidation, coercion or pressure to lower his professional standards or to not perform his duties as provided herein.

D-11.4. Resident Engineer shall serve to the satisfaction of the Authority and shall be replaced within 30 days of written notice by the Authority that approval of said Resident Engineer is terminated.

SECTION E - AMENDMENT AND INTERPRETATION *(E-1)*

E-1. The Authority reserves the right to amend or modify this publication without notice and to interpret the meaning of all statements made therein.