
SECTION 5 – SEWER DESIGN

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5 SEWER DESIGN

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5.1 GENERAL

5.1.1 SPECIFICATION AND DESIGN MANUAL

- A. All projects within the jurisdiction of the City of Fairfax shall be designed and constructed in accordance with the City's *Public Facilities Manual*, latest revision.
- B. Sanitary sewer gravity mains, force mains, and lift stations shall conform to the design and construction requirements of the *Manual of Practice for Sewerage Systems and Treatment Works*, Article 1, *Collection and Conveyance Sewers*, 9 VAC 25-790-310 through 440 as published by the Commonwealth of Virginia, Virginia Department of Environmental Quality (DEQ), latest revision, which documents are herein incorporated by reference

and made part of this document. Additional design and construction requirements have been included from the American Society of Civil Engineers (ASCE) Manual 60, *Gravity Sanitary Sewer Design and Construction*; and the Virginia Department of Transportation (VDOT), *Road and Bridge Standards*.

5.1.2 PRELIMINARY ENGINEERING REPORT REQUIREMENTS:

- A. When required by the City Engineer and prior to proceeding with design, the developer shall be required to provide a Preliminary Engineering Report satisfactory to the City Engineer. Refer to 9 VAC 25-790-940 *Preliminary Engineering Report* for required components of the Preliminary Engineering Report.

5.2 SEWER SYSTEM DESIGN STANDARDS

The purpose of this section is to establish standard design procedures and criteria for sewer system design in the City of Fairfax.

5.2.1 GENERAL

- A. **General:** Gravity Collection systems shall meet the minimum requirements of DEQ *Sewage Collection and Treatment Regulations* (9 VAC 25-790).
- B. **Sewer Collection System:** The subdivider shall be required to connect his subdivision with the municipal sewage system at his expense according to Section 86 – *Subdivisions* of the City of Fairfax code.
- C. **System Design:** The system is to be designed for the estimated ultimate tributary population including consideration given to the maximum anticipated capacity of institutions and industrial parks, etc. The capability of the downstream sewers to accept the future flow from tributary collection systems shall be evaluated by the design engineer. Wastewater flows shall be determined in accordance with *the Sewage Collection and Treatment Regulations, Part I, 9 VAC 25-790, Manual of Practice for Sewerage Systems and Treatment Works, Article 1, Collection and Conveyance Sewers, 9 VAC 25-790-310 through 440* as published by the Commonwealth of Virginia, DEQ.

5.2.2 DEFINITIONS

- A. **Definitions:** For the purposes of this section, the following definitions refer to sanitary sewer collection systems that come under the authority of the City of Fairfax, Virginia as specified within this section and other sections of this manual.

1) **Adjacent and Abutting Sewer**

The policy for sewer projects ensures the orderly development of the system by requiring that each property benefiting from the sewer line

must have at least a part of that line abutting or placed adjacent to the property. This policy prevents properties from simply installing long laterals across neighboring properties or connecting to neighboring property's laterals to reach public sewer lines.

2) **Approved Equal**

Approved equal is the annotation given to a product or material that has been approved by the City of Fairfax as a substitute for the product or material specified in the specifications or standard details. *Approved Equal* products and materials must be approved by the City of Fairfax City Engineer.

3) **Easement**

An instrument that depicts/describes and conveys rights and privileges to the City of Fairfax for the placement, access to, and maintenance of a utility line and/or on the property of a second party. The owner forfeits certain uses of the property. Ownership of the land remains with the second party. Easements are acquired through the owner's signing of an easement agreement, negotiation and monetary settlement or, if negotiations fail, condemnation under eminent domain statutes.

4) **Force Main**

A force main is a pressure pipe joining the pump discharge at a wastewater pumping station with a point of gravity flow.

5) **Gravity Flow System**

This is a system of conduits in which no wastewater pumping is required. Sewage flows by gravity from service points to public sewer lines.

6) **Grinder Pump**

A grinder pump is a mechanical device that shreds solids and raises the fluid to a higher elevation through pressure sewers.

7) **Interceptor or Trunk Sewer**

An interceptor or trunk sewer is a sewer pipe, which transports wastewater from collection sewers to a treatment facility.

8) **Lateral**

A sewer lateral is the pipe, which connects a building to the collector sewer located in the street. In the City of Fairfax system, sewer laterals are owned and maintained by the property owner.

9) **Lift Station**

A lift station is a specific kind of pump station. It is a small sewer pump used when gravity can no longer carry wastewater through sewer. The lift station pumps wastewater from a lower elevation to a higher elevation so that gravity can again be used to carry the wastewater.

10) **Main, Sub-main (Sewer)**

A main or sub-main is a sewer pipe typically 8 inches in diameter into which the wastewater from two or more laterals (individual homeowner's pipe) is discharged and which subsequently discharges into a main, interceptor, trunk sewer or other collector.

11) **Public Sewer System**

Sewer lines, manholes, pump stations, force mains owned and maintained by the City of Fairfax.

12) **Pump Station**

A pump station is a structure containing pumps, piping, valves, and other mechanical and electrical equipment for pumping water, wastewater, or other liquids. A pump station is used to pump wastewater from a sewer main of lower elevation to a sewer main of higher elevation. A lift station; often used synonymously with the term pump station, provides a vertical lift to sewage in order for it, in many instances, to again flow by gravity.

13) **Sanitary Sewer**

A sewer that carries liquid and waterborne wastes from residences, commercial buildings, industrial plants, and institutions, together with minor quantities of ground, storm, and surface waters that are not admitted intentionally. The spent or used water of a community or industry, which contains dissolved and suspended matter.

B. The following are industry abbreviations for various pipe materials:

- 1) **DIP:** Ductile Iron Pipe
- 2) **PVC:** Polyvinyl Chloride Plastic
- 3) **RCP:** Reinforced Concrete Pipe

5.2.3 **COLLECTION SYSTEM DESIGN**

A. **Tributary Population**

- 1) Sewer systems which provide for a complete watershed shall be designed and sized for the estimated ultimate tributary population, on the following basis:

- a. Upper limit consists of the 50-year population growth projection, except for parts of the systems that can be readily increased in capacity; and
 - b. Consideration shall be given to land use plans, planning documents, and the maximum anticipated capacity of institutions, industrial parks, apartment developments, etc.
 - c. The entire watershed shall be assumed to be completely built out according to present or predicted zoning ordinances, whichever requires the greater capacity.
- 2) Sewer systems which provide for only a part of a complete watershed shall be sized to provide for the entire watershed. Otherwise, provisions shall be made for future increased capacity. Proper modification to allow for the characteristics (i.e. domestic, commercial, and industrial wastes and groundwater infiltration) of the area under consideration shall be made.
 - 3) Trunk and sub-trunk sewers shall be designed on a basis of a population density of not less than 10 persons/acre. Design provisions in excess of this minimum shall be made where the engineer deems it necessary. Supporting data shall be included in the design analysis.

B. Capacities

- 1) In determining the required capacities of sanitary sewers, the following factors shall be considered:
 - a. Maximum hourly domestic sewage flow;
 - b. Additional maximum sewage or wastewater flows from industrial plants and commercial areas;
 - c. Groundwater infiltration;
 - d. Topography of area;
 - e. Location of sewage treatment works;
 - f. Depth of excavation;
 - g. Pumping requirements; and
 - h. Occupancy rates.
- 2) New sewer system capacity shall be designed on the basis of an average per capita flow of sewage from the equivalent population served of not less than that set forth in Table 3 *Contributing Sewage Flow Estimates to be Used as a Design Basis for New Sewage Works* of 9 VAC 25-790-460. On this basis, lateral and sub-main sewers shall be designed with capacities, when running full, in accordance the peak flows. In accordance with 9 VAC 25-790-310:

- a. The minimum peak design capacity for lateral and submain sewers should be 400% of the average design flow.
 - b. The minimum peak design capacity of main, and trunk, sewers should be 250% of the average design flow.
 - c. The minimum peak design for interceptor sewers shall be 200% of the average design flow. These factors include infiltration but exclude inflow. If inflow is anticipated or known to exist in upstream sewers, the City Engineer may require that the design flow be increased accordingly and the justification/computation/source referenced in the design calculations and provided to the City Engineer for review.
- 3) Unless evidence is presented to prove a different flow from industry at ultimate development, the minimum allowance for industrial flow shall be determined by providing an equivalent population of 40 persons per acre or one equivalent population per employee, whichever is the greater, in the industrial areas. "Area" shall include entire areas zoned for industry, except public road, street and highway rights-of-way, floodplains on which construction is prohibited, and "green zones" separating industrial from residential areas, on which construction is prohibited.
 - 4) The minimum allowance for flows from commercial areas shall be determined by providing an equivalent population of 30 persons per acre or one-half the equivalent population per employee, whichever is greater, in the commercial areas. Areas shall include entire areas zoned for commercial development, including off-street parking areas and landscaped areas, but excluding the rights-of-way of public roads, streets and highways, floodplains of streams on which construction is prohibited and "green zones" 100 feet or more wide separating commercial from residential areas, on which construction is prohibited.
 - 5) In cases where the above criteria are not applicable, an alternate design procedure may be submitted to the Department of Public Works for approval. A description of the procedure used and justification for the modifications for sewer design proposed shall be included with the design analysis and plans submitted for approval.

Minimum Size/Sizing: No public gravity sewer conveying wastewater shall be less than 8 inches in diameter, with the exception of cul-de-sac laterals. Minimum easement widths shall be determined as follows:

Minimum Easement Widths/Pipe Size	
Pipe Size, in.	Easement Width, ft.
15-18	10
21-33	15
36-48	20
54-72	24
Where multiple pipes are installed, the edge of the easement shall be 5 ft. clear of outside of pipe. Where easements do not generally follow established lot lines, add 5 ft. to the easement width on the side toward the building.	

- C. **Sewer Connections:** Connections to sewer lines 6-inches in diameter and larger shall only be made at manholes.

5.2.4 STRUCTURAL DESIGN

- A. **General:** The structural design of sewers shall conform to the methods given in the latest revision of ASCE Manual No. 60 for the Design and Construction of Gravity Sanitary Sewer.
- B. **Working Strength:** The working strength for rigid pipes shall be the minimum ultimate 3-edge bearing strength divided by a safety factor, depending on the type of material and its use that conforms to the latest revision of ASCE Manual No. 60, Chapter 9.
- C. **Allowable load:** The allowable load shall be the working strength times the bedding factor shown below:
- 1) In trench condition:

Type Bedding	Bedding Factor
Class A – Concrete Cradle Plain concrete with lighting tamped backfill	2.2
Class A – Concrete Cradle Plain concrete with carefully tamped backfill	2.8
Class A – Concrete Cradle Reinforced concrete	3.4
Class A - Concrete Arch Plain concrete	2.8
Class A - Concrete Arch Reinforced concrete	Up to 3.4
Class B	1.9
Class C	1.5

2) In embankment condition:

Calculate based on ASCE Manual No. 60 guidance for Positive-Projecting Sewer Pipe, Negative-Projecting Sewer Pipe, or Induced Trench Conditions, depending on the conditions. (Embankment Condition = pipe installed with the pipe projecting above the original ground level and but backfilled to a minimum of 2 feet above the proposed top of the pipe).

3) Concrete encased pipe:

The bedding factor for concrete encasement varies with the thickness of concrete and the use of reinforcing, and may be greater than that for concrete cradle or arch. Refer to ASCE Manual No. 60 guidance for Encased Pipe.

D. Dead Load:

1) In trench condition: Unless more specific data is available, the dead load shall be computed using the following values:

$$\begin{aligned} \text{Backfill Weight, } w &= 130 \text{ pcf} \\ K_u = K_u' &= 0.130 \text{ (ordinary clay curve)} \end{aligned}$$

2) In embankment condition: Formula and curves are given in VDOT Standards.

$$\text{Backfill Weight, } w = 130 \text{ pcf}$$

E. Live Load: Unless more specific data is available, the minimum wheel load equivalent to an HS-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% of the design wheel load shall be added for impact.

F. Bearing Strength: Severe loads under unusual conditions may be accommodated by using ductile iron pipe which is heavier than the minimum allowed. In such a case, the ultimate minimum 3-edge bearing strength shall be determined by the following formula:

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

where,

t =	average barrel thickness of pipe (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 (inches)
W =	value of equivalent 3-edge bearing strength

- G. **Bedding of Pipe:** All sewer pipe shall be bedded by one of the methods shown in **Standard Details 4.01 Sheet 1 to Sheet 3** and shall comply with the most recent revision of the VDOT Road and Bridge Standards. The bedding used in design shall be compatible to that obtainable in the field.

5.2.5 ACCEPTABLE PIPE MATERIAL

- A. Refer to of Section 2.5 – *Sanitary Sewer, Part 2 - PRODUCTS* for detailed specifications for pipe and fittings. Use pipe, fittings, and joining methods according to the application indicated. Also refer to Section 2.3 – *Trenching, Backfilling, and Compaction of Utilities*.

- B. Pipe Materials for Public Sewers:

Allowable Materials for Sewer Pipe up to 12 inches in diameter	
Gravity Mains	DIP PVC AWWA C900 (DR 25)
Force Mains Services	Cement Lined DIP As required by the City of Fairfax Code Enforcement Division

Allowable Materials for Sewer Pipe 14 inches or larger in diameter	
Gravity Mains	PVC AWWA C905 DIP

- 1) RCP, PE, or VCP is not permitted.
- C. In the system design, the engineer may consider control of hydrogen sulfide generation through system design and/or use of corrosion resistant high alumina (calcium aluminate) pipe linings.
- D. The material selected shall be adapted to local conditions such as character of industrial waste, possibility of septicity, soil characteristics, exceptionally heavy internal-external loadings, abrasions, and similar problems. The pipe material shall conform to applicable ASTM, AWWA, ANSI, or other appropriate standards and the pipe is to be marked with an approved identification such as the specifications standard.

5.2.6 LOCATION

- A. **Sewer Location:** All sewer mains shall be installed within the street right-of-way or within a dedicated sewer or utility easement. Preferably, the sewer shall be located equidistant from property lines or curb lines wherever possible.
 - 1) The horizontal distance between sewers and existing or projected water mains shall be not less than 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 6 feet will be permissible.

- 2) Deflection angles for all horizontal turns shall be shown and elevations shall be tied to mean sea level reference datum, including benchmarks. Plans must show manhole number, top elevations, station, slope, and depth along with invert elevations.
- 3) Where tributary flow is expected from an upstream natural drainage basin, designers shall provide extensions of sewer mains to the farthest property line of the tract.
- 4) **Crossing other utilities:** When other underground utilities are encountered, (i.e. telephone lines, gas lines, cable TV, etc.) 12-inches of separation should be maintained.
- 5) **Sewer/Well Conflict:** If a sewer main is installed within 100 feet of an existing well, watertight joints meeting DEQ requirements shall be employed in the sewer line for all portions of the sewer line within a 100-foot radius of the well. In the event a sewer line is installed within 25 feet of a well, the well shall be capped and the property shall be required to connect to the City's water system if available or either the existing well abandoned a new well drilled meeting the setback requirements.

B. Sewers in relation to streams and other bodies

Sewers locate in relation to streams, lakes and reservoirs shall meet the following requirements:

- 1) **Alignment:** Sewers crossing streams shall be designed to cross the stream as nearly perpendicular to the stream flow as possible.
- 2) 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, 1 foot of suitable cover shall be provided where the stream is located in rock and 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. All sewers below the 25-year WSEL shall be encased.
- 3) 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.

The sewer interceptors, manholes, or other structures shall be located so they do not interfere with free discharge of flood flows of the stream. Portions of manholes above grade subject to hydrodynamic forces of

flooding shall be designed to resist the flood forces with a safety factor of 2.5 considerations shall be given for impact from debris.

Sewers paralleling creeks shall be below the stream elevation, such that lateral connections will be below streambed whenever possible. In certain circumstances where rock is present, sections of the main may be raised to allow lateral connections above the streambed provided the ability to serve the upstream property is not compromised and the pipe crossing is designed sufficiently restrained to prevent line breakage by the dynamic effects of the stream flow.

- 4) Sewers crossing streams shall be Class 52 rated ductile iron, encased in concrete, from manhole to manhole. Concrete encasement shall extend 10 feet beyond the bank on both sides of the stream. The pipe and joints shall be air-tested in place. The joints shall exhibit “0” infiltration and shall be designed, constructed, and protected against anticipated hydraulic and physical, longitudinal, vertical, and horizontal loads and erosion and impact.

Material used to backfill the trench shall be stone, coarse aggregate, washed gravel or other materials that will not readily erode, cause siltation, damage pipe during placement, or corrode the pipe.

C. Public Easements:

The minimum width of easements (except when adjacent and parallel to right-of-way) shall be 10 feet. Consideration shall be given for deeper cuts (generally greater than 12') by including an additional temporary construction easement (usually 10' - 50'). The Director of Public Works may require that the width of the **permanent easement** increase with the depth of sewer for maintenance purposes.

Except at stream crossings and as may be limited by wetland permit requirements, easements shall be fully accessible by rubber-tired vehicles. Refer to Section 9 *Permits* of this manual for additional information about permitting requirements. The City may require that small streams be piped, provided crossings are consistent with USCOE requirements.

5.2.7 SERVICE CONNECTIONS

- A. Services connected to gravity sewers shall be connected using in line wyes and tees only. Service saddles may be used on pre-existing mains. All wyes and tees shall be embedded in stone. See **Standard Details 4.12 and 4.13** for service tap detail. Connections to sewer lines 6 inches or larger shall be made at manholes.
- B. Connections to trunk line sewers: Trunk line sewers may not be tapped, but where available and with the approval of the Department of Public Works, building sewer may enter a trunk line manhole and a satisfactory bench and invert built at the expense of the developer. If no manhole is available, permission to construct a new manhole must be secured from the Director of

Public Works and it must be built at the developer's expense and under the direction of the Director of Public Works.

- C. Service connections should cut in to main lines along the direction of flow. While a 90-degree connection is acceptable, connections should not cut in against the direction of flow.
- D. Tap size: No 8-inch sewer shall be tapped for a building sewer larger than 4 inches unless approved by the Director of Public Works.
- E. A cleanout will be installed on each house service. Unless topography prohibits, place services at low side of lot.
- F. The cleanout shall be located outside the right of way or the easement line on the City side of the property line as shown on **Standard Detail 4.12**.
- G. See **Standard Details 4.12** and **4.13** for service lateral slopes.

5.2.8 DEPTH/MINIMUM COVER

The depth of sewer mains should be such that they are deep enough to serve all upstream properties within the drainage basin.

- A. Sewer installed where subjected to vehicle traffic shall generally be placed with a minimum cover of 6 feet below the finished street surface or ground and with a minimum cover of 3 feet in rights-of-way with no highway traffic. In isolated instances where only a few houses are served and where the required 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 the effects of traffic.
- B. Where approved by the Department, sewers with less than 3 feet of cover shall be ductile iron or encased in concrete. Sewers with 18 feet or more of cover shall be DIP.

5.2.9 BUOYANCY

Refer to buoyancy calculations in ASCE Manual 60. Buoyancy of sewers shall be considered and flotation of the pipe shall be prevented with appropriate construction where shallow cover and high groundwater or flooding conditions are anticipated. For design purposes, assume water to top of pipe and pipe is empty.

5.2.10 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 Department of Public Works.

- 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 sewers at the junction are at the same level. Generally, this condition will be met by placing the crowns of both sewers at the same elevations.
- C. Sewers shall be designed to be free flowing with 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 (fps). 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. “n” shall be no less than the following:

Sewer Size (inches)	“n”
8 to 27(laid in lengths of 20 feet)	0.013
30 and greater (laid in lengths of 4 feet or more with tongue and groove joints made carefully smooth)	0.012

- D. For sewage flow depth less than $\frac{1}{4}$ full, allowances shall be made for increased value of “n” and in no case shall velocities of less than 1.3 fps be permitted. The improved velocities shall be accomplished by steeper grades and not by decreasing pipe diameter.

1) **Considerations for low flows:**

On upper reaches of small services and mains, due to water saving fixtures now employed, the designer should give consideration to increasing the slope of gravity services above the minimum allowed in order to flush solids.

Special attention must also be given to the fact that initial flows may be substantially lower than design flows and the velocities well below the minimum. The designer or the City Engineer may direct usage of greater slope or require developer to provide periodic flushing until sufficient flow has been developed to provide a self-scouring velocity.

- E. The maximum permissible velocity at average flow (before applying peak flow factor) shall be 10 fps. Where velocities must exceed 10 fps, the sewer shall be constructed of ductile iron pipe. Suitable drop manholes shall be provided to break the steep slopes to limit the velocities in the connection 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 minimum slopes in feet per hundred feet to be provided for pipes flowing full depth to one-fourth of full depth shall be:

Sewer Size (inches)	Minimum Slope (%) for Pipe Lengths up to 20 feet
8	0.47
10	0.34
12	0.26
15	0.18
18	0.14
21	0.113
24	0.088
30	0.062
36	0.048
42	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 junction boxes shall be allowed for as follows:

- 1) At manholes on straight runs, allow head loss of 0.05 feet.
- 2) **Minimum drop across invert:** The minimum drop between manhole invert in and invert out is 0.05 feet on straight junctions. Other drops (H), where there is no change in pipe size, can be computed by applying the following headloss (*K*) coefficients to the velocity head:

$$H = K \left(\frac{V^2}{2g} \right), \text{ where}$$

H = Vertical drop across invert of manhole (ft)

K = Headloss coefficient (from table below)

V = Average velocity in influent pipe (ft/sec)

g = Acceleration of gravity (32 ft/sec²)

- 3) **Turns made inside manholes:**

Condition	K
For bends at junctions of 25 degrees	0.30
For bends at junctions of 45 degrees	0.40
For bends at junctions of 90 degrees:	
Radius < 2 pipe diameters	0.50
Radius > 2 pipe diameters	0.25
For junctions of 3 pipes	0.80
For junction of 4 or more pipes	1.00

(Reference: King's handbook of Hydraulics)

In no case shall total allowance be less than 0.05 feet.

- 4) At transitions and intersection of sewers larger than 24 inches in diameter, each case shall be investigated separately and the hydraulic analysis shall be submitted to the Department of Public Works for approval.
- 5) 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 diameter sizes be thus reduced below 12-inches.
- 6) **Steep Slope – Pipe Anchorage:** Sewers constructed on 20% or greater slope shall be anchored both to prevent the sewer pipe from creeping downhill and/or to prevent water from flowing along the pipe and causing the trench to wash out. The lines shall be securely anchored with concrete anchors. Suggested minimum spacing of anchors shall be as follows:

Grade Range (% slope)		Anchor Spacing (center to center in feet)
From	To	
20	<35	36
35	<50	24
50	or greater	16

H. Changes in Pipe Size or Material:

- 1) **Pipe Size Changes:** Gravity sewer sizes shall remain constant between manholes.
- 2) **Undersized or substandard downstream sewers:** Contact the City Engineer for design considerations.
- 3) **Pipe Material Changes:** To avoid couplings of dissimilar material, pipe material must remain consistent between manholes and may not be changed. In some cases, it may be necessary to have dissimilar materials join at drop manholes. In this case, the joint shall occur where the main approaches a drop manhole.

5.2.11 INVERTED SIPHONS

Inverted siphons must be approved by the Department and will be considered only after all alternate designs have been determined as impractical. An inverted siphon of minimum size (6-inch) should not serve a population of less than 3000. Inverted siphons shall have not less than 2 barrels with a minimum pipe size of 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 fps for average flows. The inlet and outlet details shall be so arranged that the normal flow is diverted to 1 barrel and in such a manner that either barrel may be cut out of service for cleaning.

5.2.12 TESTING AND ALLOWABLE LEAKAGE

All sanitary sewer system components, including gravity sewer lines, force mains, and manholes, must be tested for leakage upon installation. See specification Section 2.5 – *Sanitary Sewer* for testing requirements, which meet the requirements specified in 9 VAC 25-790-330, -340, and -440.

5.2.13 DESIGN – MANHOLES

A. Location

- 1) **Manholes shall be installed:** On all mains 8 inches and larger, manholes shall be installed at the terminal end of the line, at all changes in grade, changes in pipe material, at changes in main size or alignment, at all intersections with other sewers, and at distances not greater than 400 feet for all sewers 15 inches or less in diameter. For sewers 18 inches to 30 inches in diameter, at not more than 500 feet apart.
- 2) Manholes shall be designed in detail incorporating the features shown on **Standard Details 4.02, 4.03, 4.04, 4.05, 4.06, 4.07, 4.08, 4.09, 4.10, 4.11, and 4.14.**

B. Diameter

- 1) **Minimum Diameter:** The minimum diameter of manholes shall be 4 feet. The minimum diameter of inside drop manholes shall be 4 feet.
- 2) **Diameter based on pipe size:** Manholes shall be 4-foot minimum diameter for lines up through 18 inches. Manholes for sewers larger than 18 inches up through 48 inches shall have an inside diameter of not less than 5 feet.
- 3) **Diameter based on depth:** Manholes 0 to 20'-0" shall be 4-foot in diameter minimum. Manholes greater than 20 feet deep shall be 5 feet in diameter. All manholes shall have extended bases. Manholes greater than 20 feet in depth may be transitioned, at the 20-foot depth, from a 5-foot diameter to 4-foot diameter manhole except after a minimum of 5' of riser (height) from invert of manhole.
- 4) **Cones:** Eccentric cones are preferred in all cases.
- 5) **Minimum drop across invert:** The flow channel through the manholes shall be made to conform in shape and slope of the sewer. However, the minimum drop between manhole invert in and invert out is 0.05 feet on straight junctions. See paragraph 5.2.10 G 2, Minimum Drop Across Invert.

C. Drop Type

- 1) A drop shall be provided for a sewer entering a manhole at an elevation greater than 18 inches or more above the invert of the manhole unless sewer pipe crowns match elevations or as may otherwise be required to conform to the use of standards fittings in the drop pipe construction. Where the difference is less than 18 inches, the base of the manhole shall be so filleted as to prevent solid deposition.
- 2) **Inside Drops:** Inside drops will be permitted on a case-by-case basis. See **Standard Detail 4.07.**
- 3) **Outside Drops:** Not permitted.

D. Doghouse Manhole

Manholes placed over existing mains shall be constructed in accordance with **Standard Detail 4.06.**

E. Water-tightness

- 1) Manholes shall be pre-cast concrete.
- 2) **Pipe connections to Manholes:** Inlet and outlet pipes shall be joined by core drilling to the manhole with gasketed flexible watertight connections (rubber boots). See **Standard Details 4.02, 4.03 and 4.04.**
- 3) Manholes shall extend above the maximum known stage of floodwaters 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.
- 4) **Ventilation:** Ventilation of gravity sewers shall be provided where continuous watertight sections greater than 1000 feet in length are incurred. See **Standard Detail 4.14.**

F. **Buoyancy:** Buoyancy shall be considered and flotation of the manholes shall be prevented with appropriate construction where high groundwater or flooded conditions are anticipated. For design purposes, assume water to top of manhole and that the manhole is empty.

G. **Inspection and Testing:** See technical specification Section 2.5 – *Sanitary Sewer* for testing requirements.

H. **Coating:** All manholes shall have bituminous coating on the outside walls.

I. Corrosion Protection for Manholes:

- 1) Where corrosion conditions due to septicity or other causes are anticipated, corrosion protection shall be provided on the interior of the manholes.

Consequently, drops in interceptor lines or drops into interceptor lines shall be avoided. Drop manholes, if required, shall be provided upstream of interceptor line connection.

- 2) Where high flow velocities are anticipated, the manholes shall be protected against internal erosion by providing erosion resistant coatings, sacrificial concrete, or other approved means. Manholes shall also be protected against displacement from impact.

5.2.14 PROTECTION OF POTABLE WATER SUPPLIES AND STORM SEWERS

See specification Section 2.5 – *Sanitary Sewer, Part 1- General, paragraph 2.5.10, Project Conditions* for separation requirements between water mains and sewer mains/manholes and water mains and drainage structures/streams.

5.2.15 PUMP STATIONS

A. General

Pump stations and force mains will be allowed only with the permission of the City Engineer.

Pump stations shall be City of Fairfax standard. Pumps shall be self-priming pumps with electro-mechanical controls. Pumps shall be designed for continuous duty pumping raw, unscreened wastewater.

Self-priming pumps: Self-priming pumps shall have alternating (transducer or float) system switches. Pumps and related controls shall be enclosed in a building. Though not preferred, with the City Engineers' prior approval, a rollback "Quonset" style fiberglass enclosure may be permitted. Pumps shall be capable of handling a 3-inch solid and any trash or stringy material that can pass through a 4-inch hose unless mechanical means of solids reduction is installed at the pump. Pumps shall be made non-clog by passing solids, trash, and stringy material through a non-clog impeller. Impellers shall have blades that are generally forward rounded or otherwise configured to avoid catching solids, trash, and stringy material.

Lift stations shall include the following as a minimum:

- 1) **Inspection and Testing:** See technical Section 2.5 – *Sanitary Sewer* for manhole testing requirements.
- 2) Service head, meter base, service connection, disconnect, and area light with switch.
- 3) Audible and visual high water alarm and alarm silence.
- 4) Auto-dialer (minimum 8 number, 4 channel). The automatic telephone dialer shall be a solid-state component capable of dialing up to 8 phone numbers, each up to 24 digits in length. The dialer shall have solid-state voice message recording and playback, all implemented with permanent nonvolatile solid-state circuitry with no mechanical tape mechanism.
- 5) Automatic air release valves, as applicable.

- 6) For self-priming pumps, provide floats or transducer type control system with hand-off-automatic (H-O-A) switches and an automatic alternator. For submersible pumps, provide mercury float switches for level control.
- 7) High water alarm circuitry.
- 8) 3-phase voltage monitor, if applicable. Indication of 3-phase power fail. All motors shall have a low voltage protection device which, on the reduction or failure of voltage, will cause and maintain the interruption of power to that motor. The low voltage protection device should protect each phase of 3-phase motors.
- 9) Suction and/or discharge gauges, as applicable.
- 10) Elapsed time indicators.
- 11) High pump temperature protection.
- 12) Pump run lights.
- 13) Motor overload resetter
- 14) Surge suppressor.
- 15) Duplex service receptacles on GFCI.
- 16) Surge relief valve and return piping to wetwell.
- 17) Start-up assistance and certification, including operational/witness/drawdown test. Certified pump curves shall be provided as part of the project closeout documents.
- 18) Dual power supply auto switchover, etc.
- 19) For self-priming pump stations, provide heaters and fluorescent lighting.
- 20) The lift station is to include back-up alarm system that operates off a 12-volt battery connection in the event of power failure. The battery system is to include a trickle charger to ensure battery integrity.
- 21) When required by the City Engineer, based on reliability (see 9 VAC 25-790-390), provide auxiliary natural gas or diesel fired automatically activated stand-by power generator source with automatic reset, placed on site. Pump manufacturer to provide power demand/ratings to contractor before ordering pump and the power demand appropriately marked on the pump shop drawings. Generator shall have the capacity sufficient to sequentially start and run all pumps in the pump station. The contractor shall provide a complete engine driven generator set. The generator set shall consist of four-cycle, radiator-cooled, engine direct connected to an alternating current generator, a unit-mounted control panel, all mounted on a common sub-base. The control panel shall be complete with engine controls and instruments, safety controls and panel lights including the following:
 - a. The generation unit shall be capable of powering the pump motors starting current, electrical systems, instrumentation /controls and alarm systems, and other auxiliary equipment as may be necessary to provide for the safe and effective operation of the pump station. The generation unit shall have the appropriate power rating to start and continuously operate under all connected loads. The starting system shall be appropriately alarmed and instrumented to indicate loss of readiness (e.g. loss of charge on batteries, loss of pressuring in air accumulators, etc.).
 - b. The generation unit shall be provided with special sequencing controls to delay lead and lag pump starts unless the generating unit has the

- capacity to start all pumps simultaneously while the auxiliary equipment is operating.
- c. The generation unit shall be capable of shutting down and activating the audible and visual alarms and telemetry if a damaging operating condition develops.
 - d. The generation unit shall be protected from damage when restoration of power supply occurs.
 - e. The generator shall be equipped with an automatic transfer switch to start generator and transfer load to emergency in case of utility under voltage, over voltage, power loss, phase reversal, or phase loss.
 - f. The control panel shall be complete with run-stop-remote switch; remote start-stop terminals; cranking limit; battery charge rate ammeter, oil pressure gauge, temperature gauge; low oil pressure shutdown; high engine temperature shutdown; over speed shutdown; AC voltmeter; voltage adjustment; frequency meter; and running time meter.
 - g. Circuit breakers shall be provided with a built in control panel.
 - h. Provide manufacturer's recommended anti-freeze, engine heaters, and suitable trickle battery charger. All accessories shall be engine-mounted and within the weatherproof sound attenuated housing.
 - i. The manufacturer of the unit shall completely assemble and test the unit before shipment. He shall be one who is regularly engaged in the production of such equipment, and who has spare parts and service facilities. He must also provide 1 complete set of filters.
 - j. The controls must indicate engine run, common engine fail, transfer switch position, low fuel level, and fuel tank leak for remote telemetry purposes.
 - k. The automatic transfer switches must have a disconnect on the utility service main side.
 - l. The generator shall comply with the following minimum requirements:
 - i. Engine: Four-cycle, 4 cylinder, radiator cooled, at 1800 RPM. Starting shall be from batteries, with capability to start the unit at 32 degrees temperature.
 - ii. Generator: Rating shall be continuous standby service at 0.8 power factor, at 1800 RPM.
 - iii. Voltage: Three-phase, 208. KW rating to match facility needs.
 - iv. Engine shall be equipped with an isochronous governor as manufactured by Woodall.
 - v. Frequency regulation shall be less than 3-cycles from no-load to full load.
 - m. All accessories needed for the proper installation of the system shall be furnished. Included should be batteries, battery cables, exhaust piping, mufflers, vibration mounting, and three bound sets of detailed operation and maintenance manuals with parts list. Batteries should be lead acid.
 - n. The generator set shall be enclosed with a factory-installed weather-protective housing (sound abating enclosure to 68db @ 23 ft.) Housing shall provide easy access to the engine-generator and instrument panel. Muffler to be designed so exhaust is not blown or sucked across the set by cooling air.
 - o. Included with the generator shall be a complete fuel system consisting of a fuel tank, fuel gauge, fuel lines, fuel pumps, valves and any and all other items incidental to a first-quality installation.

- p. Provide integral sub-base double-walled diesel tank. The tank is to be UL approved closed-top dike type. The tank shall also be fitted with a leak sensor device. The tank must have a capacity to run the generator for a minimum of 48 hours at 100% load.
- q. Tank shall consist of the fuel tank separate and contained within the frame. No generator weight is to be supported by the tank. Provide a drain plug at one end of the rupture basin. Provide vibration isolators between generator set and tank assembly. Provide fuel low-level alarm remote mounted.
- r. Provide manufacturer's recommended anti-freeze and engine block heater, per manufacturer's recommendations, with thermostatic controls to maintain engine coolant at proper temperature to fulfill start-up requirements, adjustable if possible. Provide suitable trickle battery charger. All accessories shall be engine-mounted and within the weatherproof sound attenuated housing.
- s. Provide annunciator panels with visual and audible alarms to monitor and warn of emergency operation conditions affecting line and generator power sources.
- t. Provide stainless steel super critical grade type exhaust silencer mounted inside of the generator enclosure for corrosion protection.
- u. Provide amp meter, voltmeter, and frequency meters with phase switches.
- v. Provide fuses or circuit breakers for battery charger and engine.
- w. Provide an automatic battery charger, static type, magnetic amplifier control with DC voltmeter, DC ammeter and potentiometer for voltage adjustment. The charger is to be completely automatic and rated for the type of battery use. The charging rate is to be determined by the state of the battery and reducing to milliamp current on fully charged battery. The charger shall be 120 V., single-phase, 60 cycle, AC input with 6-amp maximum output.
- x. Operation and Maintenance instructions. The contractor shall provide a minimum of 4 continuous hours of operation and maintenance instructions for the Owner's personnel.
- y. The City must be furnished with one complete set of air, oil and fuel filters.

B. Station Design:

- 1) Design of station shall be according to the provisions of the Sewage Collection and Treatment Regulations, Part I, 9 VAC 25-790, *Manual of Practice for Sewerage Systems and Treatment Works*, Article 2, *Sewage Pumping Stations*, 9 VAC 25-790-380 through 430 as published by the Commonwealth of Virginia, DEQ.
- 2) The pump station shall have a 100% reserve peak pumping capacity (dual pumps) and be capable of pumping at a rate of 2.5 times the average daily flow rate with any one pump out of service. Pump on/off elevations shall be set to achieve 2 to 8 pumping cycles per hour at the average flow rate. When the station is expected to operate at a flow rate less than $\frac{1}{2}$ times the average design flow for an extended period of time, the design shall address measures taken to prevent septicity due to long holding times of untreated sewage in the wet well.

- 3) Each pump shall have an individual intake and suction line. Pump suction and discharge piping shall not be less than 4 inches in diameter except where design of special equipment allows.
- 4) The design velocity in pump piping shall not exceed 6 fps in suction piping and 8 fps in the discharge piping. All pumps shall be provided with an air relief line on the pump discharge piping.
- 5) Valve Vaults: All pumps, connections, shut-off valves, and check valves shall be located in a separate vault above the wet well, allowing accessibility to both the wet wall and pump/vault for inspection, maintenance, etc.
- 6) The power source, voltage and phasing shall be verified before ordering pumps.
- 7) Adequate lighting for the entire pump stations shall be provided in accordance with Virginia Occupational Safety and Health Compliance Program (VOSH) and other applicable codes and standards.
- 8) Ventilation shall be provided in accordance with VOSH requirements and shall comply with Article 2, *Sewage Pumping Stations*, 9 VAC 25-790-380 through 430 as published by the Commonwealth of Virginia, DEQ for enclosed spaces within pump stations during all period when the station is manned. Where the pump is permanently mounted below the ground, mechanical ventilation is required and shall be arranged so that it independently ventilates the dry well.
- 9) Evaluate the capacity of the receiving sewer main at the point of discharge and downstream to determine that the line can handle the pumped sewer flow.
- 10) The pump station and force main must be sized to accommodate the total basin area that could gravity flow into it.
- 11) The City of Fairfax reserves the right to require odor control facilities at pump stations.
- 12) All control panels must be weatherproofed and have weatherproof identifying labels attached with stainless steel screws.
- 13) The use of rigid conduit is required.

C. Wetwells:

- 1) Wetwells shall have the interior walls painted in accordance with the technical specifications, Section 2.5 – *Sanitary Sewer*.
- 2) Buoyancy shall be considered and flotation of the wetwells shall be prevented with appropriate construction where high groundwater conditions are anticipated.

- a. **Computations:** Provide buoyancy calculations to the City Engineer. Assume water to top of structure and structure is empty except that you may include the weight of the liquid below pump off elevation.
- 3) Surface water shall be directed away from the station pad in all directions.
- 4) Wetwells and the access road to the site shall be located above the 100-year flood elevation.
- 5) Provide a screened exterior vent with the end either turned downward or provided with a “mushroom” cap to prevent gas entry to either the panel or pump house enclosure. The vent must be at least 4 inches in diameter.
- 6) Wetwell components shall be located such that normal maintenance and operation of the components can be performed without having to enter the wetwell.
- 7) Seal the electrical conduit running from the wetwell to the control panel to prevent gas entry into panel or pump house enclosure.
- 8) All bolts, mounting brackets, guide rails, pump lift chains, etc. must be stainless steel, sized to support the applicable static and dynamic loads imposed by the equipment. Cable pump lift chains are not permitted.
- 9) Provisions shall be made to prevent solids deposition. Where used, wet well fillets shall have a minimum slope of 1:1 to the hopper bottom. The horizontal area of the hopper bottom shall be no greater than necessary for proper installation and function of the inlet.

D. Site:

- 1) All mechanical and electrical equipment which could be damaged or inactivated by contact with or submergence in water (motors, control equipment, blowers, switchgear, bearings, etc.) shall be physically located above the 100-year flood or otherwise protected against the 100-year flood. All stations shall be designed to remain fully operational during the 25-year flood event.
- 2) Provide a service head, meter base, service connection, disconnect, area light with photocell.
- 3) A 10-foot wide all weather access road consisting of 8 inches of VDOT #21 stone on a pre-compacted subgrade graded to drain is to be provided to the station with a turn-a-round area of sufficient size to accommodate turning of City maintenance vehicles. If the lift station easement does not directly abut a publicly dedicated road, a 30 ft. access easement shall be provided.

- 4) When a generator is required, provide an 8-inch thick concrete generator pad.
 - 5) Sites for stations shall be of sufficient size for future expansion or addition, if applicable.
 - 6) An area light on breaker, on a separate circuit from the pumps, shall be provided at the station. The light shall be a minimum of 100-watt sodium high-pressure with a minimum clear mounting height (ground to fixture) of 15 feet.
 - 7) 10 ft x 10 ft x 8-inch concrete pad for water tank with drain and valve.
 - 8) Emergency pump connection with quick connect flange and plug valve.
 - 9) A metered potable water source with non-freeze yard hydrant is required, unless approved otherwise by the City Engineer. The Non-Freeze Yard Hydrant shall be Clayton Mark model 5451 Lever type, Woodford W-34 (3/4"), Woodford Y-1 (1") frost proof yard hydrant or approved equal.
 - 10) Provide a non-freeze shower w/ eyewash and concrete pad.
- E. **Force Mains:** the hydraulic design of force mains shall be based on the following conditions:
- 1) Force mains shall be designed for a minimum velocity of 2 feet per second and a maximum velocity of 8 feet per second.
 - 2) The minimum size of force mains shall be 4 inches in diameter, except for grinder pumps, which shall be provided with a minimum diameter of 2 inches.
 - 3) Force main materials shall at a minimum conform to the table in *paragraph 5.2.5, Acceptable Pipe Material.*
 - 4) Provide combination air valve air release valves at all high points with differential grade separation of 15 feet or more between high and low points to relief air locking.
 - 5) Force mains shall enter gravity sewer 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 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 wall of the force main termination structure shall have the AgruLiner lining, or approved equal.
 - 6) 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.

- 7) All force mains shall be tested at a minimum of at least 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.
- 8) A plug valve or valve vault shall be placed outside of the pump station.
- 9) Sewer force main valve boxes shall have the valve cap marked SEWER.

5.2.16 SEPTIC TANKS

A. Existing Upon Annexation

- 1) Properties that are served by wells and/or septic tanks when they are annexed may continue the well supply and/or septic tank until there is a failure or until ordered by the Fairfax County Health Department to discontinue such use. Upon failure of a well or septic tank, the owner will be required to connect to the water or sewer system if it is reasonably available as determined by the City Engineer. The plumbing inspector cannot issue a permit for repair or upgrade of a well or septic tank.
- 2) If a sewer main is installed within 100 feet of an existing well, water tight joints meeting public water supply requirements shall be employed in the sewer line for all portions of the sewer line within a 100 foot radius of the well. In the event a sewer line is installed within 25 feet of a well, the well shall be capped and the property shall be required to connect to the City's water system.
- 3) At such time as a property that has been supplied by a well elects to connect to the City's water system, the well supply must be completely disconnected as a supplemental feed. Under no circumstances shall a well be connected to the City's distribution system.

B. Development Proposed After Annexation

- 1) Wells and septic tanks will not be allowed to serve property proposed for new development after annexation.
- 2) Exceptions to this policy are allowed as follows:
- 3) When **the City cannot or will not extend service**: If water and/or sewer service is desired, the owner shall first submit a petition. If the City does not accept the petition and the City Council does not order the improvements installed, the City may allow a well or septic tank to serve the property. In such cases, the property owner must obtain written authorization from Fairfax County for the well or septic tank and submit it to the City's plumbing inspector prior to release of the building permit.

5.3 POLICY AND EXECUTION

The purpose of this section is to outline minimum plan submittal requirements for sanitary sewers; identify City policy regarding sanitary sewer design and implementation in addition to that outlined in Section 5.2 *Design Standards*; and to establish additional requirements for execution, inspection, and acceptance of sanitary sewer.

Approval of Sanitary Sewer Design Plans and Calculations by the City of Fairfax does not complete the City of Fairfax review process. All other applicable City Departments, State, and Federal agencies must also approve the plans as warranted. It shall be the sole responsibility of the Owner/Developer/Designer to acquire all applicable approvals.

5.3.1 PLAN SUBMITTAL REQUIREMENTS

The section outlines the minimum plan submittal requirements for plan review and approval of sanitary sewers. Applicants should also refer to the City of Fairfax Site Plan Package, located on the City's website.

Seven (7) complete sets of site plan drawings and two (2) complete sets of site work calculations shall be submitted to the City of Fairfax, Attn: Planning Department for review and approval. The submission shall include:

A. Designer's Certification

The following certification shall appear on the cover page and signed by a certified engineer, architect or land surveyor.

<p>"I hereby certify that, to the best of my ability, this plan has been prepared in accordance with the latest City of Fairfax Public Facilities Manual and City Code."</p>
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<p>Signature: _____ Printed Name and Title: _____ Date: _____ Registration Number: _____</p>
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- B. City of Fairfax Department of Public Works Sanitary Sewer Standard Notes, as they appear in the City of Fairfax Site Plan Package.
- C. Site Plan Review Fee Calculation Sheet, specifying the linear feet of sanitary sewer proposed and estimated fee.

5.3.2 PERMITS

Refer to Section 9 *Permits* of this manual for additional information about permitting requirements.

5.3.3 RULES AND REGULATIONS GOVERNING EXTENSIONS WITHIN SPECIFIED AREAS

5.3.3.1 GENERAL

Under special contract agreements, the Department may permit (a) an extension of its sewage 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 Department. In either case, the installation shall be in accordance with the standards and specification presented in the Public Facilities Manual herein, shall be made by and at the expense of the Applicant desiring to secure sewer services for said area, and, upon acceptance by the Department, shall be dedicated to the Department 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 Department and written permit therefore, including approval of said plans and specifications, have been obtained from the Department, all as hereinafter provided.

5.3.3.2 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); and shall be accompanied by 2 copies of a preliminary plat (measuring 24 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 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 Section 5 Sewer Design of the Public Facilities Manual, latest edition.”
- B. The application shall include such other pertinent information, as the Department may require, and shall include in full detail the manner in which the Applicant proposes to meet the standards set forth in Section 5 of the Public Facilities Manual herein. Said plat shall be prepared and certified by an engineer dully authorized by the State of Virginia to perform such work.

5.3.3.3 REVIEW OF APPLICATION

In making its review of the application and accompanying preliminary plat, the Department 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 standard presented in the Public Facilities Manual herein and (2) to permit future extensions where circumstances so indicate.

5.3.3.4 PLANS, SPECIFICATIONS AND COST ESTIMATES

In case the Department 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 Public Facilities Manual herein, the applicant shall submit to the Department, 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 Section 5 of the Public Facilities Manual herein.

5.3.3.5 CERTIFICATION

After the Department has approved said plans and specifications, and before a permit can be issued, the Applicant shall certify as follows:

- A. That the installation shall conform to said plans and specifications and shall be subject to inspection by the Department at any time as work progresses.

- B. That the location of all existing utilities has been confirmed. Where actual locations differ from the plans, conflicts shall be resolved prior to starting the work.
- C. 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.
- D. 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 Department, an easement and a free unobstructed and uninterrupted right-of-way for inspection, operation, maintenance, enlargement, replacement, alteration and extension of the installation.
- E. That in the event the construction work is to be done by contract, the Applicant shall, upon letting such contract or contracts, advise the Department as to the total cost thereof.
- F. 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 incidental to said project without regard to whether or not the Applicant, his agents, employees or contractors have been negligent, and that the Department shall be by the Applicant held and kept free and discharged of and from any and all responsibility and liability thereof 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.
- G. That the Applicant will not commence work on this project until he has obtained all insurance required and approved by the Department and that the Applicant will not allow any contractor or subcontractor to commence work on this project until a similar insurance has been obtained and approved.
- H. 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 Department.
- I. That ownership of the completed installation shall, upon acceptance by the Department, be in the Department, its successors and assigns.
- J. 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 Department and to the satisfaction

of the Department for a term of 1 year from date of acceptance by the Department. The guarantee shall be secured by a bond of a surety company acceptable to the Department, in the amount of 5% of the estimated construction cost of work, for faithful performance of the guarantee.

5.3.3.6 PERFORMANCE BOND

Simultaneously with his delivery of the executed contract agreement, the Applicant shall deliver to the Department an executed performance bond in the amount of 100% of the estimated cost of the project, including a contingency item, the amount of said bond to be satisfactory to the Department, 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 Department. 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.

5.3.3.7 ISSUANCE OF PERMIT

Upon delivery to the Department by the Applicant of the certification and performance bond, as hereinbefore provided, the Department 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.

5.3.3.8 NOTICE OF CONSTRUCTION

The holder of a permit hereunder shall notify the Department 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.

5.3.3.9 AS-BUILT DRAWINGS

- A. Record drawings are required to be submitted upon completion of the project prior to final acceptance or issuance of a CO. Record drawings shall conform to the following:
 - 1) Applicants should comply with the Right of Way / Easement Permit Package and the As-Built Plan Application and review checklist, both available on the City's website.
 - 2) Deed book references of easements prepared by a surveyor or engineer duly authorized by the State of Virginia to prepare same, shall be submitted to the Department as a condition precedent to use
- B. **General**

of the facilities. The drawings shall be referenced to the Virginia State Plane Coordinate System.

- 3) The Contractor shall provide the City with an electronic copy of the As-Built drawings for sewer installation in portable document format (PDF) on CD or DVD. In addition, the as-built drawings shall be provided to the Department in an electronic format, compatible with AutoCAD drawing file format.
- 4) As-built drawings shall accurately show only those lines installed at time of submittal and in the correct location. Lines not installed shall not appear on the as-built drawings. "Omit" or "Omitted" is not an acceptable method of indication that lines were not installed.
- 5) Any changes made in grade, alignment, or placement of manholes, valve hydrants, etc. because of problems encountered during installation shall be accurately shown on the as-built drawings.
- 6) When the as-built information differs from the approved construction plans, a justification for the modified conditions may be required.
- 7) The exact location of taps/service connections shall be shown on the as-built drawings in the following manner:

Lot or House #	Sewer		
	Station	Offset R/L	Length

Footnotes:

- a. Station on sewer main to the corporation or service saddle to the nearest 0.1 feet.
 - b. Right or left is off of main looking up station.
 - c. Horizontal distance is from the corporation to meter box or service saddle to curb cleanout.
 - d. Depth of sewer service connection at clean-out plug.
 - e. The sketch shall indicate whether mains are PVC, ductile iron, etc.
- 8) Measurements shall be made to the nearest 0.1 foot.

C. Sewers Construction:

As-built drawings of sewers shall include the following obtained from an actual field survey: Cleanout station, invert in and invert out elevations at each manhole and the actual field-measured distance between centerlines of manholes, grades, manhole top elevations, distances from one clean out to another, and horizontal and vertical lengths for cleanouts.

1) **Acceptable Grade variation from required minimum slope:** The line is to be inspected for conformance with line and grade shown on the plans. The maximum allowable drift between structures from the proposed alignment is:

a. **Horizontal alignment:** 0.50 foot (applies to manholes)

b. **Vertical alignment:**

c. **Minimum Slope:** No tolerance below the minimum slopes will be allowed unless otherwise approved by the City Engineer. When permitted by the City Engineer, drift in vertical grade between as-built manholes shall not decrease the slope of the sewer line below the minimum permitted slopes based on the following tolerance:

Pipe size (inches)	Variation (%)
8 through 12	No flatter than 75% of the specified slope
12 through 24	No flatter than 90% of the specified slope

d. When permitted, if the slope in the pipe is found to be less than the approved variation, the Contractor shall relay the pipe. Errors in vertical grade between manholes shall be compensated for by adjusting the manhole inverts or by resetting the manhole as required by the City Engineer. Pipe removed due to faulty grade shall be replaced with new pipe.

D. **Inspection scheduling:** All inspections must be scheduled 24 hours prior to when inspection is needed and 48 hours in advance of when testing is needed. Inspections will be performed in the order received. Every effort will be made to accommodate the time of request, however, this cannot be guaranteed.

E. Upon completion of project, staging/storage areas restored and portable toilet facilities removed from project.

F. **Re-inspection fees:** All inspections that fail or are not ready for inspection are will be subject to a re-inspection fee.

5.3.3.10 EXTENSION OF SEWAGE SYSTEM BY DEPARTMENT

Nothing contained herein shall be construed as limiting or preventing the Department from extending its sewage system whenever and wherever it may determine that circumstances so warrant.

5.3.3.11 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 Department, (3) employed by the Applicant.

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 Department, for compliance to these standards, approved specifications and plans, and the terms of any contract or agreement between the Department and Applicant.

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

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

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

5.3.4 EASEMENT REQUIRED

- A. Where possible, all sewer mains shall be placed within the right-of-way. When this is impractical, or where, due to depth or slope, additional easements are required, then easements shall be dedicated and recorded on plats prior to acceptance for maintenance. When utilities are located outside the public street rights of way, the developer and his/her Engineer shall verify that the final location of the public utilities is located within a platted easement. The City will verify that the easements shown on the preliminary plat are also duplicated on the final plat.
- B. All public easements including (sewer, water, and storm sewer) **are to remain clear of obstructions**. No building or other obstruction shall be erected and no trees shall be planted on any easement other than fences and hedges of a type approved by the City, and only with the understanding that such fences, trees, or

shrubbery are subject to removal at such time as access to the easement becomes necessary for maintenance or repair of utility. Driveways, walkways, asphalt and parking lots may be permitted in easements; however, the City reserves the right to remove such asphalt, concrete, base course and sod as necessary to access its facility in the case of emergency. Pavement or concrete will be replaced with a patch. Sod will be replaced with Fescue or rye seeding. The City will not be responsible for replacing a property owners sod after repairing a utility line.

5.3.5 INSPECTIONS

A. The following items must be inspected during and after the installation of sewer lines for compliance with City Specifications and Standard Details.

1) Gravity Lines

- a. All materials for acceptable make and model in compliance with City of Fairfax approved product list.
- b. Sewer service from the main to the right-of-way cleanout.
- c. A TV inspection shall be performed on all gravity sanitary sewer lines. Only the initial TV inspection will be performed at City expense. If additional inspections are necessary, the cost shall be borne by the Contractor/Developer.
- d. Sewer line pressure test (completed after installation of all cleanouts), per Section 2.5 – *Sanitary Sewer*.
- e. Deflection Test: Mandrel pull-through test (95% certified mandrel).
- f. Manhole integrity, invert (construction, etc.).
- g. Manhole vacuum test.
- h. Check for removal of debris from manholes and sewer mains.
- i. Testing logs shall be provided to the inspector. The City's construction coordinator must be informed in advance of testing.

2) Force Mains:

- a. Pressure Test & Leakage.
- b. All bend fittings, tees, valves, tapping sleeves and valves, for proper installation, bedding, blocking, and restraining.

5.3.6 ACCEPTANCE OF SEWER MAINS

A. **Pre-final Inspection:** All inspections are to be coordinated with the City Engineer. A pre-final inspection will be made at the request of the

Contractor upon satisfactory completion of construction and required tests for the entire project or approved phase. Streets shall have subgrade in place and curb & gutter, if applicable. Landscaping shall be to rough grade. A representative of the Contractor (foreman or supervisor) shall be present or no inspection will be given. A punch list will be prepared stating any deficiencies found. A copy of the punch list can be picked up from the City during the next working day. When all deficiencies have been corrected, the Contractor may request a final inspection.

- B. **Final Inspection:** At the request of the Contractor, a final inspection shall be made. If in the course of the inspection any deficiency is found that was on the punch list given at the pre-final inspection, the inspection shall stop at that point. When the Contractor has satisfactorily corrected all deficiencies on the punch list, he may request another final inspection. One week's notice is to be given in scheduling all repeat final inspections.
- C. Applicants should comply with the Right of Way / Easement Permit Package and the As-Built Plan Application and review checklist, both available on the City's website.
- D. **Tentative Acceptance:** Tentative Acceptance will be given upon completion of paving for the related streets and landscaping (including off site construction), receipt of Recorded Easements, Certificate of Completion for Sewer System, As-Built Drawings, and Recorded Plat with street addresses. Mains and related appurtenances will be reviewed to assure that no damage has been done during paving and landscaping. Any problems found will have to be corrected. Tentative Acceptance will be made in writing upon completion of the above items. The 12-month Warranty Period will begin at the date of Tentative Acceptance.

The Inspector will make the appropriate recommendation for Tentative Acceptance to the City Engineer.

If approved, meters will be installed upon payment of applicable fees and issuance of a Work Order by the City.

- E. **Final Acceptance:** One month before the 12-month warranty period is over, the project will be inspected for any failures or defects (including TV inspections of sewer lines if deemed necessary). Any problems found will have to be corrected within 30 days. Final Acceptance will be made in writing at this point.
- F. **Check for buried items:** It is the responsibility of the developer and not the contractor to ensure that all manholes and sewer cleanouts are not buried.

5.3.7 WARRANTY

- A. **Warranty and Defects Guarantee:** Any work or materials not in accordance with these specifications will be rejected. All work that has been rejected or condemned shall be repaired or, if it cannot be satisfactorily repaired, shall be removed and replaced at the Contractor's expense. Materials not conforming to the requirements of these specifications shall be removed immediately from the

site of the work and replaced with satisfactory material by the Contractor at his own expense.

Upon the failure of the Contractor to repair satisfactorily or to remove and replace, if so directed, rejected, unauthorized, or condemned work or materials immediately after receiving formal notice from the Engineer, the Owner may recover for such defective work or materials on the Contractor's bond or by action in court having proper jurisdiction over such matters, or may employ labor and equipment and satisfactorily repair or remove and replace such work and charge the cost of same to the Contractor, which cost will be deducted from any monies due him.

The approval of material and workmanship by the City Engineer, Public Works Director, Construction Coordinator, or any employee of the City, does not under any consideration preclude the right of the City Engineer or Public Works Director to reject all or any part of the same at any time previous to final payment, if found not to be in accordance with these specifications, nor does any inspection of work release the Contractor from any of his obligations to fulfill his Contract as herein specified and defective work and materials shall be made good or rejected notwithstanding such work and material that may have been previously accepted for payment.

- B. Upon the acceptance of facilities, utilities or streets for permanent maintenance, a one-year warranty for all improvements shall become effective. This warranty must be satisfactory to the City of Fairfax. A bond in the amount of the total construction costs (to guarantee the correction of all defects in such facilities, utilities, or streets) shall be required on developments and projects which include public infrastructure (water, sewer, storm drainage, and roads).
- C. **Reference Point for commencement of warranty period:** Upon completion of construction the developer shall request a final inspection. In addition to preceding requirements, the following items must be completed prior to final inspection:
- 1) All punch list items,
 - 2) The provision of a set of acceptable record drawings,
 - 3) Copies of asphalt density and core thickness test results and of concrete strength test results.
 - 4) Operation and Maintenance manuals,
 - 5) List of subcontractors, manufacturers and suppliers who participated in this project,
 - 6) Statement of payment of taxes,
 - 7) Affidavit of Payment of Debts and Claims
 - 8) Affidavit of Release of Liens, and
 - 9) The submission of the design engineer's water and/or sewer certifications,
 - 10) All flushing and testing logs.

Upon completion of the above, a one-year warranty period shall commence. The City issued Acceptance Letter will state warranty date.

- D. For the purposes of this section, the term “defects” refers to any condition in publicly dedicated facilities, utilities or streets that requires the City to make repairs to such improvements over and above the normal amount of maintenance that they would require. If such defects appear, the warranty may be enforced regardless of whether the facilities, utilities, or streets were constructed in accordance with the requirements of the Public Facilities Manual.
- E. **Latent Defects:** During the one-year warranty period the developer shall repair any latent defects that occur.
- F. **End of Warranty Period:** At the end of the one-year warranty period the developer shall request a cursory inspection. Upon successful completion of all warranty items, the developer shall be released from maintenance responsibilities for the warranted construction and construction bonds will be released.
- G. Warranty repairs to the following common problems shall be as follows:
- 1) Trench failures in pavement shall be repaired in accordance with the requirements of Section 2.3 – *Trenching, Backfilling & Compaction of Utilities*.
 - 2) If more than 3 trench failures occur within a longitudinal distance of 800 feet on any segment of a street, the City may require a 1.5-inch overlay once repairs have been completed.
 - 3) Cracks in sidewalk, driveway entrances and/or curb and gutter shall be repaired by removing and repouring such sections as necessary.
 - 4) Concrete sidewalks, driveways, and curb and gutter, which fall below the specified strength shall be removed and replaced as necessary.
 - 5) Pavement, sidewalk or curb and gutter failures caused by latent subsurface problems shall be repaired in accordance with the recommendations of an approved Geotechnical engineer.
 - 6) All water, sewer, storm sewer, drainage and street appurtenances impacted by the water and/or sewer construction shall be in acceptable condition and properly exposed (particularly water meters and sewer cleanouts);
 - 7) Overseeding and reseeding may be required if an acceptable stand of grass has not been achieved by the end of the warranty period.
 - 8) All other defects shall be corrected in accordance with the recommendations of the City Engineer or Public Works Director or his/her representative;
- H. If a developer fails to complete warranty items, future projects of the developer shall not be reviewed by the City Engineer or Public Works Director. In addition, the City may take additional legal action against the developer.

5.4 REFERENCES

1. Virginia Administrative Code (VAC)
2. Sewage Collection and Treatment Regulations (SCAT) (9 VAC 25-790)
3. Virginia Department of Transportation (VDOT), Road and Bridge Standards (2008)
4. Fairfax County Public Facilities Manual (2015)
5. American Society of Civil Engineers (ASCE) Manual of Practice No. 60, Gravity Sanitary Sewer Design and Construction (2nd Ed, 2007)
6. City of Fairfax Department of Public Works, Right-of-Way / Easement Permit Package

END OF SECTION 5

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