

## CHAPTER 2 - DESIGN STANDARDS FOR GRAVITY SANITARY SEWERS

### 2.1 GENERAL REQUIREMENTS

2.1.01 Sanitary sewers are to be provided solely for the removal of sanitary waste. Under no circumstances shall any roof drains, foundation drains, surface or subsurface drains or other appurtenance conveying storm or ground water be either directly or indirectly connected to sanitary sewers. The following design parameters include an adequate allowance for normal infiltration but will not accommodate the above forbidden connections.

### 2.2 TECHNICAL DESIGN

#### 2.2.01 System Layout

- A. The overall layout and general design shall conform to the parameters set forth in the approved Engineering Report.
- B. All sanitary sewers shall be located in:
  - (1) Legally established street right-of-ways.
  - (2) Legally established permanent easements for such purpose, either existing or as proposed by the designer in accord with paragraph 1.7 "Easement Requirements" of these Standards.
- C. Construction shall be along the center line of rights-of-way or easements except when this location has been previously used by another utility, or when the width of a road right-of-way justified the use of two sewer lines. Exception to this specified location will be allowed only when it can be established that it is not practical to adhere to the standard location.
- D. All sewers shall be on a continuous grade between manholes.
- E. Sewers should intersect in manholes at angles not greater than 90 degrees. In the event that this is impractical the designer must satisfy the Department that adequate losses have been provided in the hydraulic analysis.
- F. Sewer mains and manholes shall be a minimum of 10 feet horizontally from any part of a building or structure.

## 2.2.02 System Design

The overall design shall be in accordance with the provisions of the approved Engineering Report in accordance with paragraph 1.2 "Engineering Report" of these Standards.

- A. Design carrying capacities of sewers shall be based upon the total drainage area served by the line or lines in question. The design flow shall be based on acreage density, using the City's Land Use Map or approved zoning, whichever allows higher densities.
- B. Equivalent flows from motels, schools, hospitals, etc. shall be based upon that of current Commonwealth of Virginia "Sewerage Regulations."
- C. In the absence of information on densities or equivalent flows, the designer shall supply sufficient information, substantiated by sound engineering judgment to verify the design. This information shall be subject to approval by the Department.

## 2.2.03 Capacity Design

- A. All sewers shall be designed to carry the ultimate tributary population with a 50 year projection as an upper limit.
- B. Computations of all lines shall be shown. Computations shall be accompanied by a Drainage Area Map. Map(s) shall show entire drainage area involved, location(s) of line(s) in system, and points of entry of flows, including any flows being received from other areas. The Drainage Area map shall be keyed to a computation sheet. Computations and maps shall be submitted to the Department for approval.

## 2.2.04 Hydraulic Design - Sewers

- A. Minimum grades shall not be less than those required to produce a velocity of approximately two (2.00) feet per second when the sewer size selected is flowing full or half full.
- B. The minimum size pipe to be used in sanitary sewer systems shall be eight (8) inches inside diameter.
- C. Allowable minimum grades shall be as follows:

Sewer Size (Inches)	Minimum Slope in Feet/100 Feet
8	0.40
10	0.28
12	0.22
14	0.17
15	0.15
16	0.14
18	0.12
21	0.10
24	0.08
27	0.067
30	0.050
33	0.060
36	0.046

- D. Computations for velocity of flows shall be based upon the following values of "N" as used in the Kutter or Manning formula for velocity of flow:
- (1) Sizes 8 inch through 21 inch: N equals 0.013
  - (2) Sizes 24 inch and above: N equals 0.012
- E. In cases where the calculated depth of flow is less than a pipe flowing full, the velocity at actual depth of flow shall be computed.
- F. For sewage flow depth less than 1/4 full, an allowance shall be made for increased value of "N" and in no case shall velocities of less than 1.3 feet per second be permitted. The improved velocities shall be accomplished by steeper grades and not by changing pipe diameter.
- G. Generally the sizes of pipe shall be continually increasing with increase of tributary areas. However, when steep grades are available and length is such that a significant cost savings will result without jeopardizing the system, the size of pipe may be reduced a minimum of two (2) normal diameters, but not below an inside diameter of twelve (12) inches. Proper hydraulic allowances must be made for resulting head losses (H).

#### 2.2.05 Structural Design

- A. Structural requirements must be considered in the design of all sewers and appurtenances.

- B. The proper strengths shall be determined and indicated for sewer pipe materials being specified. Strength shall be based upon pipe size, proposed depth, width of trench, bedding conditions, existing ground conditions, etc. This is a matter of detail design not subject to simple generalizations.
- C. In deep cuts, it is generally preferable to change pipe strengths to obtain proper design rather than vary bedding conditions. However, pipe strength or class shall be shown on plans with stations to indicate the location.
- D. No change in pipe strength or material shall be made between manholes unless it can be substantiated that a considerable cost savings would result and integrity of system would not be jeopardized. Proper precautions shall be taken regarding correct location(s) of varying strength of pipe.
- E. The thickness of precast concrete manhole walls shall be increased when total depth of manhole exceeds thirty (30) feet. The minimum manhole diameter shall be increased to 60" when the total depth exceeds 15 feet.
- F. Gravity systems receiving pumped flows shall be protected against sulfide attack for a distance of 1200 feet downstream from point of pumped flow entry. This shall be accomplished by the use of acid-resistant pipe and manholes. The City shall approve the materials and design for the conditions at each individual location.
- G. Ductile iron pipe shall be used for all stream, or estuary crossings.
- H. Anchor sewers on slopes of 20% or greater.
- I. Steel casing pipe shall have a minimum yield strength of 35,000 psi and a minimum inside diameter of 12" greater than the largest exterior diameter of the carrier pipe.

#### 2.2.06 Sewer Appurtenances

- A. Standard and drop manholes, service connections and other appurtenances shall be constructed in accordance with Standard Drawings.
- B. Manholes shall be installed at the end of each line, at all grade, size or alignment changes, and at all sewer line intersections.

- C. Drop manholes shall be required when the vertical drop exceeds 30”.
- D. Sewer lines serving more than one building shall be a minimum 8 inches inside diameter and shall include manholes located at pipe junctures on the private property and at the City sewer main.
- E. When manholes are located in paved areas accessible to vehicular traffic, they shall be spaced at distances no greater than 400 feet for sewer sizes up to 15 inches and no greater than 500 feet for sewer sizes 18 inch through 30 inch. When located in inaccessible areas, spacing of manholes on sewer lines 30 inches and less, shall not exceed 350 feet.
- F. Sewer lines shall be protected from a 100 year flood by either raising manhole tops above flood plain or by the use of watertight frames and covers. Where watertight frames and covers are used, unventilated length of sewer cannot exceed 1000 feet. Manhole covers shall be no more than 30 inches above ground level.
- G. All new food preparation facilities, such as restaurants and bakeries, shall be required to construct an outside grease trap for the retention of grease, fats, and oils generated by that business. The design of the grease trap shall be approved by the City Engineer. The grease trap shall be operated and maintained properly by the discharger.
- H. A monitoring manhole shall be required on all new construction or renovations or modifications to existing facilities, where the discharge originating in the new, renovated, or modified facility is, or will have the potential to be, non-domestic in nature.
- I. Sewer laterals for non-residential connections shall be a minimum of 6-inches. Sewer laterals for residential connections shall be a minimum of 4 inches. Connections shall be made at an angle of 90 degrees to the main.
- J. All vehicle/equipment washes shall have oil-water separator of size to be compatible with maximum flow conditions.

- A. Generally, all sewers shall be of sufficient depth to provide service to lowest sewer elevation of the structure in question, allowing proper service connection grade. However, a greater depth may be required due to future extension or possible future lowering of existing road grade or utilities; minimum depth of cover over sewers shall be 3.0 feet.
- B. Where there are roadside ditches instead of curb and gutter, the engineer shall profile each sewer service connection from the sewer main in the street to the property line being served, and must show the service connection material, grade, and cover at the ditch line.
- C. Exceptions to the above requirements will be considered only if impractical to provide required depths; in which case, special approval must be secured, in writing, from the Department. In the special case of less than minimal cover, ductile iron pipe of adequate thickness shall be provided.
- D. Sewers over 15 feet deep shall be Class 52 ductile iron.
- E. Sewers over 24 feet deep shall be poly lined ductile iron with a minimum film thickness of 40 mils.

## 2.3 DRAWINGS

2.3.01 In addition to requirements in Chapter 1.6. "Drawing Organization and Format" of these Standards, drawings shall also have:

- A. Stationing, pipe size, material, bearings, direction of flow, deflection angles, grade and distance between center lines of manholes.
- B. All manholes numbered, with drop manholes identified and top, influent and effluent elevations clearly shown.
- C. The plans shall indicate the following information to provide for service to the elevation of the connection as follows:
  - (1) Lowest sewer structure elevation.
  - (2) Low ground corner of structure with first floor service only.
  - (3) Ground level at building line on unoccupied parcel.

(4) The elevation and location of any existing structure to be sewerred shall be clearly shown.

- D. If in conjunction with water project, water mains shall be shown and profiles shall indicate points where crossings occur, clearly indicating vertical clearance between utilities.
- E. Plans shall show the location of erosion control devices on the plans. These devices shall be in conformance with the Virginia Erosion and Sediment Control Handbook and Chapter 7 of these Standards..