SECTION 2 - DESIGN STANDARDS FOR GRAVITY SANITARY SEWERS

2.1 General Requirements.

2.1.01 Sanitary sewers are to be provided solely for the collection and transport of sanitary waste. Under no circumstances shall any roof drains, foundation drains, or surface or subsurface drains be either directly or indirectly connection 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. Since all sanitary sewers must be accessible for operation and maintenance:

   (1) Locate all sanitary sewer in legally established road rights-of-way.
   (2) Where it is impossible to avoid placing public sewers on private property, the sewer shall be installed in legally established permanent easements for such purpose, either existing or proposed in accordance with these Standards.
   (3) Sewers shall be located outside of jurisdictional wetland areas whenever possible.
   (4) Stormwater BMPs shall not encroach on the sanitary sewer.

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 justify 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 continuous grade between manholes.

E. Sewers should intersect in manholes at deflection 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. Where sewer depth is 10 feet or less, sewer mains and manholes shall be located a minimum of 10 feet horizontally from any part of a building, structure, or its foundation. Where the depth of sewer is greater than 10 feet, the sewer mains and manholes shall be located a minimum of 15 feet from any part of a building, structure, or its foundation.

2.2.02 System Design.

The overall design shall be in accordance with the provisions of the approved Engineering Report in accordance with Paragraph 1.1.02 of these Standards.

(1) The design of carrying capacities of lateral, trunk, and interceptor sewers shall be based upon the total sewer shed area served by the line or lines in question. The design flow shall be based on acreage density, using the Henrico County Land Use Map or approved zoning, whichever allows higher densities.

(2) Equivalent flows from motels, schools, hospitals, etc. shall be based upon that of the Virginia Department of Environmental Quality Sewerage Regulations.

(3) 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. Laterals shall be designed to carry ultimate tributary population with a 50 year projection as an upper limit. Proper allowance for peak flow, as shown on the Peak Flow Chart, Form F-2, shall be included.

B. Trunks and interceptors shall be designed on the same basis as laterals, except in cases where capacities of system or parts thereof can be readily increased by future relief, allowing for shorter capacity design life of initial or subsequent lines.

C. Computations of all lines shall be shown on a form similar to the sewer design form, Form F-4, including anticipated future relief lines that may be required.

Computations shall be accompanied by an Overall (System Layout) Plan (Paragraph 1.1.02 B.), conforming basically to requirements of index map (Paragraph 1.2.02 C.) 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. Drainage area map shall be keyed to computation sheet (hydraulic analysis, Form F-4). 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 and one quarter (2.25) feet per second when the sewer size selected is flowing full or half full. Pipe sizes shall not be arbitrarily increased in order to take advantage of a flatter grade.

B. The minimum size pipe to be used in systems shall be eight (8) inches.

C. Allowable minimum grades shall be as follows:

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<tr>
<th>Sewer Size (Inches)</th>
<th>Minimum Slope in Feet/100 Feet</th>
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<td>0.05</td>
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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 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 no more than two (2) nominal diameters, but not below twelve (12) inches. Proper hydraulic allowances must be made for resulting head losses.

H. Miscellaneous head losses at manholes and curves shall be computed as follows. Junctions of more than two (2) pipes will require special consideration.

1. Manholes where radius of turn is less than 2 pipe diameters:

   \[ H = 0.50 \left( \frac{\text{angle}}{90^\circ} \right)^{0.5} \left( \frac{V^2}{2g} \right) \]

2. Manholes where radius of turn is greater than 2 pipe diameters:

   \[ H = 0.25 \left( \frac{\text{angle}}{90^\circ} \right)^{0.5} \left( \frac{V^2}{2g} \right) \]

   Where:

   \[ \text{angle} \quad \text{is horizontal deflection angle} \]
   \[ \frac{V^2}{2g} \quad \text{is velocity head of effluent pipe} \]

3. Loss for straight run manhole shall be 0.05 feet. In no case shall loss less than 0.05 feet be allowed.

I. Where pipe diameters increase at manholes, in direction of flow, effluent invert shall be lowered below influent elevation as follows:

   Change equals 0.8 \( (D_1 - D_2) \) Ft. Where:

   \[ D_1 \text{ equals downstream diameter} \]
   \[ D_2 \text{ equals upstream diameter} \]

   This adjustment shall be in addition to computed miscellaneous head loss.

J. Special consideration shall be given to cases where pipe diameters decrease in direction of flow.
K. Where velocities greater than 15 feet per second are expected, special provisions shall be made to protect against internal erosion by high velocity. The pipe shall conform to appropriate ASTM or AWWA specifications which provide protection against internal erosion.

2.2.05 Structural Design and Location.

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. Minimum bedding shall be Class C.

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 the integrity of the 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 the total depth of manhole exceeds thirty (30) feet. The minimum manhole diameter shall be increased to 60-inches when the total depth equals or exceeds 24 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 Department shall approve the materials and design for the conditions at each individual location.

G. Ductile iron pipe shall be used where sewers enter or cross streams, estuaries, lakes or reservoirs; cross jurisdictional wetland areas; or as a carrier pipe within any bore or tunnel crossing.

H. Anchor sewers on slopes of 20% or greater.

I. Steel casing pipe shall be sized in accordance with Paragraph 3.2.01 S.

J. Ductile iron pipe shall be used in subdivisions for sanitary sewer lines installed in an
K. Ductile iron pipe shall be used in easements where, in the opinion of the Department, the sanitary sewer is not accessible from a street, parking lot, or driveway.

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. Sewer connections serving more than one building shall be made by construction of a manhole on the County sewer and an 8" sewer line terminating in another manhole at the uppermost building connection. Such construction shall be in accordance with County Standards.

D. 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 500 feet for sewer sizes 16 inch through 30 inch. When located in unaccessible areas, spacing of manholes on sewer lines 30 inch or less shall not exceed 350 feet.

E. Spacing of up to 600 feet may be permitted in sewers larger than 30 inches.

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. Vandal proof manhole frames and covers shall be used on all manholes not in paved streets unless watertight covers are required.

H. Restaurants, bakeries and other facilities involved in preparation of food have the potential to discharge oil and grease to the sanitary sewer system. It is the discharger’s responsibility to install and properly maintain such pretreatment system necessary to ensure that concentrations of oil and grease discharged to the sanitary sewer system do not exceed 300 parts per million (ppm) as required by Section 23-109 of the County Code.

I. Oil/Water separators, where required, shall be shown on the plans. Separators shall comply with requirements of the Plumbing Code. A schematic of the oil/water separator shall be shown on the plans.
J. 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. All waste from the facility shall flow through the monitoring manhole.

(1) For multi-use buildings such as shopping centers, the sewer should be an adequate distance from the building to allow installation of a monitoring manhole and grease traps on each sewer lateral when the tenant spaces are upgraded.

(2) For individually metered facilities, a sewer lateral is required for each meter. Enough space to accommodate installation of the monitoring should be provided.

(3) If the facility is master metered, a monitoring plan is required for the entire facility. A monitoring manhole shall be provided.

K. Where possible in unpaved areas, manhole castings shall be approximately 12 inches above final grade.

L. 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° to the main. Connections shall be installed at a minimum grade of ¼ inch per 1 foot. Connections shall be installed a horizontal distance of at least 10 feet past the side property line.

M. At the upstream manhole in a cul-de-sac, the maximum number of sewer connections allowed into the manhole is three (3).

N. Manholes shall not have bricked-up or partially scored openings for future sewers. Manhole connections shall be in accordance with Paragraph 12.3.11 at the time the sewer is to be extended.

2.2.07 Depth of Sewers.

A. Generally, all sewers shall be of sufficient depth to provide service to the lowest sewered elevation of structure in question, allowing proper service connection grade. Minimum depth of cover over sewers shall be 5.5 feet in rights-of-way and 3.5 feet in easements; however, a greater depth may be required due to future extension or possible future lowering of existing road grade or utilities.
B. The Engineer shall certify that all proposed sites will be served by gravity with sewer service connections installed at a slope of ¼ inch per 1 foot except where shown otherwise on the plans. The depth of service connections shall be in accordance with Paragraph 12.3.7 D.

C. Exceptions to the above requirements will be considered only if it is 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 18 feet deep shall be of ductile iron. The depth shall be determined by measuring from the ground surface to the pipe invert.

E. Sewers over 24 feet deep shall have a polyethylene or epoxy lining specifically designed to resist hydrogen sulfide corrosion. Manufacturer’s data shall be submitted prior to plan approval.

F. Sanitary sewers crossing under storm sewers shall maintain a minimum separation of 12 inches. Where this separation is not possible, Ductile Iron pipe shall be used. Concrete supports may be required for the storm sewer.

G. The tops of all sewers entering or crossing streams shall be at a sufficient depth below the bottom of the streambed to protect the sewer line. In general, one foot of suitable cover shall be provided where the stream is located in rock and three 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 the stream channel. Reasons for requesting less cover shall be given in the application.

2.3. Drawings.

2.3.01 In addition to requirements in Section 1.2 "Drawing Organization and Format" of these Standards, drawings shall also have:

A. Stationing, pipe size, pipe material, bearings, direction of flow, deflection angles, grade, and distance between center lines of manholes.

B. All manholes shall be 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 sewered existing 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 sewered shall be clearly shown. The street address of existing house(s) shall be shown.

D. Water mains shall be shown, and profiles shall indicate points where crossings occur, clearly indicating vertical clearance between utilities.

E. Consultants shall show the location of erosion control devices on the plans. These devices shall be in conformance with the Erosion and Sedimentation Control Handbook for Henrico County. Consultants shall include approved erosion control details from the Department of Public Works.

F. Consultants designing facilities for developers shall show the appropriate water and sewer notes on the drawings.

G. Sewer or water lines not to be owned by the County shall be identified as "Private."

H. Additional Information

(1) Drawings shall include estimated materials quantities, current Henrico County water and sewer notes, and pipe specs.

(2) Horizontal scale in Plan and Profile Sheets shall be no smaller than 1 inch equals 100 feet.

(3) Vertical profile scale shall be no smaller than 1 inch equals 10 feet.

(4) All known existing structures and utilities, both above and below ground, which might interfere with the proposed construction, particularly water mains, gas mains, storm drains, etc. shall be shown in plan and profile.

(5) Bench Marks shall be set no more than 500 feet apart along the lines of construction but outside the limits of construction. Datum for elevations shown shall be USGS (Mean Sea Level).

(6) Drawings shall show off-site easements required and identify Deed Book and Page Number.

(7) Drawings shall reference the applicable DPU water and sewer sheet numbers for the project location.