CHAPTER 11
GRAVITY SANITARY SEWER DESIGN

1. GENERAL

A. This chapter covers the minimum design criteria to be used for designing sanitary sewer pipelines and appurtenances including those portions of sewer service connections that lie in public rights-of-way and in easements granted to Charlotte Water. All other systems are the responsibility of the respective property owner unless otherwise documented via agreement with Charlotte Water.

B. All engineering plans for sanitary sewers must meet the Charlotte Water design standards as presented, the State standards as indicated in the most recent amended *Administrative Code, Title 15A, Subchapter 2T Waste Not Discharged to Surface Waters* by the North Carolina Department of Environmental Quality (NCDEQ), and the Division of Water Resources' *Minimum Design Criteria*. In general, the Charlotte Water standards should be the primary source for design guidance with the State standards as a supplement. In some cases, the Charlotte Water standard is more stringent than the State standard.

C. All designs must be sealed by a North Carolina professional engineer.

2. HYDRAULIC DESIGN

A. General

1) In general, sewers and associated manholes and structures shall convey the ultimate flow within the area tributary to the sewer including any flow pumped to the sewer basin from adjacent basins.

2) For new sewers servicing previously undeveloped areas, design flows shall be calculated per Item 2(B) of this chapter. For new sewers serving developed areas, design capacity should be determined per the Capacity Assurance Program (CAP).

3) New flow requests shall confirm downstream sewer facilities' capacity through the CAP.

B. Calculating Flows

1) Flow analysis shall include a sewer basin map showing the project's total potential sewered area including any existing upstream sewered or unsewered areas, location of any contributing pumped sewer flow, and downstream connection to an existing sewer.

2) Populations to be served shall be calculated from Future Land Use (FLU) plans for the sewer basin. Population may include residential, commercial, industrial, and institutional categories. Population should be estimated based on developable area.

3) For service areas tributary to the collection system(s) that are provided treatment through the Charlotte Water treatment facilities, the Average Daily Flow (ADF) will be

190 gallons per day (GPD) per single family residential dwelling unit and 135 GPD per multi-family residential dwelling unit. For service areas tributary to the collection system that is provided treatment through interconnection with the Water and Sewer Authority of Cabarrus County (WSACC), the ADF for both single and multi-family dwelling units shall be 65 GPD per bedroom.

4) Commercial, industrial, and institutional unit flow rates should be per *15A NCAC 02T.0114* or project specific where data is available. Unit flow rates below the State minimum are not allowed without written approval from Charlotte Water.

5) Peak daily flow shall be proportional to population and calculated using the following equation:

$$PF = \frac{18 + \sqrt{P}}{4 + \sqrt{P}}$$

Where:

PF = peaking factor, minimum of 2.5

P = service population in thousands

Based on the complexity of the proposed project, Charlotte Water may request population projection calculations.

C. Minimum Slope Requirements

Minimum slope for various size sewer pipes is provided in Table 11.1.

Table 11.1: Minimum Slopes for Sanitary Sewers

Sewer Pipe Size (inches)	Minimum Slope (feet per 100 feet)
4	1.50
6	1.25
8	0.60
10	0.35
12	0.28
15	0.19
16	0.18
18	0.15
21	0.13
24	0.10
30	Based on 2.5 fps minimum scour velocity
36	

D. Pipe Sizing

1) Minimum size of a gravity sewer shall be 8 inches.

2) The sewer pipe shall be sized to convey the peak hourly flow with the pipe flowing 90% full.

3) Manning's Equation shall be used to determine pipe size. All sewer pipes shall have a velocity of > 2.5 feet per second (fps) and < 10 fps based on the equation:

$$Q = \frac{1.486AR^{2/3}}{n}S^{1/2}$$

Where:

Q = Capacity, cubic feet per second (cfs)

A = Cross sectional area of pipe, ft^2

R = Hydraulic radius, ft = $\frac{\text{cross sectional area}}{\text{wetted perimeter}}$

n = Manning's roughness coefficient, use n = 0.013

S = Slope, ft/ft

4) Where velocities exceed 10 fps, special provisions shall be required in order to prevent scour and protect against internal erosion and/or impact.

5) The sewer pipe slope and diameters shall be selected in order to minimize sediment accumulation. Flatter slopes shall not be justified or substituted with oversized sewers.

6) Charlotte Water will determine each project's level of required calculation and/or modeling documentation during the CAP application process which will be determined based on amount of flow contribution, location of the project, and sewer network. Calculations may be provided in the form of a spreadsheet summary of each pipe segment for sewer extensions and small development connections, or a calibrated hydraulic model for a large sewer basin connecting to a trunk sewer.

3. SEWERS

A. Location

1) In general, gravity sewer shall be located within the limits of public road rights-of-way (ROW). Where this is not achievable, any gravity sewer location in a properly recorded public easement on private property outside of a public road ROW must be approved by Charlotte Water.

2) Sewer lines shall not be located in either public or private alleys.

3) Gravity sewer mains serving drainage basins shall follow the natural drainage pattern of the basin as closely as possible. Specific horizontal alignment shall be made with consideration to property lines, topography, creeks/top of banks, environmental damage, and property owner requirements.

4) Sewer lines between manholes shall be laid in straight lines and at constant grade.

5) Upstream main lines or branch lines shall intersect downstream main lines at a 90 degree angle or greater.

6) Sewer lines shall be installed with warning tape and copper tracer wire as shown in the standard details and referenced in the specifications.

7) Sewer pipe and laterals laid along residential lot lines, extending from the front setback to the rear setback, and between permanent structures shall be epoxy lined ductile iron pipe. Fittings shall be epoxy lined or fusion bonded epoxy lined.

8) Sewer easements shall be located a minimum of 10 feet outside the top of streambank. Consideration for sewer pipe within stream and water quality buffers shall be reviewed to meet current regulations. The following buffers are known to exist in Charlotte Water's service area including, but not limited to:

   a. Water Supply Watershed Buffers

   b. Surface Water Improvement and Management (SWIM) Buffers

   c. Post-Construction Buffers

   d. Goose Creek and Six Mile Creek Buffers

9) Where sewer pipe is located near water bodies or wetlands and the sewer trench has the potential to convey and drain the water body, anti-seepage collars shall be installed per the standard detail. Anti-seepage collars shall be placed starting at the downstream pipe boundary of the top of stream bank or wetland and at every 150 feet upstream until the sewer pipe reaches the opposite top of stream bank or exits the wetland boundary. The governing authority may have more stringent requirements.

10) Charlotte Water may set additional requirements for the proposed sewer locations.

B. Steep Slope Allowance

Charlotte Water may, on a case by case basis, allow high velocity/steep slopes for 8-inch sewer between 10% (0.10 ft/ft) and 19% (0.19 ft/ft) if all the following requirements are met:

1) High velocity sewer mains shall only be 8-inch in diameter.

2) Slopes greater than 19% are not permitted.

3) The minimum design flow shall be equal to that generated from 20 upstream single-family lots or equal design flow.

4) The maximum design flow depth shall be limited to half of the pipe diameter.

5) If the design velocity is greater than 10 fps, the pipe material and thickness shall be at least AWWA C900 DR 25 PVC pipe or epoxy lined ductile iron pipe. Fittings shall be epoxy lined or fusion bonded epoxy lined.

6) If the design velocity is greater than 15 fps, the pipe shall be epoxy lined ductile iron pipe. Fittings shall be epoxy lined or fusion bonded epoxy lined.

7) Drops are not permitted in the downstream manhole of pipes with slopes greater than 10%.

8) The deflection angle of the discharge in the downstream manhole shall be less than 45 degrees.

4. LATERALS

A. Each dwelling unit or building shall be served by a lateral meeting the requirements.

B. A single lateral may serve a Single-Family or Duplex Dwelling and an Accessory Unit Dwelling if located on the same parcel. These shared laterals are deemed permitted per 15A NCAC 02T.0303.

C. If a parcel contains sublots with separate, individual ownership, each sublot must be served by an individual lateral meeting the requirements below.

D. Each building of a Triplex, Quadraplex, and Multi-Family Dwelling Unit shall be served by a lateral meeting the requirements below.

E. Location

1) Lateral connections onto a new sewer main shall be installed with a tee or into a manhole. Where practical, laterals shall connect to manholes in lieu of tees in roadways.

2) Laterals connecting in manholes shall match larger downsteam pipe crowns.

3) Lateral connections on sewer outfalls greater than 24 inches in diameter shall connect to manholes unless otherwise approved by Charlotte Water.

4) Lateral connections may be installed onto an existing sewer main with a tee saddle if the existing sewer main is a minimum of twice the diameter of the lateral.

5) A doghouse manhole is required when the lateral connection is the same size or one size smaller than sewer main (i.e. not twice diameter).

6) Lateral connections shall be perpendicular to the sewer main.

7) Minimum spacing between sewer laterals and water services shall be 5 feet.

8) Minimum spacing between sewer laterals and parallel storm pipes and/or catch basins shall be 5 feet.

9) Minimum spacing between lateral connections to a sewer main shall be 7 feet and a minimum of 3 feet from pipe joints.

10) Minimum spacing between a lateral connection to a sewer main and a manhole shall be 7 feet.

11) No more than one lateral may be connected to each side of an inline manhole with a minimum angle of 35 degrees between the lateral and sewer main. The minimum angle between the lateral and the downstream pipe shall be 90 degrees.

12) No more than three laterals may be connected to a terminal manhole. No more than two laterals may be connected to a terminal manhole if a future extension upstream is possible. The minimum angle between the lateral and the downstream pipe shall be 90 degrees.

13) Minimum slope on a lateral is 1.5% for 4-inch laterals, 1.25% for 6-inch laterals, and 0.6% for 8-inch laterals.

14) Maximum slope on a lateral is 10% unless approved by Charlotte Water.

15) Laterals are prohibited inside the curb radius point of public or private road intersections unless the lot only has road frontage inside the curb radius point.

16) Laterals shall terminate with a cleanout or manhole located outside the road right of way or sewer easement and no closer than 3 feet from the side property line.

17) All private service lateral easements shall be acquired by the developer/property owner when applicable to confirm land locked customers have established and maintained access to their services. Private service lateral easements are allowed in these situations:

    a. Property is landlocked, i.e. no frontage on a public street,

    b. Property has Charlotte Water sewer service directly available, but the property owner prefers to connect in a different location, i.e. to provide gravity service, or

    c. There is no justification to require Charlotte Water sewer to be extended to the property, i.e. all surrounding property is served.

F. Sizing

1) Laterals shall be a minimum of 4-inches in diameter.

2) Laterals serving a Single-Family or Duplex Dwelling and an Accessory Unit Dwelling shall be a minimum of 8-inches in diameter.

D. Backwater Valves

1) When the building finished floor elevation is located at or below the ground elevation at the sewer main connection, the lateral shall have a private sewer backwater valve

located after the property line cleanout, and a cleanout pop off on a private cleanout located between the backwater valve and the building.

5. MANHOLES

A. Location

1) Manholes shall be placed at all horizontal and vertical break points and at the confluence of two or more separate sewer pipes.

2) When located outside of street rights-of-way, roads, sidewalks, driveways, and maintained lawns, manhole rims shall be at least 2 feet above finished grade.

3) When located within street rights-of-way and in approved landscaped areas and maintained lawns, manhole rims shall be flush with the finished grade.

4) When located in subdivision streets (single family and multi-family developments), manholes shall be located at the crown of the road when possible but at no time closer than 4 feet from the lip of the curb, as measured to the center of the manhole. Sewer pipe shall be no closer than 3 feet from the lip of the curb, as measured to the center of the pipe.

5) When manhole covers are located in roads within 6 feet from the lip of the curb, a solid cover shall be provided.

6) Manhole rims shall be 2 feet above the 100-year flood elevation unless provided with a watertight and locking frame and cover.

7) Manholes shall not be placed within a 100-foot radius of a water supply well.

B. Sizing

Minimum manhole sizing requirements for connected pipe diameter sizes and manhole cover sizes are summarized in Table 11.2 below:

Table 11.2: Minimum Manhole Sizing Requirements

Sewer Pipe Diameter (inches)	Minimum Manhole Diameter (feet)	Manhole Cover Diameter (inches)
8 – 16	4	24
18 – 36	5	30
42 - 54	6	30
54	8	30
60	12	30
$\geq$ 64	12	30

The manhole diameter for a given pipe size may be increased from that shown above for applications where the angle between the influent and effluent pipes precludes proper installation of the pipe connections in the standard size manhole.

C. Spacing

Maximum manhole spacing requirements are summarized in Table 11.3 below:

Table 11.3: Maximum Manhole Spacing Requirements

Sewer Pipe Diameter (inches)	Maximum Manhole Spacing (feet)
8 ≤ 24	500
24 - 42	700
> 42	800

Charlotte Water is the Owner of the connected sewer pipes and has the experience and equipment capability to perform routine cleaning and maintenance at these distances.

D. Venting

1) Manholes shall be vented by use of vented covers or external vent pipe structures.

2) Manhole vents are required at intervals of approximately 1,000 feet.

3) Any manholes subject to flooding or inflow from storm water shall have watertight frames and covers according to the Standard Details for frames and covers.

4) Manholes with external vents shall have locking watertight frames and covers with the vent inlet 2 feet above the 100-year flood elevation or 6 feet above the rim, whichever is greater, and installed on straight wall of manhole, facing downstream. External vents shall be 5-inch diameter, Schedule 40 steel with internal lining and external coating per steel pipe specifications. Vent inlets shall be provided with welded-on external flange ring with flanged stainless-steel bird screen.

5) Offset vents are only allowed in extenuating circumstances as approved by Charlotte Water.

E. Falls and Drops

1) For sewer mains 16 inches in diameter and smaller, a 0.2’ sloped vertical fall shall be provided through each manhole unless approved by Charlotte Water.

2) For sewer mains 18 inches in diameter and larger, no vertical fall is required through the manholes.

3) Fall through manholes shall be limited as much as possible to prevent turbulent conditions, such as hydraulic drop conditions.

4) At manholes where a smaller diameter pipe connects to a larger diameter pipe, match the crown of the smaller pipe to the crown of the larger pipe.

5) Drops are not allowed unless existing conditions justify their need.

   a. When the vertical drop through the manhole is less than 2.5 the unpiped drop shall have a sloped trough across the manhole.

   b. Inside drops shall be used when the vertical drop through the manhole is 2.5 feet or greater. Inside drops shall be constructed of Schedule 80 PVC pipe as shown in the Standard Details. Drop pipe shall be one pipe size larger than the inlet pipe diameter. Inside drop manholes shall be a minimum of 5 feet in diameter and contain no more than two (2) inside drops. Inlet pipes shall have a minimum 5 feet of cover and shall not enter the cone section of the manhole.

   c. The maximum height of an inside drop is 10 feet.

   d. Outside drops must be approved by Charlotte Water on a case by case basis. Outside drops shall be constructed of DIP and fittings. An outside drop shall have a minimum of 5 feet of cover and installed as shown in the Standard Details as either an attached or detached/cleanout drop. Attached drop shall be used when located in a road right-of-way and detached/cleanout drops shall be used when located outside of a road right-of-way. Inlet pipes shall not enter the cone section of the manhole.

6. UTILITY SETBACKS AND SEPARATIONS

The minimum clearance requirements for conflicts with utilities and other features, in accordance with NCAC 02T.0305 and governing utility guidelines, is shown in Tables 11.4 and 5. Depth of cover shall be defined from the top of the pipe. Charlotte Water reserves the right to require increased separations.

Table 11.4: Minimum Separations for Sewers per NCAC 02T.0305

Setback Parameter	Separation Requirements*
Storm Sewers and other utilities not listed below (vertical) Where separation cannot be met, DIP or structural bridging to prevent crushing the underlying pipe shall be used.	2 feet
Water Lines Vertical, water over sewer including in a shared, benched trench Horizontal Where a water main crosses over a sewer, one full length of water pipe shall be located so that both joints will be as far from the sewer as possible.	 18 inches 10 feet

Reclaimed Water Lines Vertical, reclaimed over sewer Horizontal, reclaimed over sewer	 18 inches 2 feet
Any private or public water supply source, including any wells, WS-I waters of Class I or Class II impounded reservoirs used as a source of drinking water (stream classifications from Division's NC Surface Water Classifications webpage) For public or private wells where minimum separation cannot be met, piping materials, testing methods and acceptability standards meeting water main standards shall be used. All appurtenances shall be outside the 100' radius. The minimum separation shall however not be less than 25' from a private well or 50' from a public well.	100 feet
Waters classified WS-II, WS-III, WS-IV, B, SA, ORW, HQW, or SB from normal high water or tide elevation, wetlands directly abutting these waters, and wetlands classified as UWL or SWL (stream classifications from Division's NC Surface Water Classifications webpage)	50 feet
Any other stream, lake, impoundment, wetlands classified as WL, waters classified as C, SC, or WS-V, or ground water lowering and surface drainage ditches	10 feet
Any building foundation	10 feet
Any basement	10 feet
Top slope of embankment or cut of 2 feet or more vertical height	10 feet
Drainage systems and interceptor drains	5 feet
Swimming pools	10 feet
Final earth grade (vertical) Where minimum cover cannot be met, DIP shall be used. Where sewers are subject to traffic bearing loads, DIP or other pipe with proper bedding to develop design supporting strength shall be provided.	36 inches
For all other separations, materials, testing methods, and acceptability standards meeting water main standards (15A NCAC 18C) shall be required in any alternative.	

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Table 11.5: Minimum Separations for Sewers to Other Features	
Stormwater BMP	Sewer easement remain outside 1:1 slope to the BMP easement
Retaining Wall	Sewer to remain a minimum of 5 feet from footings and outside of geogrid area/structural impact of retaining wall

Roadways and Driveways	2 feet from edge of pavement and/or back of curb measured to center of pipe
Gas	3 feet from top of gas main to bottom of sewer
Existing Utilities (water, storm drain, etc.)	1 foot clearance from top of utility to bottom of sewer when sewer crosses over other utility lines, if clearance cannot be met, DIP shall be used from 5 feet outside the utility trench for a minimum length of 20 feet
Ponds/Lakes	Anti-seep collars and DIP shall be used when sewer is 6 feet or greater below the full pond water elevation and within 25 feet as measured from the toe of slope

7. DEPTH AND STRUCTURAL DESIGN

A. A minimum of 4 feet of cover shall be provided for all sewers in off-road easements.

B. A minimum of 5 feet of cover and maximum of 14 feet of cover shall be provided for all sewers in road rights-of-way and other paved areas.

C. A minimum of 4 feet of cover at the curb line or road right of way shall be provided for all laterals.

D. When minimum depths cannot be provided and are approved by Charlotte Water, sewer shall be ductile iron pipe and may require piers or concrete collars to stabilize the pipe.

E. Maximum depths and bedding requirements for each type of allowable pipe material are addressed in the pipe material specifications.

F. Where unstable soil conditions are known to exist, the design shall include special structural elements (pilings, cradles, piers) based on evaluation of actual subsurface explorations and testing.

G. Special structures such as piers, vaults, and pumping stations shall have a foundation design based on evaluation of actual subsurface explorations and testing.

H. Ductile iron pipe and epoxy lining or fusion-bonded epoxy coating may be required at additional locations at Charlotte Water's discretion.

8. STREAM CROSSINGS

Stream crossings shall be minimized, and the following design standards shall be followed:

A. Streambanks shall be protected from erosion at all times and shall comply with all requirements of the jurisdiction having authority.

B. Sewer pipe shall cross stream channels at a near-perpendicular direction.

C. When possible, stream crossings shall be made with the top of pipe casing (or carrier pipe, if no casing) a minimum of 3 feet below the stream bed. Pipe shall be protected from flotation by the use of piers, piles, and/or concrete collars.

D. When necessary, as dictated by depth of cover, stream width, flow conditions, and soil conditions, special anchorage shall be required to prevent flotation and/or washout.

E. Pipe under streambed shall be factory installed restrained joint ductile iron or Charlotte Water approved material.

F. Aerial stream crossings are not recommended and shall only be reviewed by Charlotte Water in extreme circumstances.

G. Designers shall be responsible for compliance with floodplain regulations and any approval(s) required by appropriate jurisdiction having authority.

9. INVERTED SIPHONS

Inverted siphons are not allowed however, Charlotte Water may review on a case-by-case basis.

10. CORROSION PROTECTION

A. Where areas of potential release of corrosive hydrogen sulfide gas exists, such as force main discharges and low pressure sewer discharges, corrosion resilient manholes and structures shall be provided at the discharge structure and a minimum of 100-feet downstream up to a maximum of three downstream manholes at Charlotte Water's direction. This may include protective coatings on exposed concrete surfaces, additives, or polymer concrete structures at Charlotte Water's discretion.

B. When located downstream of force main and low pressure sewer discharges, ductile iron pipe and fittings shall be lined with epoxy lining a minimum of 100-feet downstream up to a maximum of three downstream manholes at Charlotte Water's direction.

C. Where ductile iron pipe may be installed in corrosive soils, polyethylene encasement of the ductile iron pipe and fittings is required. Soil testing shall be required to be conducted by an experienced technician as certified by The Association for Materials Protection and Performance (AMPP) to determine if additional protective measures are required.

D. Where pipes are installed near impressed current utilities, such as gas pipelines, high voltage power transmission lines, light rail, street cars, and railroads, a stray current field analysis and soil testing shall be required to be conducted by an experienced technician as certified by The Association for Materials Protection and Performance (AMPP) to determine if additional protective measures are required. External protective measures may include zinc coating, double-wrapped polyethylene encasement, or bonded joints and sacrificial anodes as approved by Charlotte Water. PVC or HDPE pipe is preferred however, at a minimum ductile iron pipe and fittings shall be double-wrapped in polyethylene encasement and lined with epoxy lining. Upon approval of controlling agency, C900 PVC carrier pipe inside a casing or open cut HDPE casing pipe may be allowed.

E. Reference Chapter 18 Corrosion Control for specific requirements and details for corrosion control and monitoring systems.

11. DESIGN OF EROSION AND SEDIMENT CONTROL MEASURES

Regardless of size, all sanitary sewer projects shall include measures and/or devices to prevent erosion and to contain sediment within the limits of the right-of-way and/or proposed easements. Design and permitting of erosion and sediment control devices shall be in accordance with Charlotte Land Development Standards including the City of Charlotte Soil Erosion and Sedimentation Control Ordinance for Developer-Donated projects. Charlotte Water designed projects shall meet NCDEQ requirements, as outlined in the North Carolina Erosion and Sediment Control Planning and Design Manual. Projects outside of City limits but within Mecklenburg County or outside of Mecklenburg County shall follow the appropriate county, town, and/or state requirements.

12. BORES AND TUNNELS

A. Sewer crossings of railroads, major city streets, secondary roads, hydrocarbon transmission pipeline easements, and numbered highways must be encased in a steel pipe installed by either auger boring, boring and jacking, hand tunneling lined with prefabricated steel liner plates, or by another approved method by the controlling agency.

B. Minor city streets may be open cut with specific permission of the controlling agency, CDOT, NCDOT, or respective governing agency and if detailed on the construction drawings.

C. The carrier pipe shall be restrained ductile iron pipe, restrained AWWA C900 DR 18 or DR 14 PVC pipe, ASTM F714 HDPE SDR 9 pipe, or other controlling agency approved pipe material.

D. Steel encasement pipe shall be new and manufactured of Grade “B” steel with minimum yield strength of 35,000 psi. Steel pipe shall have machine cut, bevel ends that are perpendicular to the longitudinal axis of the casing or Permalok brand jointed casing pipe. Pipe shall be designed in accordance with AWWA M11.

E. Casing spacers shall be used on all gravity sewer pipes installed within a steel, or HDPE open cut casing pipe or tunnel or solid wall PVC open cut casing. A minimum of 3 casing spacers per joint shall be required. Casing spacers shall be evenly spaced to support the same weight of the carrier pipe and provide the necessary grade of the carrier pipe. Casing spacer manufacturer shall provide the load carrying capacity of each spacer to determine when additional casing spacers are required. Casing spacers shall not allow the carrier pipe to float within the casing pipe.

F. Within NCDOT encroachments, the annular space between the carrier and casing pipe shall be filled if the casing pipe has a diameter of 24 inches or larger. Lightweight cellular concrete grout may be used to fill the annular space to allow future removal if necessary. The Engineer of Record shall certify the casing pipe durability and design life of 100 years in lieu of filling the annular space when approved by NCDOT.

G. Bores and tunnels shall be designed to meet specific encroachment permit requirements, based on the governing agency (CDOT, NCDOT, CSX Corporation, Norfolk Southern Railway, NC Railroad, hydrocarbon transmission pipeline, etc.) based on loadings, depths, and minimum separation and clearances. The minimum size and

thickness standards for steel casing pipe, carrier pipe, and tunnels for various sewer pipe sizes shall be in accordance with the governing agencies and meet the minimum requirements in Table 11.6.

H. The minimum thickness provided in Table 11.6 are provided by the controlling agencies. The actual thickness required must be calculated based on site conditions and actual depth of cover.

Table 11.6: Minimum Requirements for Steel Casing Pipe and Tunnels

Carrier Pipe Size (inches)	Casing Pipe Minimum Thickness (inches)			Minimum Tunnel Size (inches)
	Casing Pipe Size (inches)	NCDOT	Railroads	
4	12	.250	.250	36
6	12	.250	.250	36
8	18	.250	.312	48
10	20	.250	.344	48
12	24	.250	.375	48
16	30	.312	.469	48
18	30	.312	.469	48
24	36	.375	.532	54
30	48	.500	.750	60
36	54	.500	.781	72
42	60	.500	.844	84
48	66	.625	.938	90
54	72	.625	1.000	96

I. When HDPE SDR9 casing pipe is used for open cut casing installations, the minimum casing pipe size shall be as shown in Table 11.7. Bedding shall be Charlotte Water Type IV Granular Stone Bedding.

Table 11.7: Minimum Requirements for HDPE Open Cut Casing Pipe			
Carrier Pipe Size (inches)	Casing Pipe Size (OD, inches)	Casing Pipe Minimum Thickness (inches)	Casing Pipe Average ID (inches)
6	18	2.000	13.760
8	20	2.222	15.289
12	26	2.889	19.875
16	34	3.778	25.991

13. ABANDONMENT AND DISMANTLEMENT

A. Abandonment of existing pipes, structures, appurtenances, and limits of abandonment shall be clearly indicated on the project plans and shall meet the minimum requirements listed below. Abandonment procedures may be more stringent in accordance with the appropriate governing agency's standards.

1) All sewer pipes to be abandoned that are greater than 15 inches shall be filled with excavatable flowable fill or lightweight cellular concrete or removed.

2) Comply with current standards for sewer pipe to be abandoned inside NCDOT rights-of-way.

3) All sewer main pipes with less than 3 feet of cover shall be filled with excavatable flowable fill.

4) All abandoned pipe ends shall be plugged watertight.

5) All abandoned sewer mains shall be removed from active manholes and pipe and manhole walls plugged watertight. The manhole invert shall be rebuilt to conform with the standard details removing the abandoned trough.

6) All manholes shall be demolished to 3 feet below grade, removed from the site, and remaining structure filled with excavatable flowable fill or washed stone. Abandoned mains and laterals shall be plugged watertight at the wall of the abandoned manhole.

7) Abandoned manholes within 50 feet of wetlands shall have mains and laterals disconnected from the manhole, removed a minimum of 2-feet from the manhole, and plugged prior to filling with excavatable flowable fill.

8) Sewer laterals shall be abandoned/dismantled according to the following:

a. Short side sewer lateral – tap outside of pavement, shall be cut at the main/manhole, plugging the main/manhole invert watertight. Lateral shall be cut/plugged watertight at road right-of-way. Dismantled lateral shall be removed from main/manhole to road right-of-way.

b. Long side sewer lateral – tap outside of pavement, shall be cut at the main/manhole, plugging the main/manhole invert watertight. Lateral shall be cut/plugged watertight at road right-of-way. Dismantled lateral shall remain in place below pavement.

c. Sewer lateral – tap inside pavement, shall be cut at the main/manhole, plugging the main/manhole invert watertight. Lateral shall be cut/plugged watertight at road right-of-way. Dismantled lateral shall remain in place below the pavement to the road right-of-way

d. Sewer lateral with outside drop structure at manhole located outside pavement - shall be cut at the manhole, removing outside drop structure and plugging the manhole watertight at both pipe penetrations. Lateral shall be cut/plugged watertight at road right-of-way. Remove pipe from manhole to road right-of-way for short side laterals. Dismantled lateral shall remain in place below the pavement to the road right-of-way for long side laterals.

e. Sewer lateral with outside drop structure at manhole located inside pavement - shall be cut/plugged at the manhole. Lateral shall be cut/plugged watertight at road right-of-way. Invert in manhole and top pipe penetration shall be plugged watertight and the existing tee will be plugged. Dismantled lateral shall remain in place below the pavement to the road right-of-way.

f. Sewer lateral with inside drop structure in manhole located outside pavement - shall be cut at the manhole, removing inside drop structure and plugging the manhole wall at the top pipe penetration watertight. Lateral shall be cut/plugged watertight at road right-of-way. Remove pipe from manhole to road right-of-way for short side laterals. Dismantled lateral shall remain in place below the pavement to the road right-of-way for long side laterals.

g. Sewer lateral with inside drop structure in manhole located inside pavement - shall be cut at the manhole. Lateral shall be cut/plugged watertight at road right-of-way. Inside drop structure shall be removed and the manhole wall at the top pipe penetration shall be plugged watertight. Dismantled lateral shall remain in place below the pavement to the road right-of-way.

h. Sewer laterals inside Charlotte Water easements shall be removed from main to easement limits. Plug lateral watertight at easement limits. Plug lateral watertight at main/manhole per items above.

9) Aerial pipe and piers to be abandoned shall be fully removed from the stream channel to the concrete footings. Pipe shall be removed 3 feet within the stream banks and pipe ends shall be plugged watertight.

10) When a gravity sewer project includes the abandonment of a pump station and/or force main, refer to the Sewer Lift Station chapter for the abandonment requirements.

11) All disturbed areas shall be properly restored per Chapter 23 Restoration.

14. PIPE MATERIALS

A. The pipe material and classification shall be shown on the project plans.

B. For pipe greater than or equal to 24 inches in diameter, material changes may only occur in a manhole.

END OF SECTION

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