11.00 SANITARY SEWER MAIN CONSTRUCTION

11.01 DESIGN OF SANITARY SEWER MAINS

11.01.01 PERMITTING

1. City of Monroe has delegated authority to review and approve the construction of all public gravity sanitary sewer mains that connect to the City of Monroe's existing sewer collection system to be owned and maintained by the City of Monroe. All permit applications shall be in accordance with Chapter 57 of the City of Monroe's Ordinance; Water and Sewer Main Extensions Delegated Permit Authority, Delegated Permit Program and further referenced by 15A NCAC 02T.0306. Any projects involving, private gravity sewer mains, pump stations, forcemains, low pressure sewer or vacuum systems, or an environmental assessment shall be permitted through the North Carolina Department of Environmental Quality Division of Water Resources (NCDEQ- DWR).

11.01.02 EXTENSION POLICY

Developers/Engineers shall refer to the City of Monroe Water and Sewer Extensions Policy before proceeding with design of sewer mains.

11.01.03 HYDRAULIC DESIGN

No public gravity sewer main shall be less than 8 inches in diameter. All design flow calculations shall be based on current North Carolina Department of Environmental Quality (NCDEQ) guidelines and standards.

The following are the current City of Monroe and NCDEQ design standards:

1. Zoning Areas

   a. Residential Areas:

      Residential Areas shall be based on NCDEQ flow criteria of 120 Gallons/Day/Bedroom

      Multifamily Area shall be based on NCDEQ flow Criteria of 120 Gallons/Day/Bedroom with a minimum per unit flow generation of 240 Gallons/Day.

      The City of Monroe Zoning Regulations limit the total units of multifamily dwellings to 10 units per acre.

   b. Commercial Areas:

Flow generation shall depend on the specific type of commercial dwelling. Please refer to the NCDEQ Regulations (15A NCAC2T.0114).

c. Industrial Areas:

Flow generation shall depend on the specific type of industrial development. Please refer to the NCDEQ Regulations.

The City of Monroe Water Resources Department reserves the right to determine flow design criteria and proper sizing for all sewer main extensions.

2. Peaking Factors:

Determine peak daily flow by multiplying the average daily flow by the appropriate peaking factor. The minimum peaking factor permitted by the North Carolina Department of Environmental Quality is 2.5 and this factor should be used in the absence of specific design or flow data supporting a higher peaking factor.

3. Size the Sanitary Sewer Pipe:
All sewers shall be designed flowing half full at the average daily flow. All sewers shall be designed and constructed to give mean velocities when flowing full of not less than 2.0 feet per second, based on Manning's equation

Manning's Equation:

$$V = \frac{1.486}{n} \times (R_H)^{2/3} \times S^{1/2}$$

Where: V = velocity in feet/second
n = coefficient of roughness (n = 0.013)
S = slope of energy grade line, ft/ft
R_H = hydraulic radius, ft
= cross sectional area of flow (ft^2) or diameter (in)
wetted perimeter 48

4. Determine the Minimum Slope:

The following lists the minimum and the City of Monroe's recommended minimum design slopes based on the diameter of sewer main. Sewers shall not be oversized to justify using flatter slopes.

MINIMUM SLOPES FOR SANITARY SEWER MAINS		
	REQUIRED BY NCDEQ	**RECOMMENDED BY CITY OF MONROE**
Sewer Main Size (Inches)	**Minimum Slope (Feet / 100 Feet)**	**Minimum Slope (Feet / 100 Feet)**
8	0.40	0.50
10	0.28	0.35
12	0.22	0.28
14	0.17	0.22
15	0.15	0.17
16	0.14	0.15
18	0.12	0.14
21	0.10	0.12
24	0.08	0.10
27	0.07	0.08
30	0.06	0.07
36	0.05	0.06

5. High Velocity Protection

Where design velocities are projected to be greater than 15 feet per second, the sewers and manholes shall be protected against displacement by erosion and impact. Measures to be used shall be approved on a case by case basis. For velocities greater than 20 feet per second, erosion control measures shall be documented on the "Record Drawings" and in the Engineer's Certification.

6. Steep Slope Protection

Sewers on 20 percent slopes or greater shall be anchored securely with concrete, or equal, with the anchors spaced as follows:

a. Not greater than 36 feet center to center on grades 21% to 35%;
b. Not greater than 24 feet center to center on grades 35% to 50 %; and
c. Not greater than 16 feet center to center on grades 50% and over.

11.01.04 GENERAL SEPARATION DISTANCES REQUIRED

Three (3) feet minimum cover shall be provided for all sewer mains unless Sewer Rated Ductile Iron Pipe is specified.

Conflicts with Existing and Proposed Utilities

1. Water Mains

   a. Maintain minimum of 18-inch vertical clearance for water mains installed above and below sewer mains.

   b. Whenever it is necessary for a sewer main to cross under a water main with less than 18-inches of vertical separation, the water main shall be constructed of ductile iron pipe for a distance of 10-feet on each side of the point of crossing by use of a single piece of pipe.

   c. Whenever it is necessary for a sewer main to cross over a water main, the sewer main shall be constructed of sewer rated ductile iron pipe and water main shall be constructed of ductile iron pipe, with joints meeting water main standards, for a distance of 10-feet on each side of the point of crossing by use of a single piece of pipe.

   d. Sewer mains shall be laid a least 10-feet horizontally from existing or proposed water mains unless local conditions or barriers prevent a 10-foot horizontal separation. In that case, the sewer main will be laid in a separate trench, with the elevation of the bottom of the water main at least 18-inches above the top of the sewer. When these conditions are not met the sewer main shall be constructed of sewer rated ductile iron pipe and water main shall be constructed of ductile iron pipe with joints meeting water main standards.

   e. Sewer mains shall be installed at least 100 feet from potable water wells. Where this separation is not possible the sewer main shall be sewer rated ductile iron pipe. Sewer mains shall not be installed within 25 feet of any private well or within 50 feet of any community well.

   f. Upon review, the Water Resources Department may require in certain cases the use of sewer rated DIP if deemed necessary by the Water Resources Engineer.

2. Storm Sewer

   a. There shall be 24-inch clearance between the utility and the sewer. If this clearance is not possible the sewer main shall be sewer rated ductile iron pipe with a minimum length of 10-feet on each side of the utility.

   b. If the sewer main crosses under an existing or proposed storm drain pipe that is 30-inches or greater in diameter, sewer rated DIP shall be used and

centered under the storm drain pipe crossing with a distance of 10-feet on each side of the storm drain pipe.

c. Upon review, the Water Resources Department may require in certain cases the use of sewer rated DIP if deemed necessary by the Water Resources Engineer.

3. Gas Mains, Electrical and Telephone Duct Banks

a. When crossing gas mains, electrical or telephone duct banks, a vertical clearance of 18-inches shall be maintained. Whenever the 18-inch clearance requirement is not met, sewer rated DIP shall be used; unless an exception is made by the gas utility. Separation distances and type of pipe material may deviate from above as authorized by the City of Monroe Energy Services Gas Manager.

b. A minimum 10' horizontal distance shall be maintained between the sewer and the gas, electric or telephone unless an exception is made by the City of Monroe Water Resources Engineer.

4. Underground Cables

Individual telephone, electric power and cable TV cables may be crossed with a minimum clearance of 12-inches and a horizontal separation of 2-feet. The Design Engineer shall refer to the City's **Standard Detail for Local Residential Streets in Division 02,** if applicable.

11.01.05 PROTECTION OF POTABLE WATER SUPPLIES

1. A horizontal distance of 100 feet shall be maintained from any private or public water supply source, including any WS-1 waters or Class I or Class II impounded reservoirs used as a source of drinking water.

2. A horizontal distance of 50 feet shall be maintained from waters classified WS-II, WS-III, WS-IV, B, SA, ORW, HQW, or SB from normal high water.

3. Any other stream, lake, or impoundment, from normal high water is a minimum of 10-feet separation.

11.01.06 PIPE MATERIAL SELECTION

The City of Monroe approves the installation of four (4) different types of pipe, which are Sewer Rated DIP, PVC SDR-35, PVC C900 DR-25, and HDPE SDR-17.
HDPE shall only be used in pipe bursting applications. The selection of the type of pipe to be installed is based on the following conditions per **Standard Detail 12.09.00**:

1. Depth of Bury < 3 feet shall always require the installation of sewer rated ductile iron pipe.

2. Depth of Bury > 20 feet shall always require the installation of sewer rated ductile iron pipe.

3. Depth of Bury < 12 feet and > 3 feet shall permit the installation of SDR-35 PVC pipe provided it is in accordance with general separation distance requirements.

4. Depth of Bury > 3 feet and < 20 feet shall permit the installation of PVC C900 DR-25

5. PVC SDR-35 shall always require a minimum of TYPE III Bedding per the **Standard Detail 12.09.00**.

6. PVC C900 DR-25 shall always require a minimum of TYPE II Bedding per the **Standard Detail 12.09.00**. TYPE III may be required where rocky conditions are encountered.

11.01.07 MANHOLE SELECTION

1. Manholes will be furnished with the following clear inside diameters according to the sewer main diameter unless amended by written permission from the Water Resources Engineer:

8” to 12” pipe	4’ Manhole
15” to 36” pipe	5’ Manhole
39” to 54” pipe	6’ Manhole
54” and larger	8’ Manhole

2. 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.

3. All manholes for 8" sewer main shall be four (4') feet inside diameter unless otherwise directed as per above. All manholes constructed with an invert separation of 2.5 feet or greater shall include an outside drop per standard detail 12.03.00.

4. Inflow dishes/inserts shall be installed on all new manholes, for mains 12-inches or less, with the exception to cross-country type manholes.

5. <u>Manhole Types</u>:

   a. Cross Country Manholes: All manholes located outside of the public-right-of-way shall be considered Cross Country Manholes and shall be

designed in accordance with **Standard Detail 12.02.00** of these Specifications. All frame and covers shall utilize a cover-to-swivel function. Manholes shall be 2 feet above final grade with a permitted tolerance of 6-inches. Special Conditions may require these manholes to be installed flush with or even below the ground. Written permission from the Water Resources Engineer shall be required before such installations are permitted.

b. Street Right-of-Way Manholes: All manholes installed inside the public right-of-way shall be considered Street Right-of-Way Manholes and shall be designed in accordance with Standard Detail 12.01.00. All manholes inside of roadways shall be installed flush with the pavement and have inserts installed. All manholes installed outside of pavement but in the right-of-way shall be installed with inserts and be flush with grade. Manholes shall not be installed in low laying areas or in the conveyance path of storm water.

c. Concentric Cone Manhole: In locations where the depth of bury of the manhole is less than 5 feet a concentric manhole shall be installed without steps designed in accordance with **Standard Detail 12.05.00**. All other manhole installations shall require an eccentric cone. Flat Top Manholes shall not be permitted unless a design review is completed by Water Resources Engineer and written permission is granted.

d. Drop Manholes: Drop manholes are recommended for design in areas that permit their installation in order to minimize the sewer main depth of bury. All manholes with a drop of greater than 2.5 feet shall require the design of a Drop Manhole in accordance with **Standard Detail 12.03.00**. All sewer piping considered a part of the Drop Manhole Assembly shall be Sewer Rated Restrained Joint DIP.

e. Inside Drop Manholes: Inside drops may be permitted on case by case basis after review by the Water Resources Department. The minimum manhole diameter shall be 5 feet in such cases.

f. Rim elevations of all manholes shall be shown on the plans. Manholes with rim elevations below the 100-year flood elevation shall have sealed watertight lids. These locations shall be shown on the plans. Outside vents for watertight lid manholes shall be located every 1000-feet and shall conform to the plan detail with the opening of the vent at least two foot above the 100-year flood elevation. Please refer to **Standard Detail 12.08.00**.

11.01.08 MANHOLE SPACING

The number of manholes shall be held to a minimum subject to the following:

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

2. Maximum manhole spacing shall be as follows:

Pipe Size	**Maximum Manhole Spacing**
8" – 15"	**425'**
> 15"	**550'**

11.01.09 SANITARY SEWER LATERALS

1. Sanitary Sewer Laterals shall range in size between 4 and 12-inch. The City of Monroe shall make all sanitary sewer taps on live sewer mains unless written permission is granted by the City of Monroe Water Resources Engineer to the Developer's Contractor to perform the tap under the inspection of the City of Monroe's onsite representative.

2. All taps to be designed inside a residential or commercial subdivision shall extend to the right-of-way and property line or the edge of the public utility easement. Refer to the Water Resources **Standard Detail 12.13.00** for a graphical representation of construction of a standard sanitary 4-inch sewer lateral. Refer to the City of Monroe Engineering Department Standard Street Right-of-Way Details for a location description of sanitary sewer laterals.

3. To minimize conflicts with lot driveways, the City of Monroe shall require that all water and sewer services be installed within 1-foot of the exact center of each lot (except cul-de-sacs) and have a 2-foot separation with each other. The Developer shall have a licensed surveyor place a stake in the ground to identify the exact location of the each lot's centerline and the right of way. Contractor shall use this stake to install the sewer services. Sewer services <u>not</u> installed within 1-foot of the centerline shall be rejected.

4. No sewer service shall be installed under a lot's driveway or in low lying areas. If an installed sewer service is in conflict with a proposed driveway, the service will be required to be relocated at the Developer's expense.

5. 4-inch Sanitary Sewer Laterals shall be permitted to be connected into the sanitary sewer main or a manhole. 6-inch and greater sized sanitary sewer laterals shall be required to connect directly to a manhole; unless written permission is granted by the Water Resources Director

6. Please refer to the City of Monroe's Engineering Department **(Division 2) Standard Detail 02.01.05** for street utility locations. The sanitary sewer clean

outs should be installed at the General Public Utility Easement line for all service laterals installed outside of a dedicated public right of way.

7. Two separate properties connecting to one sanitary sewer lateral shall not be permitted.

11.01.09A 8-INCH AND LARGER SEWER LATERAL TESTING

1. All proposed private sewer lines 8-inches and larger with or without manholes to serve a facility on a single parcel shall be tested per NCDEQ requirements listed in these specifications for public sewer mains and manholes. The testing of the sewer main and manholes shall be observed by an appointed City of Monroe Inspector and a copy of the results sent to the Water Resources Department for review. All tests must pass before the discharge of sewer from the facility will be permitted into the City's sewer collection system

11.01.10 PROVISIONS FOR TESTING

1. Provisions for testing shall be covered under the **Construction, Installation and Testing of Sanitary Sewer Mains Section**, of these Specifications.

11.01.11 ENGINEERING PLAN SUBMITTAL REQUIREMENTS

1. Licensed North Carolina Professional Engineer:

   All plans submitted for review and permitting by the City of Monroe Water Resources Department must be stamped, signed and dated by a Licensed North Carolina Professional Engineer with expertise in the design of sanitary sewer mains. The Professional Engineer shall be in good standing with the North Carolina State Board of Registration and shall be in responsible charge of the sanitary sewer project.

2. Drafting Standards:

   a. The standard scale for City Of Monroe construction drawings is 1" = 40' or 1" = 50' in plan view and 1" = 4' or 1" = 5' in profile view, respectively. Expanded detail drawings should be used whenever needed to clearly convey design details.

   b. Standard sheet size shall be 24" x 36" for construction plans. Please note that 42" x 30" sheets will not be permitted. Standard sheet size shall be 8-1/2" x 14" for any NCDOT encroachment maps.

   c. All sheets must contain the standard City of Monroe title block format, City of Monroe Erosion Control Detail Sheets and Water and Sewer Details Sheets where appropriate.

d. Engineer shall submit all digital drawings in an AutoCad format that is compatible with the City of Monroe's most current release. Engineer shall submit as-builts in digital format and on 0.3 mm Mylar dated, sealed, and clearly marked as-built.

e. Elevations must be shown at the left side of the profile section. Station numbering should increase from left to right and should be approximately above the corresponding plan view stationing. **Both plan and profile must be shown on the same sheet**.

g. Sewer main drawings should run from left to right upstream. Structures and appurtenances (vaults, manholes, piers etc.) should be labeled in plan and profile with station number and standard detail reference if applicable.

h. All underground obstructions shall be shown on both plan and profile (if applicable). Vertical clearance requirements are to be shown in profile and any requirements for Ductile Iron Pipe should be shown.

i. Pipe sizes shall be shown on the plan view and properly scaled on profile.

j. Drainage ditches are to be shown with direction of storm runoff. Erosion control devices are to be shown as well in plan view and properly labeled.

k. Bearings and distances on sewer mains shall be labeled in the upstream direction.

l. Subdivision sewer plans shall include lateral locations only to show how each lot will be served. It shall be noted on the plans that exact lateral locations are determined during construction, and the exact locations are required for as-built records.

m. The Design Engineer shall state on the plans that "All work shall conform to the current City of Monroe's Water Resources Department Standard Specifications and Details. Any discrepancies between the plans and specifications shall be subject to the decision of the Water Resources Engineering Manager or their authorized representative.

3. Plan Submittals and Permitting Process:

a. All information called for on the checklist included in at the end of this Section shall be used as a reference for the design of water main projects.

b. The Engineer shall submit two (2) sets of Plans for each review until approval has been granted.

c. Upon approval of the construction plans, the Developer shall submit three (3) sets of plans along with a completed Sanitary Sewer Extension Permit Application and a check in the amount of the prevailing City's fee schedule made payable to City of Monroe.

d. For projects requiring approval from the NCDOT, the Design Engineer shall provide the City with a cover sheet stamped with the NCDOT permit number. The City will place their approval stamp on that cover sheet in order to create a Master Cover Sheet, thereby covering both permits and eliminating multiple sets of plans required on the project site. The City will send the Master Cover Sheet to the Design Engineer for the printing and distribution of plans.

4. Encroachments:

a. The Developer shall secure permits from the following, but not limited to, agencies for work within their jurisdiction: NCDOT, Duke Energy/Union Power Cooperative, Railroad (CSX, Amtrak, Norfolk), and Army Corps of Engineers. The Developer shall abide by all submittal requirements per each agency.

5. Easements

a. All sanitary sewer mains installed outside of a dedicated public right-of-way shall have a 30' General Public Utility Easement centered on the main. Sanitary sewer mains can share a General Public Utility Easement with other utilities provided a 10' horizontal separation exists. The Water Resources Department will consider General Public Utility Easements less than 30' provided there is minimal depth of bury. Developer shall be required to meet with the Water Resources Department prior to contacting any property owners to obtain the required easement forms and notification policy.

6. Shop Drawings and Submittals:

a. Shop Drawings and Submittals for Materials to be used in the sanitary sewer main construction are covered in the **Sanitary Sewer Main Materials Section** of these Specifications.

7. As-Builts and Engineering Certification:

a. Final As-Builts Plans: After construction has been completed and approved by the City of Monroe Water Resources Department, the Contractor shall submit to the Engineer a set of as-built drawings from the construction plans. The Engineer shall make the necessary modifications

to the plans to reflect the as-built changes and present to the City of Monroe Water Resources Department one (1) "As-built" set of the plans on **Mylar Sheets**.

b. The City of Monroe requires the following information to be provided on the sanitary sewer main as-builts. All sanitary sewer taps shall be identified on the plans and stationed from the nearest downstream manhole. The offset of the clean-out location shall be taken from the center of the sewer main. All sewer grades shall be verified to be in conformance with design requirements.

c. Engineer's Certification: After completion of the project the Project Engineer shall submit to the City of Monroe Water Resources Department the Engineer's Certification statement as attached to construction permit.

d. No system shall be activated nor Certificate of Occupancy be issued until the Engineer's Certification is received.

11.01.12 ENVIRONMENTAL IMPACT ASSESSMENT

The Developer's Engineer shall be responsible for determining the need for an Environment Assessment. This shall be permitted through NCDEQ- DWR.

11.01.14 Water Resources Department Checklist for Design Review for Sewer Main Extensions

Subdivision or Project Name: _____

First Review By: _____Date: _____

Second Review By: _____ Date: _____

Third Review By: _____ Date: _____

PRE-DESIGN REQUIREMENTS

_____ Notification to North Carolina One Call of Intent to Design a Gravity Sewer Main
_____ Field verification of all utilities:
-Telephone
-Gas
-Electric
-Fiber optic
-Cable
-Water Mains
_____ Coordination of Gravity Sewer Main Location with Off-Site Utilities

Check-off each of the requirements in the appropriate column as each requirement is approved. Do not check-off a listed requirement where revisions are required as result of review. Revision requirements should be noted in response to designer. Enter "N/A" under First Review if a requirement is not applicable to project of specific review

GENERAL REQUIREMENTS

First Review	Second Review	Third Review	
_____	_____	_____	Plans Sealed and Signed by Registered Professional Engineer
_____	_____	_____	Scale of All Plan Sheets Labeled
_____	_____	_____	Date of Plans and Each Revision Shown
_____	_____	_____	If Major Subdivision, Preliminary Plat Approved by Planning Director
_____	_____	_____	If Major Subdivision, Streets and Lots Conform to Approved Preliminary Plat
_____	_____	_____	If Multi-Unit Development, Approved by Planning Director
_____	_____	_____	If Multi-Unit Development, Site Plan Conforms to Planning Approval
_____	_____	_____	Survey for Design Tied to City Monument or NC Grid Coordinates
_____	_____	_____	Submit Industrial Waste Survey if Applicable
_____	_____	_____	NC DOT Encroachment (if required)
_____	_____	_____	Erosion Control Permit Applied For (if required)
_____	_____	_____	Wetlands Permit/Certification (if required)
_____	_____	_____	Stormwater Permit Applied For (if required)

SEWER MAIN DESIGN

_____	_____	_____	Sewer Main Sizes Conform to City Sewer System Plan
_____	_____	_____	Sewer Main Sizing Provide Adequate Capacity
_____	_____	_____	Sewer System Downstream Provide Adequate Capacity
_____	_____	_____	Sewer Manhole Spacing Correct (Not >500 Ft)
_____	_____	_____	Sewer Manholes In New Streets at Street Centerline +/- 4 Feet
_____	_____	_____	Sewer Manhole Rim Elevations in Street R/W at Grade
_____	_____	_____	Sewer Manhole Rim Elevations in Off-Street Easements 2 Feet Above Grade
_____	_____	_____	Sewer Manhole Rims Above Storm Drainage or Floodway Areas or Sealed
_____	_____	_____	On-Site Necessary Easements Shown on Approved Plat or Recorded
_____	_____	_____	Off-Site Necessary Easements Obtained and Recorded
_____	_____	_____	Easement Widths Meet Current Standards for all New Sewer Mains
_____	_____	_____	Sewer Tap Stub-Out Shown to Each Lot
_____	_____	_____	10 Ft Horizontal Separation from all Parallel Water Mains; or DIP if Not Achievable
_____	_____	_____	18 Inches Vertical Separation at All Water Main Crossings Over Sewer; or DIP if Not Achievable
_____	_____	_____	12 Inches Vertical Separation from all Storm Sewers or DIP if Not Achievable
_____	_____	_____	100 Ft Distance from Water Supply Reservoir or DIP and 50 Ft if Not Achievable
_____	_____	_____	50 Ft Distance from WS-III and WS-IV Surface Water Normal High Water or DIP if Not Achievable
_____	_____	_____	100 Ft Distance from Private Drinking Water Well or DIP and 25 Ft if Not Achievable
_____	_____	_____	Creek Crossing Bottom of Pipe Above 25-Year Flood Elevation
_____	_____	_____	Drop Manholes Provided Where Grade Drop Exceeds 2.5 Ft
_____	_____	_____	Sewer Rated DIP Where Depth of Bury <3 Ft or >20 Ft
_____	_____	_____	Sewer Rated DIP or PVC C900 Where Depth of Bury >12 Ft or < 20 Ft
_____	_____	_____	No Greater than 2 Pipe Transition Couplings in Any Run of Pipe Between Manholes
_____	_____	_____	All Service Taps 4” or Larger at Manholes
_____	_____	_____	All Sewer Lines Profiled
_____	_____	_____	All Distances Between Manholes and Pipe Slopes Shown on Profile and Correct
_____	_____	_____	All Water Main and Storm Sewer Crossings Shown on Sewer Profile
_____	_____	_____	Existing and/or Proposed Grade Shown on Profile
_____	_____	_____	Minimum Pipe Slope Provided for 2 Ft/Sec Velocity and Capacity Requirements of Design
_____	_____	_____	All Sewer Lines Labeled and Stationed