WATER & SEWER DESIGN

(Last revised 6/22/10)

SELECTED LINKS TO SECTIONS WITHIN THIS DOCUMENT

USEFUL REFERENCES

Cross-Connection/Backflow Protection (Town Code, Title V: Public Works, Chapter 53)
Unified Development Code (Town Code, Title XV: Land Usage, Chapter 155)

1.1 GENERAL

1.1.1 SPECIFICATION AND DESIGN MANUAL:

A. All projects within the jurisdiction of the Town of Clayton shall be designed and constructed in accordance with the Town of Clayton's Manual of Specifications and Standards, latest revision.

B. Public sanitary sewer gravity mains, force mains, and lift stations shall conform to the design and construction requirements of the NC Department of Environment and Natural Resources, Division of Water Quality, NCAC Title 15A 02T, *Waste not Discharged to Surface Waters*, latest revision.

C. Public water distribution systems shall conform to the design and construction requirements of the NC Department of Environment and Natural Resources, NCAC Title 15A, Subchapter 18C, *Rules Governing Public Water Systems*, latest revision.

1.1.2 PERMITS:

A. **Encroachment Permits:** An encroachment permit will be required from any Contractor or Developer wishing to excavate or place utilities on NCDOT or other public right-of-ways.

B. **Pavement Cuts**: Pavement cuts in streets shall be repaired in accordance with the specific requirements of public agency on whose street or roadway the utility is being placed, as well as any other applicable requirements dictated in the approved encroachment permit. Open cut or bored crossings shall otherwise adhere, as applicable, to specification section 02275, *Trenching, Backfilling & Compaction of Utilities*.

C. Developer must obtain all other State and Local permits, as applicable (Air Quality, Erosion and Sedimentation Control, Zoning, etc.).

D. **Plan approvals, Water & Sewer Permits**: Prior to commencing construction, all plan approvals and water and/or sewer permits shall be obtained. The Town Engineer shall require that a preconstruction conference be held at Town Hall prior to commencing construction.

1.1.3 Plan Review and Observation Fees: All plan review and construction inspection fees must be paid prior to obtaining NCDENR (Sewer) and PWS (Water) permits. Refer to the current Town fee schedule for applicable fees.

1.2 WATER SYSTEM DESIGN STANDARDS

The purpose of this module is to establish standard design procedures and criteria for water system design on systems owned and maintained by the Town of Clayton.

1.2.1 DISTRIBUTION SYSTEM

A. **General:** Distribution systems shall generally meet the minimum requirements of the NC Department of Environment and Natural Resources, NCAC Title 15A, Subchapter 18C, *Rules Governing Public Water Systems*, latest revision.

1) **Water Supply System**: The developer shall connect the subdivision or development with the water system at his expense and shall design and construct it in such a manner as to adequately provide and serve the development with water for both domestic use and fire protection.

2) No new permanent structure or pond shall be constructed over water mains or located within water or sewer easements.

B. **Fire Demand:** For design purposes, refer to the NC Fire Prevention Code, latest revision (http://www.ncdoi.com).

C. **Design - System Design:** As part of the design, the Engineer shall model all new systems using either **EPAnet, Kentucky Pipe, WaterCAD**, or other approved compatible, software. The design data shall include a sketch of the system showing assumed minor losses, pipe roughness (“C” Constants assumed), line lengths, fixed grade node elevations, node numbers, demands, pipe numbers, time of day of field test of hydrant (static pressure converted to elevation head) for verification of starting elevation head, the static water elevation in tank at the time a static pressure reading was taken and, ground elevation of hydrant tested.

1. **Pipeline Velocity**: 3 to 6-fps normal working conditions are preferred although higher velocities in short lengths of pipe may be tolerated for brief periods. Sustained high discharge velocities can scour the pipe's interior and increase leakage.

2. **Main Size:** Water mains shall be sized in accordance with the Town of Clayton's long-range water distribution system plans. Standard main sizes in the Town of Clayton's distribution system are 6, 8, 10, 12, 16, 24, and 30 inches. The minimum diameter of public water main is 6 inches.

   Fire hydrants shall not be installed on mains less than 6 inches in diameter.

3. **Looping/Interconnectivity**: Water mains shall be designed to be looped and interconnected as required by Town Engineer.

4. **Valving**: Valve shall be fully accessible from ground surface by means of a valve box.

   a. **Valve type/size**:

      i. **Valves on 6- through 12-inch mains**: 6- through 12-inch valves shall be resilient wedge gate valves.

      ii. **Valves on 16-inch and larger mains**: Either resilient wedge gate valves or Butterfly valves are permitted on 16-inch and larger mains.

   b. Valves shall be installed at all branches from feeder mains and between mains and hydrants according to the following schedule:

      i. One 6-inch valve shall be installed on each fire hydrant leg.

      ii. 3 valves at tees (excluding fire hydrant tees),

      iii. 4 valves at crosses,

      iv. An in-line valve shall be installed on the water line and shall not exceed the distances given below:

Line size	Distance
6 thru 10-inch mains	450 feet
12-inch mains & Larger	1000 feet

      If required, when tapping an existing live main and inserting a main line valve, the main being tapped must be shut off and a valve installed (cut-in) on the existing main within close proximity to the new connection. In lieu of shutting off the existing main and cutting in a valve, the Town Engineer may allow an "inserting" valve to be placed if the former is undesirable or impractical.

c. **Valve Size to Match Main Size**: Unless otherwise approved by the Town Engineer, the valve size must match the line size.

d. **Downsizing Mains**: When downsizing a main, locate a valve after the reducer on the side with the smaller diameter. However, the designer must evaluate thrust forces and accommodate the forces by placement of a thrust collar (if required) on the larger main.

e. **Manhole Valves**: Unless approved otherwise by the Town, valves 16 inches and larger shall be placed in a minimum 6-foot diameter precast concrete doghouse manhole. The operating nut must be positioned under the manhole opening. See **Standard Detail 513.09**.

D. **Piping Material Applications**

a. **General**: Use pipe, fittings, and methods of joining in accordance with the following:

MATERIAL	WATER MAINS	WATER SERVICES	BACKFLOW PREVENTION BOXES/VAULTS
UNDERGROUND APPLICATIONS			
Ductile Iron	6-inch through 30-inch	3-inch and larger	3-inch through 30-inch
PVC C-900, Class 150, DR 18	6-inch through 12-inch	Not allowed	Not allowed
PE 2406 – Directionally Bored	6-inch through 12-inch	Not allowed	Not allowed
Type K Soft Copper	Not allowed	3/4" through 2-inch	Not allowed
Brass Pipe	Not allowed	Short sections of 2-inch	3/4-inch through 2-inch
ABOVE GROUND APPLICATIONS			
Ductile Iron	6-inch through 30-inch	Not allowed	6-inch through 30-inch
Brass Pipe	Not Allowed	Not Allowed	3/4-inch through 2-inch

b. **Metallic Warning Tape**: 3-inch wide blue warning tape marked "Caution Water Main Below" shall be installed in the ditch over all water mains. See **Standard Detail 511.01**.

c. **Tracer Wire**: 12-gauge blue insulated solid copper wire shall be installed along the top of all pipe. The wire shall be continuous and uninterrupted. A sufficient excess length of wire shall be left in each valve box to provide at least 2 feet of length above finished grade. See **Standard Details 511.01, 513.01, 513.02 and 513.03**.

E. **Joint applications**

PIPE	JOINT TYPE	COMMENT
UNDERGROUND APPLICATIONS		
Ductile Iron Pipe	Push On	6-inch through 30-inch
Ductile Iron Fittings	Mechanical Joint	6-inch through 30-inch
PVC C900/C905	Push On or Fusible Butt Joint	6-inch through 12-inch
Type K Soft Copper water service	Compression type brass fittings	3/4-inch through 2-inch
PE 2406 water main, directionally bored	Fusible Butt Joints	6-inch through 12-inch
Brass Pipe	NPT threaded	Short sections of ¾-inch through 2-inch
Stainless Steel	NPT threaded	Short sections of ¾-inch through 2-inch
ABOVE GROUND APPLICATIONS		
Ductile Iron	Flange Joint	3-inch through 30-inch
Brass	NPT threaded	3/4" through 2-inch
Stainless Steel	NPT threaded	3/4" through 2-inch

1) Galvanized pipe and galvanized fittings are not permitted in the Town of Clayton water system.

2) PVC glued or threaded pipe or fittings are not permitted in the Town of Clayton water system.

3) Provide transition couplings and special fittings with pressure equal to or exceeding the pressure rating of the pipe or fitting to which they will be either connected or fitted.

4) Do not use flanges, unions, or keyed couplings for new underground piping. With the approval of the Town Engineer, they may; however, be used in above ground applications such as vaults. 3-part unions may be used for repairs.

F. **Location**: Water mains shall be located within dedicated street rights-of-way or publicly dedicated easements.

G. **Fire Hydrants:** Fire hydrants shall not be installed on mains less than 6 inches in diameter.

1) All public hydrants are to be located in a street right-of-way or Town of Clayton public utility easement. See **Standard Details 514.04 and 514.05** for hydrant location in relation to street:

2) **Hydrant Location**: A hydrant shall be located at every street intersection, and; unless shown otherwise below, hydrants shall be located in accordance with Appendix C, *Fire Hydrant Locations and Distribution* of the NC Fire Prevention Code and are subject to review and approval by the Town Engineer and the Fire Marshall.

3) **Maximum Distances from Structures**:

   i. **Residential**: 500 feet by the pull of the hose method (not as the crow flies).

   ii. **Commercial**: 300 feet by the pull of the hose method.

4) **Minimum distances from a structure**: No new hydrant shall be located closer than 40 feet from a structure.

5) **Fire Hydrant Pavement Markers**: A permanent raised bidirectional one color (blue and blue) pavement marker shall be placed at the centerline of the road directly in front of the fire hydrant. See section 02510, *Water Distribution,* paragraph 2.3.6, Fire Hydrant Pavement Markers and **Standard Details 514.04 and 514.05**.

6) **Minimum Fire Flow at Hydrants**: The minimum design fire flow for residential subdivisions shall be 1000 gpm with 20-psi residual flow. Each phase shall be required to meet this requirement. For nonresidential subdivisions (commercial, multi-family, etc), the minimum flow shall be no less than 1500 gpm; however, the NC Fire Prevention Code, as updated from time to time, shall be utilized in determining the estimated water needs for fire protection.

7) **Services on Fire Hydrant Branches:** Services on fire hydrant branches are not permitted.

H. **Pressure**:

1) **Minimum System Pressure:** Water distribution mains shall be sized to provide a minimum pressure at all points within the distribution system of not less than 20 psi (gauge) during periods of peak demand (fire flow). Systems not designed for fire flows shall have the capacity to maintain a pressure of at least 30 psi (gauge) throughout the system during periods of peak flow.

2) **Pressure Reducing Valves**: When the maximum static pressure in a new system exceeds 80 psi, businesses and/or residences shall be equipped with a pressure-reducing valve. The valve shall be located on private service lines. The NC State Plumbing Code covers the installation of pressure reducing valves. The pressure reducing valves are neither owned by nor maintained by the Town of Clayton.

I. **Bury**:

1) Water mains shall be designed with a minimum bury of 36 inches cover and a maximum of 72 inches of cover, as measured from the top of crown to the finished grade, unless approved otherwise by the Engineer.

2) Under conditions which otherwise prevent 36 inch bury, such as at crossings above shallow buried structures or rock, the pipe shall be Ductile Iron and the minimum cover shall be 30 inches, as approved by the Town Engineer.

3) Lines which have less than 30 inches of cover at ditch or culvert crossings shall be Ductile Iron and encased in concrete. The casing shall extend through all areas until the depth of cover above the DIP is greater than 30 inches but may be no less than 5 feet on each side the ditch or culvert. Such encasements class shall require approval of the Town Engineer.

J. **Horizontal and Vertical Blocking**: Concrete thrust blocking, tie rods, restrained joint pipe, and/or other means of restraint shall be provided at all changes in pipe direction. Concrete thrust blocking is not recommended where the blocking may bear on other utilities or where the area behind the block may be excavated in the future.

K. **Dead end lines:** A blowoff assembly, fire hydrant or other means of purging dead end lines is required. Blowoff assemblies, in lieu of fire hydrants (only as directed by the Town Engineer), shall be installed at the end of all water mains and at other locations as required for flushing. The following blowoff sizes shall apply for the applicable main size:

Main Line Size	Blowoff Size Required	Blowoff Valve Size	Standard Detail Reference
Permanent Blowoff Assemblies			
Mains up to 8 inches	2-inch	2-inch	**514.02**
12-inch and larger mains	Fire Hydrant	6-inch leg valve	**514.04 & 514.05**
Temporary Blowoff Assemblies			
Mains up to 8 inches	2-inch	Valve to match main size[a]	**514.01**

[a]A temporary blowoff shall have a full 18-foot joint of pipe between the valve and the standpipe.

The maximum length of a permanent dead end 6 and 8-inch main shall be 700 feet and 1000 feet; respectively, unless approved by the Town Engineer. A fire hydrant is required at the dead end.

L. **Sag Vertical Blowoffs**: When directed by the Town Engineer, provide a fire hydrant when lines have severe sag where sediment can accumulate and retard flow in water line (such as when running beneath large streams, ditches or culverts). See **Standard Details 514.04 and 514.05**.

M. **Crest Vertical – Air Release Valves**: Where water mains are subject to air entrapment, provide an air release valve constructed in accordance with **Standard Detail 516.01,** as applicable, located at the highest elevation on the main. Where the main undulates along its length and several crests are encountered, a separate air release manhole will be required at each crest. The Town Engineer, before placement, shall approve the final actual location of all air release manholes. Typically, when the relative elevation difference in a water

main (from the main's sag elevation to the crest elevation) is greater than 25 feet, an air release valve will be needed, unless otherwise directed by the Town Engineer.

A 2-inch air release valve shall be used on water mains 6 inches and larger in diameter. Refer to air release valve manufacturer's recommendations for air release sizing and quantity.

The valve shall be used to bleed air from the line as it is filled with water for testing.

Manhole Size Determination:
a. The minimum diameter of manholes shall be 5 feet.
b. Manholes with 16-inch diameter or larger pipe shall be a minimum of 6 feet in diameter.

N. **Vertical upward thrust**: Vertical upward thrust at fittings or vertically deflected joints shall be resisted with thrust collars of adequate size and weight, pilings, or other acceptable methods approved by the Town Engineer. As an alternate, swivel connectors may be used on 6-inch mains. See **Standard Detail 512.04**.

O. **Relation of Water Mains to Sewers:**

See specification Section 02510 – Water Distribution, Part 1 - General, paragraph 1.9 *Project Conditions* for separation requirements between water mains and sewer mains/structures and between water mains and other utilities/structures.

P. **Stream crossing**:

Where possible, all stream crossings shall be made below water level. Stream crossings shall be made as close to a 90-degree angle as possible. All stream crossings shall be made with mechanical joint ductile iron pipe. A valve shall be placed on each side of the crossing and restrained by anchor blocks. All stream crossings shall require steel casing (see **Standard Detail C07.01**). Valves shall be a minimum of 20 feet from end of casing if valves are in line with casing. See **Standard Detail C07.02** for typical stream crossing detail.

Below streambed crossing: Unless otherwise permitted by the Town Engineer, streambed crossings shall be made with no less than 2 feet of cover.

Above stream crossing: Water mains crossing streams above normal water level shall be placed above the 25-year storm elevation when practical and otherwise meet DWQ requirements for stream crossings. Stream crossings above water level shall be constructed with piers or other suitable methods approved by the Town Engineer.

Hanger Support from Bridges: In the design of an aerial system, provide both details and calculations showing the hanger type, hanger capacity, hanger-to-bridge attachment type (mechanical or chemical), and capacity with a minimum safety factor of 3. Assume the pipe to be full. Provide lateral bracing of hanger

to a girder or to bottom of bridge deck. Two pipe hangers per pipe joint shall be required. Provide plans showing the plan view and elevation of the water line crossing.

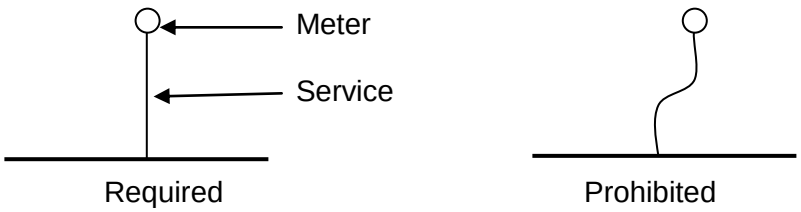
Thermal Protection, allowance for main expansion: Where aerial crossings are approved by the Town, install expansion devices as necessary to allow for expansion and contraction movement in pipe, such as on aerial bridge or creek crossings. Expansion joints are typically to be provided where the line transitions from aerial to underground. Provide calculations showing expected differential movement. To prevent freezing, provide either pipe insulation jackets that totally cover the pipe (so that the pipe and insulation is placed inside the hanger assembly) or an insulation system that covers both the pipe and hanger assembly.

Q. **Taps**: Taps shall be made in accordance with the following table:

Service Size	Type Tap Allowed	Standard Detail Reference	Comments
¾-inch, 1-inch	Double Strap Bronze saddle	**513.04**	None
2-inch	Double strap bronze saddle	**519.03**	None
3-inch	Not allowed	-	3-inch water meters shall be served by a 4-inch tap with 4-inch service lines.
4-inch and larger	All stainless steel tapping sleeve & valve or a fitting	**513.02**	None

R. **Water Services**

General: A water service shall be provided at lot center for each lot within the public right of way. The back of the meter box shall be located at the right of way and no closer than 1 foot from the back of the sidewalk, (see **Standard Detail 519.01**). Services shall be placed perpendicular to the main and shall not meander or snake in such a manner as to offset the meter from its main connection point (see schematic below). The meter box shall be set flush with the finished grade and shall not be installed in a ditch slope. In situations where the meter box is located outside of the public right-of-way, a water easement shall be provided to the Town.



For multi-family housing, individual water meters are required unless a variance is requested of, and approved by, the Town Engineer and master metered.

Service Location Relative to Sewer Service: The water service shall be located within 3 feet of the sewer service where possible.

S. **Large Meter Vaults and Above Ground Assemblies** shall be designed and constructed to provide minimum clearances between the pipe, fittings or vault walls per the dimensions prescribed in the applicable vault detail(s). See **Standard Details 519.04, 519.06, 519.07, & 519.08.** *See the applicable detail for the particular type application proposed.*

T. **Multiple Feeds**

Water systems with multiple feeds require the installation of double check valve assemblies on the downstream side of each meter, unless the use of the facility requires a RPZ in accordance with the Town of Clayton's *Water System Cross-Connection Control Ordinance*, latest revision.

U. **Cross-connection prevention**

Approved backflow prevention assemblies shall be installed on the service line to all non-residential and irrigation facilities. All backflow units shall be installed between the Town's system and the first branch or tap. See **Standard Details 519.06, 519.07, & 519.08**, as applicable. See also the Town of Clayton's *Water System Cross-Connection Control Ordinance*, latest revision for hazard classification and type backflow device requirements.

V. **Testing:**

General: The Town of Clayton will provide water for testing purposes on water mains. Refer to technical specification section 02510 – *Water Distribution*, paragraph 3.4 – *Testing and Disinfection* for required testing requirements and methods. Testing of completed water mains shall include the following:

1) Hydrostatic Testing

2) Chlorination and Bacteriological Tests

1.3 GRAVITY COLLECTION SYSTEM DESIGN STANDARDS

The purpose of this module is to establish standard design procedures and criteria for sewer system design on systems owned and maintained by the Town of Clayton.

1.3.1 GENERAL

A. **General:** Gravity Collection systems shall generally meet the minimum requirements of the State of North Carolina Department of Environment and Natural Resources, NCAC Title 15A 02T *Waste Not Discharged to Surface Waters* , latest revision.

1.3.2 DEFINITIONS

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

1. **Main or Trunk Sanitary Sewer**: Exterior gravity sanitary sewer systems receiving flow from one or more laterals or mains.

2. **Sewer Service**: Exterior domestic sewer piping serving a private residence, business, commercial facility, or industrial user. This line, in its entirety, belongs to the customer/user for operation and maintenance.

3. **Interceptor** Sewer that receives flow from a number of gravity mains or trunk sewers, usually placed along a stream or river.

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

1) **DIP**: Ductile Iron Pipe

2) **HDPE**: High Density Polyethylene Pipe

3) **PVC**: Polyvinyl Chloride Plastic

1.3.3 COLLECTION SYSTEM DESIGN

A. **Minimum Size/Sizing:** No public gravity sewer conveying wastewater shall be less than 8 inches in diameter. No private gravity sewer service in the public right-of-way conveying wastewater shall be less then 4 inches in diameter.

B. **Developments**: Wastewater flows for developments with localized sewers shall be determined in accordance with NCAC Title 15A 02T .0300 *Sewer Extensions*.

C. **System Design**:

1) The system is to be designed taking into account the total natural drainage basin, land use, ultimate population estimates, maximum anticipated commercial and industrial contribution, infiltration and a 50-year design period. The capability of the downstream sewers to accept the future flow tributary to the collections system shall be evaluated by the design engineer. Sewer size shall be based on an average daily flow of 250 gpd per single-family dwelling unit and 120 gpd/bedroom for all other residential facilities and a peak/average ratio of 2.5. The ratio includes an allowance for infiltration but not inflow. The table below should be used as a general guide for determining equivalent average daily flow and the peak flow for various non-residential developments.

Non-Residential Uses			
Land Use	**Equivalent Person/Acre**	**Average Flow (gal/acre/day)**	**Peak Flow (gal/acre/day)**
Shopping Center	18	1800	4500
Bus/Commercial	25	2500	6250
O&I	30	3000	7500
Industrial	50	5000	12500

[a]Table excerpted partially from the City of Raleigh Public Utilities Handbook

2) The Designer shall evaluate the capacity of the receiving sewer main both at and from the point of discharge to a point downstream identified by the Town Engineer in order to determine if the systems can handle the additional sewer flow.

D. **Design Flow Depth**: It is customary to design sanitary sewers with some reserve capacity. Generally, sanitary sewers through 15 inches in diameter are designed to flow half full. Larger sanitary sewers are designed to flow three-fourths full. These factors include infiltration but exclude inflow. If inflow is anticipated or known to exist in upstream sewers, the Town Engineer may require that the design flow be increased accordingly and the justification/computation/source referenced in the design calculations and provided to the Town Engineer for review.

E. **Main Depths**: The depth of sewer mains shall be great enough to serve adjoining property, allowing for sufficient grade on service lines. Main depth shall also take into consideration potential conflicts with parallel pipe systems (such as water mains and storm drainage lines), providing room for the service laterals to pass either over or below lines.

F. **Extensions to Adjacent Property**: Where tributary flow is expected from an upstream natural drainage basin, designers shall install extensions of sewer main to the farthest property line of tract in accordance with Clayton's UDO (chapter 155, latest revision).

G. **Acceptable Pipe Material**

1) Refer to **Part** 2 - PRODUCTS of section 02530 – *Sanitary Sewer* for detailed specifications for pipe and fittings listed below. Use pipe, fittings, and joining methods according to the application indicated.

Allowable Materials for Gravity Sewer Pipe up to 18 inches in diameter	
Services	Sch 40 PVC, Class 350 DIP,
Gravity Mains	SDR 35 PVC, C-900 PVC (Class 150, DR18), C905 PVC (14-inch through 18-inch; Class 160, DR 18), Class 350 DIP

Allowable Materials for Gravity Sewer Pipe 21 to 48 inches in diameter	
Gravity Mains	Class 350 DIP; C905 PVC (Class 160, DR 18)

Allowable Materials for Force Mains		
DIP	Class 350	
PVC	4-inch and larger	C900 PVC, Class 150, DR18 w/ Ductile Iron Fittings
PVC	2-inch	ASTM D2241, SDR 21, Class 200
HDPE (Directional Bore Only)	4- through 8-inch	ASTM C906, PE3408-PE3608

2) PVC sewer force mains are permitted under paved surfaces on a case by case basis as determined by the Town Engineer.

3) A-2000 PVC, Truss, HDPE, and VCP are not permitted for gravity pipe.

H. **Location:** All sewer mains shall be installed within the street right-of-way or within a dedicated Town of Clayton utility easement. When located in street right-of-way, the sewer main shall be in the center of the pavement or right-of-way, as much as practical.

1) Minimum Plan Requirements:
   a. Manhole number and station.
   b. Manhole top and invert elevations
   c. Benchmark reference (elevations must be tied to mean sea level reference datum).
   d. Pipe grade and material, encasements, piers, crossing details, and access.
   e. Profile line drawing.

I. **Bury:** A minimum of 36 inches of cover shall be provided for all sewers. The Town Engineer must approve all installations of sewer lines with less than 36 inches of cover.

1) **Trench Loading Consideration**: When the allowable depth of bury has been exceeded, the designer shall show on the plans the beginning and ending station where the pipe material, pipe class or bedding class changes are required. In the selection of the pipe material, pipe class and/or bedding class for the depth of bury required, the designer shall account for both the

weight of the trench backfill and, in roadway applications, H20 live loads on pipe. Allowances for arching action of soil may be considered. Submit calculations to the Town Engineer to justify selection of pipe material, pipe class, or bedding shown on plans.
Changes in pipe class or material shall occur only at manholes. Also, see paragraph L, Changes in Pipe Size or Material, below

J. **Slope:**

1) **General**: All sewers shall be designed and constructed to give mean self-cleansing velocities of not less than 2.0 feet per second, based on Manning's formula using an "n" value of 0.013 – this includes evaluating sewers flowing partly full. The following are the minimum slopes that shall be provided; however, slopes greater than these are recommended.

Minimum Slope	
Sewer Size (inches)	**Minimum Slope (%)**
8	0.40
10	0.28
12	0.22
15	0.15
16	0.14
18	0.12
21	0.10
24	0.08

a. **Uniform slope between manholes**: Sewers shall be designed with uniform slope between manholes.

Grade variation from required minimum slope: The line is to be inspected for conformance with line and grade shown on the plans. The Town of Clayton shall be provided with record drawing measurements (including actual distance between manholes and the as-built invert in and invert out elevations) on the As-Built Drawings.

Vertical alignment:

Maximum Slope: The maximum grade shall not exceed 10%.

Minimum Slope: No tolerance below the NCDENR minimum slopes will be allowed. If the slope in the pipe is found to be less than acceptable the Contractor shall relay the pipe.

b. **Slope Increase**:

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

ii. Special attention must be given to the early years that the new public system is used, as initial flows may be substantially lower than design flows and the velocities well below the minimum. The Town Engineer may direct usage of greater slope.

c. **Pipe size increase**: Sewers may not be upsized more than 1 OD pipe size to gain flatter slopes. If the minimum scouring velocity cannot be maintained during initial operation prior to the design flow capacities being reached, the developer may be required to periodically flush the system until volume has increased to affect a self-cleansing velocity.

d. **Steep Slope Protection**: Any time the grade is 9% or more, concrete collars shall be provided to prevent creep and/or to prevent water from flowing along the pipe and causing trench scour. Manholes shall be protected from corrosion generated by release of hydrogen sulfide gas from high turbulence associated with line velocity.

e. **High Velocity Protection**: Where design velocities are projected to be greater than 10 fps, the sewers and manholes shall be protected against internal erosion and impact by high velocity. Pipe shall conform to ASTM, AWWA, ANSI, etc., which provide protection against erosion. For velocities greater than 20 fps, erosion control measures shall be documented on the "Record Drawings" and the Engineer's Certification. See **Standard Detail 532.02**.

f. **Sewers placed in predominantly silty fine-grained soils**: The designer should consider placing either clay or concrete collars (dams) periodically along sewers constructed in and backfilled predominantly with silty soils – regardless of slope. Migration of fines from adjacent soil and loss of pipe support is possible. A non-woven separation geotextile fabric should be placed between the stone and the earthen backfill.

K. **Alignment:** All sewers shall have a straight alignment between manholes.

L. **Changes in Pipe Size or Material**:

1) **Pipe Size Changes**: Gravity sewer sizes shall remain constant between manholes. Pipe size changes shall occur only at manholes. When a smaller sewer joins a large one, the inverts of the sewers shall be arranged to maintain approximately the same energy gradient whenever possible. 0.8 times the pipe diameter of the two lines shall match.

2) **Undersized or substandard downstream sewers**: Sewer extensions shall be designed for projected flows even when the diameter of the receiving sewer is less than the diameter of the proposed extension at a manhole, with special consideration of an appropriate flow channel to minimize turbulence when there is a change in sewer size. Justification shall be provided at the beginning of the project drawings indicating that the capacity of the downstream sewer will not be overloaded by the proposed upstream installation. The Town of Clayton reserves the right to prohibit additional flow into an undersized sewer for new growth.

3) **Pipe Material Changes**: To avoid couplings of dissimilar material, pipe material or pipe class must remain consistent between manholes and may not be changed. At manholes drops, the manhole drop material shall be C900 PVC and conform to **Standard Detail 532.09**.

M. **Uneven inverts of parallel pipelines in same trench**: Where more than one pipeline is laid in the same trench and the invert elevations are not identical, and where no concrete cradle or encasement is provided for the support of the high pipeline, its foundation shall be considered to be yielding. When bridging is required to support a portion of the pipeline over such yielding trench bottom, it shall not be considered to provide bridging strength. #57 stone shall be provided and used for this purpose.

N. **Buoyancy:** 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.

O. **Connections to Existing Mains:** Connection to existing sewer mains shall be made at existing manholes or by the addition of a doghouse manhole.

P. **Service Connections**:

1) Services connected to gravity sewers shall be connected using in line wyes (**Standard Detail 533.01**) or saddles. In-line wyes shall be used for all service connections to new lines. Service saddles may be used on existing mains (see **Standard Details 533.01 and 533.02)**.

2) A cleanout will be installed on each house service. Unless topography requires otherwise, services are to be placed in the middle of the lot. The cleanout shall be located at the right of way or easement line. If the cleanout falls within concrete or asphalt, a cast iron valve box shall be installed over the cleanout (See **Standard Detail 533.01**, sheet 1).

3) Minimum grade for 4-inch and 6-inch services shall be in accordance with the North Carolina State Plumbing Code, latest revision.

4) **Service connections to manholes**: Unless approved otherwise by the Town Engineer, services connections to manholes shall be made at dead end lines only. Service connections must enter the bottom of the manhole when ever possible. If not practical, services may be located above the bottom but may not enter the cone or it's joint. Service connections in manholes shall also be core bored and booted and shall be separated by a minimum of 2 times the pipe OD (either vertically or horizontally) from other services or mains.

5) Vertical stacks or standpipe services are not allowed except as shown on **Standard Detail 533.01**, sheet 2 of 2.

6) **Services on Utility Easements**: All services going into a utility easement should be connected to the sewer line where practical. Cleanouts, typically located at the easement line, must project 3 feet above grade and be marked by an 8-foot pressure treated 4x4 buried 2 to 3 feet.

Q. **Public Easements:** Easements across lots, or centered on rear or side lot lines, shall be provided for utilities where necessary, and shall be at least 20 feet wide, which said easement may be a part of the vehicular access easements. The width of easements (except when adjacent and parallel to right-of-way) shall be based on the following:

Sewer Lines	Min. Easement Width (feet)
Sewer Easements	**20***
Combinations Easements (Sewer with either Water or Storm Drainage)	**30***

*Width to be determined by the Town Engineer.

Consideration shall be given for deeper cuts (generally greater than 12') by including an additional temporary construction easement (usually 10' - 20'). The Town may require that the width of the permanent easement increase with a depth of sewer as determined by the Town Engineer for maintenance purposes.

Easements shall be fully accessible by rubber-tired vehicles in their entirety. The Town of Clayton may require stream fords for larger streams provided crossings are consistent with NCDENR Division of Water Quality and USCOE requirements.

All off-site easements shall be acquired by the developer and dedicated to the Town of Clayton by recorded map and by deed of easement prior to approval of the project for construction. Easements shall be provided with a maximum 4:1 grade parallel to sewer centerline and a maximum of 4% cross slope.

No building or other obstruction shall be erected and no trees or shrubbery shall be planted on any easement.

R. **Testing:** See specification section 02530 *Sanitary Sewer*; paragraph 3.9 *Testing* for testing requirements.

S. **Allowable Leakage**:

Condition	Allowable Leakage
Pipe diameters 18 inches and smaller, exposed or aerial piping	No visible signs of infiltration
Pipe diameters larger than 18 inches	50 gallons per inch diameter per mile per day

1.3.4 DESIGN – MANHOLES

A. **Location**

1) **General**: Manholes shall be installed on all mains 8 inches and larger. Manholes shall be installed at the end of each line, at all changes in grade, at changes in main size or alignment, at all intersections.

2) **Spacing**: Manholes shall be placed at distances not greater than 425 feet for all sewers.

B. **Diameter**

1) **Minimum Diameter**: The minimum diameter of standard manholes shall be 4 feet. The minimum diameter of drop manholes shall be 5 feet.

2) **Standard Manhole Diameter Based on Pipe Size**:

Line Size	Minimum Diameter
8 through 12 inches	4-foot in diameter*
15 through 30 inches	5 feet in diameter
36” inches	6 feet in diameter
42 inches	7 feet in diameter
48 inches	8 feet in diameter
54 inches	9 feet in diameter

***NOTE: The number of connections or angle of connections may require a larger diameter manhole.*

3) **Standard Manhole Diameter Based on Depth**:

Depth	Minimum Diameter
Manholes 0 to 12’-0”	4-foot in diameter*
Manholes greater than 12’-0” deep	5 feet in diameter

***NOTE: The number of connections or angle of connections may require a larger diameter manhole.*

4) **Extended Bases**: All manholes greater than 12 feet in depth shall also have extended bases with appropriate reinforcing.

5) **Moorbases**: Moorbases are not permitted.

6) **Cones**: Eccentric cones are required to be used on all mains.

7) **Minimum drop across invert**: The minimum drop between manhole invert in and invert out is 0.2 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:

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

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	0.60
For junctions of 3 pipes	0.80
For junction of 4 or more pipes	1.00

(Reference: King's handbook of Hydraulics)

Drops through manholes shall be indicated on the drawings by invert in and invert out elevations.

C. **Drop Type**

1) **Inside Drops**: A drop shall be provided for a sewer entering a manhole at an elevation greater than 30 inches above the invert of the manhole unless sewer pipe crown elevations match. See **Standard Detail 532.09**.

2) **Outside Drops**: Not permitted.

3) **Service taps in manholes**: If a service is proposed in the manhole, utilize a drop bowl connection as manufactured by RELINER/Duran, Inc.

D. **Water-tightness**

1) Manholes shall be pre-cast concrete.

2) **Pipe connections to Manholes**: Inlet and outlet pipes shall be joined to the manhole with gasketed flexible watertight connections (rubber boots). See **Standard Details 532.01, 532.02, 532.03, 532.07, 532.09 and 532.10.**

3) **Manholes in streets or adjacent to streets**: Manholes subject to flooding by street water or located in flood prone areas shall have watertight covers. See **Standard Detail C06.02**.

4) **All sanitary sewers in utility easements** (other than those running parallel to creeks and/or located in a flood plain): Unless otherwise approved by the Town Engineer, manholes shall be eccentric cones sections with standard frames and covers. All manholes rims must be 12 inches to 24 inches above adjacent grade. When height above adjacent grade must exceed 24 inches, use eccentric flat top section with frames cast in to top. Manhole markers, furnished by the Town, shall be installed by the Contractor at each manhole.

5) **Utility Easements running parallel to creeks and/or located in flood plains**: Unless otherwise approved by the Town Engineer, manholes shall

be eccentric cones sections with bolt-down watertight frames and covers. All manholes rims must be 12 inches to 24 inches above adjacent grade. When the rim height exceeds 24 inches above grade, use eccentric flat top section, with frames cast into the flat top. Frames and covers shall be bolt-down watertight frames and covers. Manhole markers, furnished by the Town, shall be installed by the Contractor at each manhole.

a. Manholes shall be designed for protection from the 100-year flood by one of the two methods (see **Standard Detail 532.10)**:

i. Manholes shall be vented 24 inches above the 100-year base flood elevation with every other manhole vented, or

ii. Manholes rims shall be 24 inches above the 100-year base flood elevation.

E. **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.

F. **Corrosion Protection for Manholes**:

1) Where corrosive conditions due to septicity or other causes are anticipated, consideration shall be given to providing corrosion protection on the interior of the manholes, as directed by the Town Engineer. 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 corrosive erosion and displacement from impact.

3) See also paragraph 1.3.7F, below.

G. **Inspection and Testing**: See technical specification 02530 - *Sanitary Sewer* for manhole testing requirements.

1.3.5 SEWERS IN RELATION TO STREAMS AND OTHER BODIES

All creek crossings, unless otherwise approved by the Town Engineer, shall be made with ductile iron pipe.

A. **Materials**: Sewers entering or crossing streams shall be constructed of ferrous material pipe with mechanical joints; otherwise, they shall be constructed so they will remain watertight and free from changes in alignment of grade and tested. Material used to backfill the trench shall be stone, coarse aggregate, washed gravel or other materials, which will not readily erode, cause siltation, damage pipe during placement, or corrode the pipe.

1) **Sewers Paralleling Creeks**: Sewers paralleling creeks shall be below the stream elevation, such that lateral connections will be below streambed. 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 affects of the stream flow. Sewers shall be placed outside of applicable Watershed and stream/river Buffers.

2) **Perpendicular Crossings**: All crossings require the use of casing and carrier pipe. Creek crossings shall be as near to perpendicular to the stream as possible. Sewers crossing creeks shall be placed below the streambed such that there is a minimum of 2-foot bury below the streambed. If the minimum 2-foot bury cannot be attained, either encase the sewer in concrete or design the sewer as an aerial crossing in accordance. Aerial crossings require prior approval of the Town Engineer. All crossings shall be subject to US COE and NCDENR Division of Water Quality approval and conditions. See **Standard Detail C07.02**.

B. **Buried Pipe Cover Depth**: The top of all sewers entering or crossing streams shall be at a sufficient depth below natural bottom of the streambed to protect the sewer line. The following cover requirements shall be met:

1) 1 foot minimum cover where the sewer is located in rock:

2) 2 feet of cover in other material unless ferrous pipe is specified. In major streams or rivers, more than 2 feet may be required; and

3) With approval of the Town Engineer, in paved stream channels, the crown of the sewer line may be placed below the bottom of the channel pavement.

C. **Aerial Crossings**:

1) All crossings require the use of casing and carrier pipe. Creek crossings above water level shall be constructed with piers or other approved support/carriage and shall be approved by the Town Engineer. The bottom of the pipe should be placed no lower than the elevation of the 25-year flood. Ductile iron pipe with mechanical joints shall be required.

2) Proper joint technology, such as flanged or restrained, adequate supports to prevent excessive deflection and flexion or a combination of both shall be provided for all aerial pipe crossings. Supports shall be designed to prevent heave, overturning, uplift, and settlement. Supports shall be designed to withstand the hydrodynamic effects of the stream flow pressure using the following formula:

$$P = 2.5KV^2$$

Where,
2.5 = safety factor against overturning

P = pressure, psf
V = velocity of water, fps
K = 4/3 for square ends, ½ for angle ends when angle is < 30°, and 2/3 for circular piers.

If it is probable that the aerial pipe could be submerged by the stream flow, the effects of the flow pressure on the pipe shall also be taken into account when computing pier-overturning moments. For aerial stream crossings, the impact of floodwaters and debris shall be considered. In streams subject to flooding velocities greater than 5 fps, pipe crossing shall be anchored in bank in such a way that if all supports are lost, the pipe system will not separate and will be restrained by anchor blocking of appropriate size in the bank. Provide applicable blocking computations and details.

3) Precautions against freezing, such as insulation and increased slope, shall be provided.

4) Expansion jointing shall be provided between above ground and below ground sewers. Where buried sewers change to aerial sewers, special construction techniques shall be used to minimize heaving. Similarly, special details may be required between above ground and below ground sewer transition to account for seismic forces.

5) Computations:

   a. Provide structural calculations for any elevated main and pier system where span of the main exceeds the joint length. Provide calculations for all aerial mains, and their supporting structures that are subject to hydrodynamic forces. Calculations are to provide for a minimum safety factor of 2.5 against overturning and 1.5 for uplift. Calculations shall also address applicable seismic loads. Where stream is subject to floating debris such that the pipe system could be broken or separated by the impact forces, pipe joints shall be flexible restrained joints. Pipe crossing shall be anchored in bank in such a way that if all supports are lost, the pipe system will not separate and will be restrained by anchor blocking in the bank. Provide applicable blocking computations and details for review.

6) When steel pipe is used for aerial pipe crossings, the pipe is to be coated inside and outside.

D. **Structures:** 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. See paragraph C above.

E. **Anti-Seepage Collars – wetland areas**: In areas where the sewer trench has the potential to drain wetlands, anti-seepage collars shall be installed. In these areas, a US Army Corps of Engineers 404 Wetland Permit and/or a NCDENR 401 Water Quality Permit may be required.

F. **Environmental - Buffer Requirements**: A minimum buffer separation of 50 feet shall be maintained between sewers and streams/waters classified as nutrient sensitive streams or watershed buffers (from normal high water). See also NCDENR NCAC Title 15A 02T for other requirements regarding minimum separation with streams, lakes and impoundments. Before crossing streams or ditches, working within 100 feet of private or public water supply sources or 50 feet of non-water supply ponds, lakes, or rivers, the Designer shall verify whether either the line is exempt or obtain a permit to encroach into a watershed or nutrient sensitive river basin buffer. Unless otherwise permitted, water or sewer mains crossing a stream, river, pond, or lake buffers are to be as near perpendicular as possible (the crossing is considered perpendicular if it intersects the stream or surface water between an angle of 75 and 105 degrees). Do not disturb more than 40 linear feet (longitudinal) of a riparian buffer. Adhere to all of the following Best Management Practices in Zone 1 (the lower 30 feet beside the stream or water) during design/construction.

1) Woody vegetation is to be cleared by hand. No grading allowed.
2) Stumps to remain except in trench where trees are cut. Minimize disturbance to roots in buffer zone.
3) Backfill trench with the excavated soil immediately following installation.
4) Do not use fertilizer except for the one-time application to reestablish vegetation.
5) Minimize removal of woody vegetation, the amount of disturbed area, and the time the disturbed area remains disturbed.
6) Take measures to ensure diffuse flow of water through the buffer after construction.
7) In wetland areas, use crane mats to minimize soil disturbance.
8) Separate topsoil from the excavated material so that the original top soil is replaced over the excavated area.

1.3.6 PROTECTION OF POTABLE WATER SUPPLIES AND STORM SEWERS

A. **General**: See specification section 02530 – *Sanitary Sewer*, Part 1- General, paragraph 1.10 Project Conditions for separation requirements between water mains and sewer mains/manholes and water mains and drainage structures/streams.

B. **Sewer/Well Conflict**: If a sewer main must be placed closer than 100 feet of the well, ferrous sewer pipe with joints equivalent to NCDENR water main standards and pressure tested to 150-psi to assure weathertightness shall be used; however, no ferrous pipe gravity sewer, ferrous pipe force main, or manhole structure shall pass or be placed within 25 ft of a private well or 50 feet of a public water supply well, source or structure. If the sewer line must be installed within 25 feet of a well, the well shall be capped and the property shall be required either to connect to the Town of Clayton's water system, if available, or the existing well must be abandoned according to NCAC Title 15A 2C .0100 *Well Construction Standards*, latest revision, regarding guidelines for well

abandonment and construction of a new well drilled meeting the setback requirements.

1.3.7 PUMP STATIONS

A. **General:**

No pump station will be allowed within 5000 ft. of an existing extendable gravity line. If the design Engineer can demonstrate that gravity sewer is:

1) Not possible, or
2) That the gravity sewer construction cost, if possible, exceeds the pump station construction and present value 20-year operational and maintenance cost by a factor of 2 ½, and
3) Pump stations and force mains will be allowed only with the permission of the Town Engineer.

The estimated cost of both the gravity sewer and the pump station and O&M options costs must be prepared by a NC Professional Engineer.

Relocation and/or abandonment of an existing upstream pump station may be required.

Submersible Pumps: Pumps shall be submersible pumps with electro-mechanical controls. Pumps shall be designed for continuous duty pumping raw, unscreened wastewater. 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 either passing solids, trash, or stringy material through a non-clog or vortex-type impeller or by grinding, chopping, or cutting them prior to passing them through the impeller. Impellers shall have blades that are generally forward rounded or otherwise configured to avoid catching solids, trash, and stringy material. **Standard Detail 534.02** for typical wetwell and valve vault arrangement.

Station Layout: See **Standard Detail 534.08** for typical pump station site layout.

Lift stations, at a minimum, shall include the following:

1) Inspection and Testing: See paragraph 3.9.B.9, 02530 *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) Autodialer (minimum 8 numbers, 8 channels): Autodialer shall be RACO Verbatim telephone autodialer. 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. The auto-dialer shall be programmed

to alarm to dialer when the generator either starts or fails. As an alternate, SCADA System may be required on a case-by-case basis by the Town Engineer and reviewed for compatibility with the Town of Clayton system.

5) Automatic air release valves, as applicable.
6) Primary level control shall be ultrasonic with hand-off-automatic (H-O-A) switches and an automatic alternator.
7) Provide mercury float switch type control system as secondary level control with hand-off-automatic (H-O-A) switches and an automatic alternator.
8) Independent high water alarm circuitry.
9) 3-phase voltage monitor, if applicable. Indication of 3-phase power fail.
10) Discharge gauges.
11) Elapsed time indicators.
12) High pump temperature protection.
13) Pump run lights.
14) Motor overload resetter
15) TLVSS Surge suppressor by Seimens
16) Duplex service receptacles on GFCI.
17) Surge relief valve and return piping to wetwell.
18) Dual power supply auto switchover, etc.
19) Non-Freeze Flush Hydrant (Eclipse No. 2 post hydrant as manufactured by John C. Kupferle Foundry Company, St. Louis, MO). See **Standard Detail 514.08.**
20) Cold-weather ballast fluorescent lighting suitable for exterior use under rain hood.
21) Provide condensate heater on thermostat inside pump control panel.
22) 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.
23) Station Start-up assistance and certification: Station start-up and certification shall include an operational/witness/drawdown test.
24) Control Panel Dead Front: Panels on the primary pump station, backup pumps or generators shall comply with NFPA 70E. The following elements, when applicable for the type system under consideration, at a minimum, shall be accessible and located in front of the dead front panel and/or barriers installed to make the following accessible without being exposed to live conductors: Control/programming keyboards, all hand operated switches, H-O-A switches, disconnects, pump run lights and run time gauges, alarm silence, duplex receptacles, motor overload resetter, gauges (such as ammeter, temperature, fuel level indicator), indication of 3-phase power fail, handles, GFCI switch (on/off), circuit breakers, area light, autodialer, etc.
25) Backup Systems: The designer must provide backup service by a Dri-Prime backup pump. A backup generator can be substituted at the discretion of the Town Engineer. If a backup generator is provided, provide 1 spare pump/motor. The minimum design criteria for each option are outlined below.
26) Provide programmable auto-exercise cycle for both backup pump and generator.

DRI-PRIME BACK-UP PUMP OPTION

Provide auxiliary natural gas, LP gas, or diesel fired automatically activated stand-by dri-prime back-up pump 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. The Contractor shall provide a complete engine driven back-up pump. The back-up pump set shall consist of four-cycle, radiator-cooled, engine direct connected to pump, a unit-mounted control panel, unit-mounted fuel tank, all mounted on a common sub-base. Starting shall be from batteries, with capability to start the unit at 32 degrees temperature. The control panel shall be complete with engine controls and instruments, safety controls and panel lights and include, but not necessarily limited to, the following:

a. Permanent skid mounted trash pump for pumping raw sewage.
b. Pump shall be fitted with a fully automatic priming system capable of repeated priming from a completely dry pump casing.
c. The pump offered shall be the manufacturer's standard production model.
d. Maximum solids handling size: 3 inches
e. Maximum duty point shall meet the suction, head, and flow requirements of the station at which the pump will be located.
f. Priming System: Automatic priming system incorporates a twin-cylinder compressor and air ejector assembly, no vacuum pump. The compressor shall be installed on the engine auxiliary drive and shall be gear driven, lubricated, and cooled from the engine. The priming system shall require no fail-safe protection float gear or any adjusting at high or low suction lifts. Pumps with self-priming chambers modified with vacuum priming systems shall not be accepted as equal. The pump must be capable of running totally dry for periods up to 24 hours, then re-priming and returning to normal pumping volumes. Pump and priming system is capable of priming the pump from a completely dry pump casing. The pump shall be capable of static suction lifts consistent with the site requirements, at sea level. It shall also be capable of operation using extended suction lines. Equipment acceptance shall be contingent upon the pump's ability to run continuously at full speed in a completely dry condition for periods up to 24 hours. The Town's engineer may require a demonstration.
g. Check Valve Pump shall be supplied with an integral swing type check valve mounted on the discharge of the pump allowing unrestricted flow from the impeller. The check valve shall prevent in-line return of flow when the pump is shut off.
h. Drive Unit: The drive unit shall be a diesel water-cooled engine. The engine shall drive the pump by use of direct connected intermediate drive plate. Starter shall be 12 volt electric. Safety shut down switches for low oil pressure and high temperature shall be integral to the engine control panel. Battery shall have 180-amp hour rating. The engine control panel shall include a tachometer and an hour meter. A certified continuous duty engine curve shall be supplied to the owner/engineer.
i. Engine Control Panel: Engine speed shall be adjustable to operate the pump between maximum and minimum design operation speeds in manual mode.
j. Skid Base/Fuel Tank: Integral structural steel skid type fuel tank shall be sized with sufficient capacity to provide at least 24 hours of operating time at full load. The engine shall be capable of operating satisfactorily on a commercial grade of distilled No. 2 fuel oil.
k. Exhaust: Exhaust system shall include a stainless steel critical grade muffler of suitable size. Exhaust system shall have muffler and exhaust

tubing sized to match maximum engine exhaust flow without exceeding engine manufacture's maximum allowable back pressure values.

l. Sound Attenuated Enclosure: The engine and pump shall be completely enclosed with acoustical sound deadening material. The acoustical enclosure shall reduce pump and engine noise to 68 dBA or less at a distance of 30 feet. The panels shall be removable for easy access to the engine / pump for maintenance and repair. The engine control panel shall have a locking door for visual inspection. For maintenance and service needs, the pump discharge side of the unit shall have a hinged door for quick access to the engine oil fill, fuel fill port, oil dipstick and filters.

m. Automatic Starting Control System: The engine shall be equipped with a factory installed microprocessor-based controller and designed to start/stop the engine at a signal supplied by high and low level floats.

n. Engine/Pump Control Specifications: The engine shall be started, stopped, and controlled by a high performance state of the art digital controller. The controller shall be minimum NEMA 3R weatherproof enclosed, and contain an external weatherproof 12-position keypad accessible without the need to remove or open any protective cover or enclosure. It shall be designed to start/stop the engine at a signal supplied by high and low level floats. The pump controls shall provide the following minimum functions without modification, factory recalibration or change of chips or boards by simply accessing the keypad.

   i The keypad shall be a capacitive touch sensing system. No mechanical switches will be acceptable. The keypad shall operate in extreme temperatures, through ice, snow, mud, grease, etc. and maintain complete weather tight sealing of the panel.

   ii In automatic mode, the unit shall conserve energy and go to "sleep."

   iii The panel shall function as manual start/stop by selection at the keypad. No other equipment or hardware changes are required.

   iv The panel shall be capable of varying the engine speed to maintain a constant level in a process without a change to the panel other than via the keypad.

   v The start function can be programmed to provide 3 separate functions each day for 7 days (i.e. a start, warm up, exercise cycle on two separate days at different times and for a varying length of time all via the keypad).

   vi Manual-Automatic Button: In Manual Mode, Manual "Start" button starts engine and runs until "Stop" button is depressed or an emergency shutdown occurs.

   vii The controller shall integrate the engine safety shut-off for low-oil temperature, high-temperature, and provide over-speed protection.

   viii The controller shall include standard field adjustable parameters for engine cycle crank timer, shutdown time delay, warm-up time delay, and cool-down time delay.

   ix The panel shall have only one circuit board with 8 built in relays. Each relay can be named to provide any function all via the key pad without changing relays, chips, printed circuits or any hardware or software.

   x Circuit breakers shall be provided with a built in control panel. Provide fuses or circuit breakers for battery charger and engine.

xi Standard components shall consist of (24) digital inputs, (7) analog inputs, (1) magnetic pick-up input, (8) 20-amp form “C” relays, (1) RS232 port, (1) RS485 port, (1) RS232/RS485 port, (1) J1939 port, and (1) 64X128 pixel full graphic LCD display with backlight.

xii The industrially panel shall withstand vibration of 3 g, 3 axis, frequency swept 10-1000 Hz, in an operating temperature range of 4°F to 176°F and an operating humidity range of 0-95% Non-Condensing.

xiii The control panel shall comply with NFPA 70E and 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; and running time meter, all gauges located in front of the dead front and/or barriers to make them accessible without being exposed to live conductors.

o. The back-up pump unit shall be capable of shutting down and activating the audible and visual alarms and telemetry if a damaging operating condition develops.
p. 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.
q. Light: The unit shall include a single switch operated 12 VDC light within the enclosure.
r. Floats: The unit shall be supplied with 1 float assembly including 2 normally open (N/O) floats which shall integrate with the engine control panel via a single multi-pin plug. Bypass pump “on” float to be placed above the high water alarm.
s. 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 one complete set of filters.
t. The controls must indicate engine run, common engine fail, transfer switch position, low fuel level, and fuel tank leak for remote telemetry purposes; all gauges located in front of the dead front and/or barriers to make them accessible without being exposed to live conductors.
u. The backup pump shall be equipped with an automatic transfer switch to start pump and transfer operation to emergency operation in case of utility under voltage, over voltage, power loss, phase reversal, or phase loss. Response time on transfer switch, due to loss of utility power, needs to be adjustable by owner.
v. 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.
w. Operation and Maintenance instructions. The Contractor shall provide a minimum of four continuous hours of operation and maintenance instructions for the Owner’s personnel.
x. The Town must be furnished with one complete set of air, oil and fuel filters.
y. Provide 5-year warranty from manufacturer of Pump and Engine.

BACKUP GENERATOR OPTION

Provide auxiliary natural gas, LP 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 and include, but not necessarily limited to, 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.
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. Response time on transfer switch, due to loss of utility power, needs to be adjustable by owner.
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. Switches and gauges shall be located in front of the dead front and/or barriers to make them accessible without being exposed to live conductors and shall comply with NFPA 70E.
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 one 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. Lights and gauges must be located in front of the dead front

and/or barriers to make them accessible without being exposed to live conductors and shall comply with NFPA 70E.

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. 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 (if applicable), valves and any and all other items incidental to a first-quality installation.

p. Diesel Option: 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 24 hours at 100% load.
   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.

q. LP Option: The tank must have a capacity to run the generator for a minimum of 24 hours at 100% load.

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. Meter gauges shall be located in front of the dead front and/or barriers to make them accessible without being exposed to live conductors and shall comply with NFPA 70E.

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 four continuous hours of operation and maintenance instructions for the Owner's personnel.
y. The Town must be furnished with one complete set of air, oil and fuel filters.
z. Provide 5-year warranty from manufacturer of Generator and Engine.
aa. Provide three bound (3-ring binder) sets of Operation and Maintenance Manual for all components relative to lift station generator.

B. **Station Design:**

1) Design of station shall be according to the provisions of NCDENR, Division of Environmental Management NCAC Section 15A 02T .0305, *Design Criteria.*

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.

3) The power source, voltage and phasing shall be verified before ordering pumps.

4) The Designer shall evaluate the capacity of the receiving sewer main both at and from the point of discharge to a point downstream identified by the Town Engineer in order to determine if the systems can handle the additional sewer flow.

5) The pump station and force main must be sized to accommodate the total basin area that could gravity flow into it.

6) The Town of Clayton reserves the right to require odor control facilities at pump stations.

7) All control panels must be minimum NEMA 3R weatherproofed, constructed of stainless steel, and have weatherproof identifying labels attached with stainless steel screws.

8) The use of rigid conduit is required.

9) Where low head conditions exist, the designer may have to consider incorporating either an orifice restrictor plate or a Dresser plug valve (or approved equal with a published C_v factor) to induce a greater head. Calculations shall reflect the use of such devices and must be approved by the Town Engineer before incorporating the device.

10) Slab Design:

a. Both the bottom and top slabs of the wetwell shall be designed and reinforced to withstand a uniform live load of 100 psf plus a concentrated load of 2000 lbs on the top slab.

b. If the slab is being used as ballast to hold down the wetwell, the slab shall be so designed and reinforced to withstand the buoyant forces imposed by the wetwell, assuming flooding up to the bottom of the floor slab.

c. The top slab and all equipment of both the wetwell and valve vault must be installed a minimum of 3 feet above the 100-yr BFE. See **Standard Detail 534.02**.

C. **Wetwells:**

1) Wetwells shall have the interior walls painted in accordance with the technical specifications, Section 02530 **-** *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 Town 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 a minimum of 3 foot above the 100 year base flood elevation.

5) Provide a screened exterior vent to prevent gas entry to either the panel or pump house enclosure.

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 cables, etc. must be stainless steel, sized to support the applicable static and dynamic loads imposed by the equipment. Pump lift chains are not permitted.

D. **Site**:

1) See **Standard Details 534.02, 534.03, 534.04, 534.07,** and **534.08**.

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 2 inches of SF 9.5A and 6 inches of ABC is to be provided to the station with a turn-a-round area of sufficient size to accommodate turning of Town maintenance vehicles. Lift station lot must directly abut a publicly dedicated road.

4) Provide an 8-inch thick concrete generator pad (see **Standard Detail 534.08**).

5) Unless otherwise allowed by the Town Engineer, all stations shall be fenced with an 8-foot high galvanized chain link fence with three strands of razor wire across the top. A minimum of a 12-foot or wider rollback gate shall be provided. Depending on the location of the station, the Town Engineer may require the use of green privacy slats in the fence.

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) Minimum 10 ft x 10 ft x 8-inch concrete pad for odor control pad with drain and valve.

8) Emergency pump connection with quick connect flange and resilient wedge gate valve.

9) A metered potable water source with post hydrant and cross connection control is required, unless approved otherwise by the Town Engineer. Use a RPZ (Reduced Pressure Zone) device in an insulated and heated enclosure. See **Standard Detail 534.08**.

10) Provide a non-freeze shower w/ eyewash and concrete pad.

11) Access to all easements associated with the lift station site shall be provided. See **Standard Detail 534.08.**

E. **Force Mains**

1) Force main materials shall minimum conform to the table in paragraph 1.3.3 *G, Collection System Design*.

2) 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. The same principals used to locate air release valves on water mains shall apply to sewer mains. The designer should note that the air/vacuum valves used for water main applications are not suitable for sewer force main applications; occasionally requiring back flushing. See **Standard Detail 534.06** for typical sewer force main air release valve arrangement in

manhole. If not provided in the design, the designer shall provide calculations to prove that a surge relief valve is not needed.

3) A valve or valve vault shall be placed outside of the pump station.

4) Sewer force main valve boxes shall have the valve cap marked SEWER.

5) Force Mains: Force mains shall be designed with appropriately located combination air release and vacuum valves at high points.

F. **Connection of Force Mains to Existing Manholes – Manhole Corrosion Protection**: To protect the manholes (cementitious materials and metals) from Hydrogen Sulfide (H_2S) and Sulfuric Acid (H_2SO_4) corrosion, the Town Engineer may require the Contractor to line the manhole at the force main connection as well as the next 2 to 4 manholes downstream of the force main connection.

End of Section

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