SECTION 200
GENERAL PROVISIONS

201 General

202 Abbreviations & Definitions
- **A. Abbreviations**
- **B. Definitions**

203 Earthwork
- **A. General**
- **B. Tree Protection**
- **C. Rock Excavation - by Blasting**
- **D. Removal of Unstable Material**
- **E. Placement of Fill**
- **F. Compaction Tests**

204 Safety

205 Work Within Right-of-Way of State Maintained Roads
- **A. General**
- **B. Utility Construction**
- **C. Roadway Improvements - Pavement Widening, Curb & Gutter, and Storm Drainage**

206 Maintenance of Traffic

207 Concrete

208 Asphalt

209 Electrical Power Service
- **A. General**
- **B. Easements for Town Electric Power**
- **C. Service Connections - Special Requirements**

210 Grease Traps/Interceptors

211 Dumpsters - Installation Requirements

212 Notification Prior to Beginning Work

213 Materials

214 Inspections

215 Utility Easements - Special Provisions

216 Water for Construction

217 Street Lights

218 Guarantee

219 Retaining Walls

220 Fire Department Access Roads

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201 General

All construction shall conform to the requirements and dimensions on the approved construction plans, Town Standard Details, the Code of the Town of Apex, or as stated in these Specifications. Any conflicting requirements or lack of information shall be brought to the attention of the TOWN prior to construction.

202 Abbreviations & Definitions

A. Abbreviations

AASHTO	- American Association of State Highway Transportation Officials
ANSI	- American National Standard Institute
ASTM	- American Society for Testing & Materials
AWWA	- American Water Works Association
NCDOT	- North Carolina Department of Transportation
NPDES	- National Pollutant Discharge Elimination System
OSHA	- Occupational Safety and Health Administration

B. Definitions

Where the word “ENGINEER” is used in these Specifications, it shall be the *Director of Public Works & Transportation*, *Director of Water Resources*, of the Town of Apex or duly authorized representative.

Where the word “INSPECTOR” is used in these Specifications, it shall be *Water Resources Department*, *Infrastructure Inspections* staff of the Town of Apex or other duly authorized representative.

Where the word “TOWN” is used in these Specifications, it shall be the Town of Apex,

North Carolina or an authorized representative.

Where the word “DEVELOPER” or “CONTRACTOR” is used in these Specifications, it shall be the developer of the project, or his authorized contractor performing work on the site. For purposes of these Specifications, these words are to be considered synonymous.

Where the words “PROJECT ENGINEER” are used in these Specifications, they shall mean the design engineer retained by the developer, and the person responsible for the preparation of the final construction drawings.

203 Earthwork

A. General

Earthwork shall be defined as the removal of soil (including rock) from its natural location and the depositing of such material into the proper fill areas as indicated on the plan.

B. Tree Protection

Tree protection shown on the construction plans approved by the TOWN shall be installed and inspected prior to earthwork within the area shown on the plans for protection. The protection fencing shall also be inspected on a regular basis. In the event that the tree protection fencing is not properly maintained or is in violation, the TOWN may issue a Notice of Violation, Stop Work Order, and/or assess a penalty which shall remain in effect until such time as the fencing is restored and agreements to replace damaged trees and/or vegetation have been resolved.

C. Rock Excavation - By Blasting

1) *Permit* - Where rock must be removed by blasting, a written permit must first be obtained from the Apex Fire Department.

2) *Hours of Blasting* - Blasting for rock removal shall be conducted only Monday through Friday between the hours of 8:00 AM to 5:00 PM.

D. Removal of Unstable Material

Where unstable and/or organic material (“muck”) is encountered in trenches or in roadways, the material shall be completely removed and replaced with suitable material and thoroughly compacted.

E. Placement of Fill

Fill material for roadway embankments shall be free from stones greater than 4 inches in size, construction debris, frozen, organic and/or other unstable material. Fill material

placed in roadway embankments shall be placed in lifts of 8 inches or less, and compacted to a density of not less than 95% of maximum dry density as measured by the *Standard Proctor Method*. The 95% requirement shall apply for that portion of the roadway measured from the back of curb and extending outward on a slope of 1 to 1, measured perpendicular to the centerline. The remaining fill shall be compacted to a density of not less than 90% of maximum dry density as measured by the *Standard Proctor Method*.

Attention is called to Section 300 of this document for the inspection and testing requirements.

F. Compaction Tests

During roadway construction, the TOWN shall require the developer to provide compaction tests to demonstrate compliance with the compaction requirements outlined herein. Such tests may be required at any time that the TOWN believes the compaction to be less than the required density.

Backfilling of all trenches within the street right-of-way shall be thoroughly compacted to provide a minimum of 95% of the maximum density as determined by the *Standard Proctor Method*.

All backfilling of trenches outside the street right-of-way shall be compacted to provide a minimum of 90% of the maximum density as determined by the *Standard Proctor Method*.

204 Safety

The CONTRACTOR shall provide for and maintain safety measures necessary for the protection of all persons on the work site and shall fully comply with all laws, regulations, and building code requirements to prevent accident or injury to persons on or about the location of the work, **including all applicable provisions of OSHA regulations**. The CONTRACTOR shall protect all trees and shrubs designated to remain in the vicinity of the operations and barricade all walks, roads, and areas to keep the public away from the construction. All trenches, excavations, or other hazards in the vicinity of the work shall be well barricaded, and properly lighted at night.

The CONTRACTOR shall be responsible for the entire site and the necessary protection as required by the TOWN and by laws or ordinances governing such conditions. He/She shall be responsible for any damage to TOWN property, or that of others, by the CONTRACTOR, his/her employees, subcontractors or their employees, and shall correct and/or repair such damages to the satisfaction of the Town of Apex and/or other affected parties. He/She shall be responsible for and pay for any such claims against the TOWN.

The TOWN shall not be responsible for making the CONTRACTOR adhere to the Occupational Safety and Health Administration (OSHA) regulations or standards.

However, the TOWN may report suspected violations of unsafe practices to the appropriate enforcement agency.

205 Work Within Right-of-Way of State Maintained Roads

A. General

No construction shall be initiated within the right-of-way of roads that are maintained by the NCDOT without the prior approval of the NCDOT. The NCDOT approval shall be evidenced by an appropriate Encroachment Agreement and/or Driveway Permit, as applicable.

A copy of the approved Encroachment Agreement and/or Driveway Permit shall be in the contractor's possession at the job site at all times that work is being performed.

The Contractor shall notify the NCDOT District Office and shall post any required Indemnity Bond prior to beginning work in the NCDOT right-of-way.

B. Utility Construction

The installation of public utilities within NCDOT right-of-way shall be accomplished in accordance with the Policies & Procedures for Accommodating Utilities on Highway Rights-of-Way, latest revision, as published by the NCDOT, Division of Highway, or those of the Town, whichever, in the opinion of the ENGINEER is more stringent.

C. Roadway Improvements - Pavement Widening, Curb & Gutter, and Storm Drainage

All improvements along existing NCDOT roadways, including pavement widening, curb and gutter, and storm drainage improvements, shall be accomplished in strict accordance with the Standard Specifications for Roads and Structures latest edition, as published by the NCDOT. The NCDOT specification shall supersede the construction specifications of the TOWN. The CONTRACTOR shall call for all inspections as required by the NCDOT District Office.

206 Maintenance of Traffic

Existing public streets or highways shall be kept open to traffic at all times by the CONTRACTOR unless permission to close the streets, or portions thereof, is granted by the ENGINEER. The Town of Apex Police Department must also be contacted by the CONTRACTOR a minimum of 24 hours before any streets are fully or partially closed. Proper and sufficient barricades, lights, signing, and other protective devices shall be required to be installed when deemed necessary by the Police Department or ENGINEER.

207 Concrete

Concrete shall be only plant-mixed, transit-mixed, or mobile-mixed concrete conforming to ASTM C33 for aggregates and to ASTM C94 for ready-mixed concrete. Any concrete poured that has a slump over 4 inches as per ASTM C143, or has a batched time of more than 90 minutes, will be considered unacceptable. Periodic samples may be required at the expense of the owner to determine the strength of the material. Concrete shall not be deposited on frozen subgrade. Concrete shall not be poured when the air temperature is falling and below 40° degrees F, and/or the predicted low temperature for the succeeding 24-hour period is less than 32° degrees F. All concrete when placed in the forms shall have a temperature of between 50° and 90° degrees F and shall be maintained at a temperature of not less than 50° degrees F for at least 72 hours for normal concrete and 24 hours for high-early strength concrete, or for as much time as is necessary to insure proper rate of curing and designed compressive strength. Curing shall be accomplished in accordance with NCDOT specifications.

Concrete shall be air entrained at 5% (±1%). Retarders and accelerators shall be used only upon approval of the ENGINEER.

208 Asphalt

Asphalt and tack coat shall be applied only when the surface to be treated is sufficiently dry and the atmospheric temperature in the shade away from artificial heat is 40° degrees F or above for base and intermediate course and 50° degrees F or above for surface course. Asphalt shall not be applied when the weather is foggy or rainy. The CONTRACTOR is responsible for seeing that these conditions exist prior to the application of tack coat or asphalt.

209 Electrical Power Service

A. General

The Town of Apex will provide electrical service to projects within the Town's ETJ, in accordance with North Carolina General Statute 160A. Electrical service facilities shall be designed, constructed and maintained by the TOWN, with the developer paying fees as may be prescribed in accordance with TOWN policy. These fees may include but are not limited to an aid-in-contribution of construction, pole relocation, and other reasonable and customary charges. The Town of Apex reserves the right to not install electrical service on any right of way, easement, or lot that has not been properly graded in accordance with these specifications.

B. Easements for Town Electric Power

Where electrical distribution facilities are required to cross private property, the

DEVELOPER shall provide easements as follows:

Underground Primary Lines - 20-foot easement

Overhead Primary Lines - 30-foot easement. Easements shall be shown on the final plat for the project

NOTE: All easements shall be shown and properly labeled on the final plat.

C. Service Connections - Special Requirements

Electrical service connections to service pedestals or transformers shall be made in strict accordance with the Standard Detail.

210 Grease Traps/Interceptors

All establishments engaged in the preparation of food shall install a grease trap. The grease trap shall be located outside the building and shall intercept all kitchen wastes, floor drains, and car wash drains. Domestic waste from toilets and lavatories shall not be directed to the grease trap. The Town of Apex Code Enforcement Officer shall approve the design and construction of all grease traps as per N.C. State Building Code.

211 Dumpsters - Installation Requirements

All dumpsters shall be placed on a reinforced concrete pad conforming to the requirements shown in the Standard Detail and screened in accordance with the Apex Planning Department requirements.

212 Notification Prior to Beginning Work

The DEVELOPER or responsible contractor shall notify the TOWN not less than 24 hours prior to the commencement of any new construction activity. No new work shall commence without approval of the TOWN.

213 Materials

All materials incorporated in work to be accepted by the Town of Apex for maintenance shall be new, first quality material installed in accordance with the manufacturer's instructions or these Specifications, whichever, in the opinion of the ENGINEER, is more stringent or applicable.

It is the intent of this Specification to provide materials and construction methods of high standard and quality and to provide materials free from defects in workmanship and product. Equal material not specified may be used provided documentation and samples are furnished to the ENGINEER not less than 14 days before their delivery to the

construction site. The ENGINEER will issue written approval or disapproval of the alternate materials. Current Specifications and/or the latest revisions shall apply in all cases where materials are described.

214 Inspections

The presence of a TOWN employee at the work site shall not lessen the CONTRACTOR'S responsibility for conforming to the approved construction plans and/or specifications. Should the ENGINEER or INSPECTOR accept materials, or work that does not conform with the approved plans or specifications, whether from lack of discovery or for any other reason, it shall in no way prevent later rejection or corrections to materials or work when discovered.

The CONTRACTOR shall have no claim for losses suffered due to any necessary removals or repairs resulting from the unsatisfactory work. Any work that has been covered without the INSPECTOR'S approval, shall at the INSPECTOR'S request, be uncovered and be made available for inspection at the CONTRACTOR'S expense. After regular working hours or weekend work shall comply with the TOWN'S specifications and shall include only such work that does not require continuous observation by an INSPECTOR.

215 Utility Easements - Special Provisions

Access for the purpose of construction inspection shall be provided to the Town of Apex or designated representatives. All off-street water, sewer mains, and power lines, etc. to be operated and maintained by the TOWN shall be located in a public easement.

Private easements for water and sewer service lines are not permitted.

216 Water for Construction

The Town of Apex does not provide free or otherwise unmetered water for use on any construction project. CONTRACTORS or construction personnel shall not take water from hydrants, blow-offs, water meter boxes, etc. CONTRACTORS desiring to use TOWN water for construction purposes shall apply to the *Water Resources Department* for water service and shall pay for the water service in accordance with the Town of Apex policies and requirements.

Bulk water for construction or other water requirements may be obtained at the *Water Resources Department* located at 105-B Upchurch Street. Bulk water for construction may also be obtained from a fire hydrant using a Town approved meter with back flow preventer. Bulk water rates will be billed per load of water obtained. Bulk water rate is the current TOWN Outside Water Rate.

217 Street Lights

The Town of Apex will provide 1 street light at each intersection and 1 streetlight near the midpoint of each block or approximately every 300 feet in a residential area. The TOWN shall provide 1 streetlight at the midpoint of any cul-de-sac greater than 200 feet in length in residential areas. Additional public street lighting is provided only in areas where needed for public safety, such as major intersections, the downtown area, and in cases of clearly defined need.

218 Guarantee

The DEVELOPER shall provide a guarantee as per Town of Apex Unified Development Ordinance, on workmanship and materials for a period of at least the longer of 1 year after the date of acceptance by the Town of Apex or until 60% of the lots in the bonded phase have been issued a Certificate of Occupancy. Any defects observed within the guarantee period shall be repaired and/or replaced to the Town's satisfaction and the cost of such repairs shall be borne by the developer. The guarantee shall apply to street construction, sidewalks, water lines and appurtenances, sanitary sewers, storm sewers (including ditches, drainage channels, and appurtenances, etc.), pumping stations, force mains and appurtenances.

219 Retaining Walls

Retaining wall structures shall meet NCDOT standards. Any deviation from NCDOT standards require pre-approval of the Transportation & Infrastructure Development Director. Retaining walls higher than 4 feet shall be designed by a licensed Professional Engineer in accordance with N.C. General Statute 89C and be required to obtain a building permit in accordance with the Town of Apex Unified Development Ordinance. Safety rails or fencing may also be required. Private retaining walls, including supports, foundations, reinforcement, geogrid, and any other wall appurtenances are not allowed within public right-of-way or easements.

Where private retaining walls are intended to retain public roadway infrastructure, the walls shall be laterally offset at a 1H:1V rate from the right-of-way to the top of concrete footer. Walls shall be designed for a typical highway live traffic surcharge load of 250 pounds per square foot (psf). A vehicle accessible maintenance easement of at least 10 feet in width with 6H:1V slopes shall be provided behind the wall for walls that exceed 4 feet in height.

220 Fire Department Access Roads

The CONTRACTOR shall provide a temporary access road prior to vertical construction or import of combustible materials to the project site. The specifications for temporary emergency access roads are as follows:

- Location: within 150 feet of all exterior walls of the first floor of all buildings constructed within the site; a turnaround is required on dead-end access roads in

excess of 150 feet in length;
- Minimum width: 20 feet;
- Maximum grade: 10%
- Horizontal geometry, minimum turn radius, inside tire: 29 feet, outside tire: 52 feet;
- Vehicular weight capacity: 80,000 lbs;
- Materials: angular inch river rock, crushed granite, or other aggregate with 1-1.5" nominal size;
- Temporary Street Signs: Shall be posted at each intersection at the time the roadways are passible.

More than one access road may be required when it is determined that a single road may be impaired by vehicle congestion, climatic conditions, or other factors that could limit access. Access to buildings for the purpose of fire department vehicle access shall be provided at all times during construction. Construction vehicles and materials shall not block access to buildings, hydrants, or fire appliances. Site development managers and/or building construction superintendents shall have the responsibility to monitor emergency service access conditions on a daily basis. When conditions are such that emergency service access is diminished in minimum required width, capability of carrying imposed loads and/or providing adequate traction, appropriate measures shall be taken to mitigate such conditions to once again provide adequate emergency service access.

SECTION 300
STREETS

301 General

302 Design
- **A. General**
- **B. Pavement & Right-of-Way Widths**
- **C. ~~Grades~~Geometric Standards**
- **D. ~~Radii of Curvature~~Intersection Sight Distance**
- **E. ~~Tangents~~Stopping Sight Distance**
- **~~F. Sight Triangle~~**
- **~~G~~F. Apex Peakway Development**
- **~~H~~G. Pavement Design**
- **~~I~~H. Curb, Sidewalk, Driveways**
- **~~J~~I. Entranceway Islands**
- **~~K~~J. Trench Drains**
- **~~L~~K. Alleys**

303 Construction Requirements
- **A. General**
- **B. Placement of Asphalt Pavements**
- **C. Curb and Sidewalk**
- **D. Utility Conduits**
- **E. Pavement Markings**

304 Inspection
- **A. Proof-Rolling**
- **B. Compaction Testing - Subgrade**
- **C. Base Course & Surface Course Inspection Requirements**
- **D. Curb and Sidewalk**

305 Certification

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301 General

Unless otherwise provided herein, all materials and street construction methods shall conform to the applicable requirements as outlined in the Standard Specifications for Roads & Structures, latest edition, as published by the NCDOT.

Whenever the following terms are used in said NCDOT specifications, the intended meaning of such terms shall be as follows:

"State" or "Commission" shall be replaced by "Town of Apex".

"Resident Engineer" shall be replaced by "ENGINEER".

"Sampling and testing by Commission" shall be replaced by the words "sampling and testing by the TOWN or its authorized testing agent".

"Inspection by Commission" shall be replaced by "Inspection by TOWN or its duly authorized representative".

302 Design

A. General

Street design shall conform to the standards set forth in A Policy on Geometric Design of Highways and Streets as published by AASHTO, the Unified Development Ordinance, Standard Specifications for Roads and Structures as published by the NCDOT, Roadway Design Manual as published by the NCDOT, or the Town Standard Specifications and Details, whichever, in the opinion of the ENGINEER, is applicable.

Design vehicles and minimum edge of pavement radii shall be based on street classification per the following table. Compound curves may be considered to accommodate turning movements.

Street Classification	Design Vehicle	Control Vehicle	Edge of Pavement Radius
4 & 6 Lane Thoroughfares	WB-40	WB-62	40 feet
2 & 3 Lane Thoroughfares	~~SU-30~~WB-40	WB-~~40~~50	40 feet
Major Collector	SU-30	WB-40	30 feet
Minor Collector	DL-23[3]	FIRE[4]	25 feet
Residential Street	DL-23[3]	FIRE[4]	25 feet
Alleys	P[7]	DL-23[3,7]	10 feet[7]

Notes:

1. Design Vehicle shall not encroach on adjacent lanes for turning movements.
2. Control Vehicle may encroach on adjacent lanes for turning movements.
3. DL-23: 22.6′ length Delivery Truck, 13′ wheelbase, 23′ inside turning radius, 29′ outside turning radius (refer to Urban Street Design Guide published by the National Association of City Transportation Officials).
4. Fire Truck: 21.25′ wheelbase, 33.33′ outside turning radius w/ 5.34′ overhang (Town of Apex).
5. All designated Truck Routes shall meet WB-50 design vehicle.

6. All designated Go Triangle Bus Routes shall meet BUS-40 control vehicle.
7. Alleys that serve solid waste collection and/or provide fire access must meet the same criteria as a Residential Street.
8. Where different street types intersect, the ENGINEER shall be allowed to use the lesser of the two radii.

All proposed roadways shall conform to the Apex Transportation Plan, and the Apex Peakway Development Policy.

B. Pavement & Right-of-Way Widths

Standard street widths are shown in the Standard Details. Actual street widths shall be in accordance with the Apex Transportation Plan or any interim plan effective at the time of plan submittal. Transitions and tapers between sections or at widenings shall be made in accordance with Section 302(A) of these Specifications. The ENGINEER may, at his discretion, require additional widening and related work as deemed necessary to provide for the safety and quality of roadway for the traveling public.

C. ~~Grades~~Geometric Standards

Unless necessitated by exceptional topography, street grades shall not be less than one half percent (0.5%).

The maximum grade allowed for a local street when approaching an intersection is five percent (5%) for the last 100 feet of pavement before the intersection.

The maximum grade allowed for a collector street or thoroughfare when approaching an intersection is two percent (2%) for the last 100 feet of pavement before the intersection. The beginning of the minimum grade allowed for a street approaching an intersection is measured at the curb-line extension of the intersecting street.

Street grades at pedestrian crossing locations shall meet the following criteria or the latest approved Federal Access Board standards whichever is more stringent.

1. 2% maximum cross slope for crossings located at approaches with a stop or yield condition; and
2. 5% maximum cross slope for crossings located at approaches without stop control.

~~Refer to the Street Geometric Standards Detail for maximum grades and vertical curve controls.~~The following table outlines geometric standards for roadway design. Sound engineering judgement should be exercised when using minimum or maximum design standards for roads. Alternate designs shall be in accordance with the current edition of A Policy on Geometric Design of Highways and Streets as published by AASHTO.

CLASSIFICATION	DESIGN SPEED	HORIZONTAL CURVE CONTROLS	MIN. TANGENT B/W	MAX. GRADE (%)	MIN. VERTICAL CURVE	VERTICAL CURVE CONTROLS

	(MPH)	MAX. SUPER ELEV. (%)	MIN. CL RADIUS (FT)	REVERSE CURVES (FT)		LENGTH (FT)	MIN. LENGTH CREST (FT)	MIN. LENGTH SAG (FT)
THOROUGHFARE	50	4	926	400	7	150	84A	96A
MAJOR COLLECTOR	35	4	371	200	9	100	29A	49A
MINOR COLLECTOR	30	NC	333	150	10	100	19A	37A
RESIDENTIAL STREET	25	NC	198	0	10	50	12A	26A
ALLEY	--	RC	50	0	10	50	12A	26A

A = ALGEBRAIC DIFFERENCE IN GRADES
NC / RC = NORMAL CROWN / REVERSE CROWN

~~**D. Radii of Curvature**~~

~~Where a street centerline deflection of more than 5 degrees occurs, a curve shall be introduced. Refer to the Street Geometric Standards Detail for horizontal curve controls.~~

~~At intersections, all streets and commercial driveways shall be rounded with radii not less than:~~

~~Street Classification~~	~~Edge of Pavement Radius~~
~~Thoroughfares~~	~~50 40 feet~~
~~Collectors~~	~~40 feet~~
~~Residential~~	~~30 feet~~

~~**E. Tangents**~~

~~A centerline tangent of not less than 100 feet shall be provided between reverse curves on all streets. Reverse curves on super-elevated streets shall have a sufficient centerline tangent to accommodate entry and exit run-out, but not less than 100 feet.~~

~~**F**~~**D. ~~Sight Triangle~~Intersection Sight Distance**

All stop-controlled intersections shall meet minimum AASHTO sight distance requirements. A 10-foot x 70-foot sight triangle easement shall be provided at all intersections except where the ENGINEER is provided a plan illustrating such easements are not required or can be reduced in size based on AASHTO minimum sight line projections in cases where the typical 10-foot x 70-foot sight triangle easement would otherwise create a conflict with proposed structures. ~~Sight triangle easements shall not be less than 10 feet by 70 feet.~~ The 10-foot dimension shall be the setback from the right-

of-way of the major street, and the 70-foot dimension shall be measured along the right-of-way of the major street. Sight triangle ~~distances~~ easements shall be increased if ~~appropriate for traffic conditions and speed limits~~ necessary to meet AASHTO minimum guidelines based on the projection of sight lines from the intersection. Sight triangle easements shall be shown on the final plat for the developed tract.

Plant materials ~~and subdivision signs~~ placed within the sight triangle shall be limited to a mature height of 30 inches. Signs or other structures shall not be allowed.

Intersection Sight Distance for Left Turn from Stop (Passenger Cars)

Design Speed (Major Road)	Posted Speed (Major Road)	2-lane Undivided		3-lane Undivided or 2-lane Divided w/ 12' median		4-lane Undivided		5-lane Undivided or 4 lane Divided w/ 12' median	
		Calculated	Design	Calculated	Design	Calculated	Design	Calculated	Design
25	20	275.6	280	294.0	300	312.4	315	330.8	335
30	25	330.8	335	352.8	355	374.9	375	396.9	400
35	30	385.9	390	411.6	415	437.3	440	463.1	465
40	35	441.0	445	470.4	475	499.8	500	529.2	530
45	40	496.1	500	529.2	530	562.3	565	595.4	600
50	45	551.3	555	588.0	590	624.8	625	661.5	665
55	50	606.4	610	646.8	650	687.2	690	727.7	730
60	55	661.5	665	705.6	710	749.7	750	793.8	795

Reference: Table derived from AASHTO Table 9.7 (Case B1) using the following parameters:
ISD = $1.47*V*t_g$ where:
ISD = Intersection sight distance (length of leg of sight triangle along major road)
V = design speed of major road (mph)
t_g = 7.5s time gap for 2-lane plus 0.5s for each additional lane

Method of measurement
1. Driver's eye height shall be a minimum of 3.5 feet above pavement.
2. Driver's eye shall be placed 15 feet from edge of pavement.
3. Object height (approaching vehicle) shall be 4.25 feet above center of traffic lane.

Minimum Intersection Sight Distance for Right Turn from Stop

Design Speed (Major Road)	Posted Speed (Major Road)	Calculated	Design
25	20	238.9	240
30	25	286.7	290
35	30	334.4	335
40	35	382.2	385
45	40	430.0	430
50	45	477.8	480
55	50	525.5	530
60	55	573.3	575

Reference: Table derived from AASHTO Table 9.9 (Case B2) using the following parameters:
ISD = $1.47*V*t_g$ where:
ISD = Intersection sight distance (length of leg of sight triangle along major road)
V = design speed of major road (mph)
t_g = 6.5s time gap for 2-lane plus 0.5s for each additional lane

Method of measurement
1. Driver's eye height shall be a minimum of 3.5 feet above pavement.
2. Driver's eye shall be placed 15 feet from edge of pavement.
3. Object height (approaching vehicle) shall be 4.25 feet above center of traffic lane.

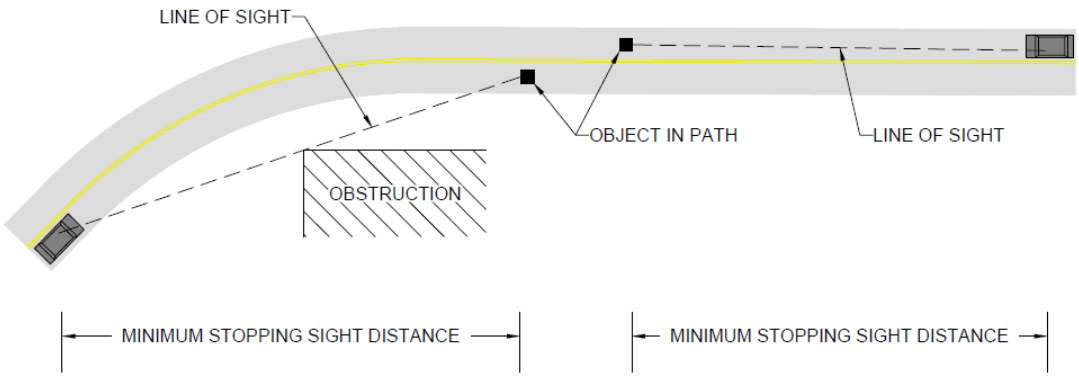
E. Stopping Sight Distance

Minimum Stopping Sight Distance (feet), Street Grade (%)							
Design Speed	Upgrades			Flat	Downgrades		
	9%	6%	3%	0%	-3%	-6%	-9%
60	495	515.0	540	570.0	600	640.0	690
55	435	450.0	470	495.0	520	555.0	595
50	375	390.0	405	425.0	450	475.0	510
45	320	335.0	345	360.0	380	400.0	430
40	270	280.0	290	305.0	315	335.0	355
35	225	230.0	240	250.0	260	275.0	290
30	180	185.0	200	200.0	205	215.0	230
25	140	145.0	150	155.0	160	165.0	175

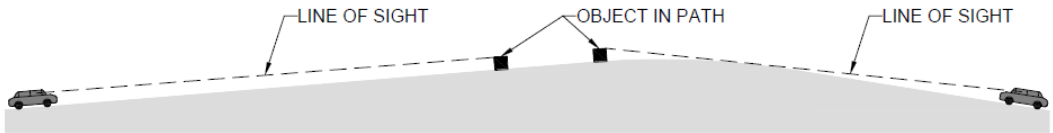
Reference: Table derived from AASHTO 2018 (Tables 3.1 and 3-2) and distances rounded to nearest 5 feet.

SOURCE: A Policy on Geometric Design of Highways and Streets American Association of State Highway and Transportation Officials

PLAN VIEW



PROFILE VIEW



NOTE:
1. DRIVER'S EYE HEIGHT SHALL BE 3.5 FEET ABOVE PAVEMENT.
2. OBJECT HEIGHT SHALL BE 0.5 FEET ABOVE CENTER OF TRAVEL LANE.

~~G~~F. Apex Peakway Development (Apex Peakway)

Refer to the *Planning Department* for the Apex Peakway Development Policy.

~~H~~G. Pavement Design

The pavement designs presented in the standard details shall be considered the minimum design requirements. The DEVELOPER shall furnish a pavement design report produced and certified by a professional engineer, using AASHTO methodology. The report shall be based on field and lab testing of in place subgrade materials by a qualified geotechnical firm and shall incorporate the following criteria: 20-year design life, 4% annual growth rate, and appropriate traffic projections. Soil sample locations shall be as directed by the INSPECTOR. If the design structural coefficient exceeds that of the standard, the design structure shall be used.

~~I~~H. Curb, Sidewalk, Driveways

Concrete for curb and gutter, driveways, or sidewalks shall be portland cement concrete having a 28-day strength of 3000 psi when tested in accordance with ASTM C39. Detailed specifications for concrete shall conform to the specifications contained in Section 200. Joint fillers shall be a non-extruding joint material conforming to ASTM D1751.

The minimum thickness of a sidewalk shall be 4 inches. Sidewalks shall have a uniform slope perpendicular to the curb of 1/4-inch per foot toward the roadway. Sidewalks shall be installed during roadway construction and/or widening.

Where a sidewalk intersects with a driveway access, the sidewalk section shall be 6-inches thick. All sidewalks and greenways shall meet the current Americans With Disabilities Act (ADA) requirements.

Sidewalks shall be constructed on the north or east side of the roadway, and at locations as indicated by the Unified Development Ordinance and these specifications.

Curb and gutter, where required, shall be standard 30-inch combination curb and gutter. Upon the approval of the Town, 30-inch valley curb and gutter may be permitted in townhome developments. Standard 18-inch median curb and gutter may be used on entrance islands and medians when deemed appropriate by the ENGINEER.

~~J~~I. Entranceway Islands

Islands shall be limited to such a size as to allow adequate turning room for larger vehicles. The minimum pavement width for both the entrance and exit lanes shall be 20 feet. Islands shall accommodate the turn radius of a WB-62 design vehicle, as outlined in A Policy on Geometric Design of Highways and Streets, AASHTO, current edition. The island shall not extend into the turnout of the intersection.

~~K~~J. Trench Drains

All entrances with irrigation systems shall require a trench drain directly behind the curb and gutter. The trench shall be a minimum of 12 inches wide and 18 inches deep. A 4-inch perforated pipe shall be laid at the bottom of the ditch in the center. The ditch shall then be backfilled with washed stone wrapped in the appropriate geotextile fabric. The perforated pipe shall drain to a catch basin.

~~L~~K. Alleys

All alleys shall either connect to the street right of way at each end or include a cul-de-sac.

303 Construction Requirements

A. General

All roadway subgrade, alley subgrade, storm sewer, and utility construction shall be inspected and approved by the TOWN prior to placement of base course materials.

All streets shall be cleared and graded for the full width of the right-of-way within 50 feet of any street intersection. Additional street clearing and grading shall be as follows:

Future Development - where planned roadways are to be built (i.e. the Peakway, roads in other phases, or roads by other developers), the rough grading shall be completed in areas where it shall impact homeowners or businesses in the phase currently under construction.

Major Streets & Thoroughfares - the full width of the right-of-way.

Collector Streets - the full width of the right-of-way.

Urban Street & Urban Cul-de-Sac - the full width of the right-of-way on the sidewalk side, and 8 feet back of curb on the “non-sidewalk” side.

B. Placement of Asphalt Pavements

Typical surface course shall have a total thickness of not less than as shown on the Standard Details, and shall be placed in 2 lifts.

Following initial lift, the CONTRACTOR shall provide temporary drains at catch basins to allow streets to drain and to eliminate ponding at the low points. Catch basin modifications shall be repaired at the time of final surface paving.

The second lift placement shall be delayed during the period of initial residential

construction activity and until such time as its placement is approved by the ENGINEER, subject to the following conditions:

> Placement of the second lift shall be no earlier than 12 months after placement of the first lift and only after 75 percent of the Certificates of Occupancy have been issued for the subdivision or phase of subdivision under construction.

Prior to placement of the final lift of pavement, the existing initial lift shall be thoroughly cleaned and all cracks, spalling, and other failure shall be repaired to the satisfaction of the ENGINEER. A tack coat shall be used on the road surface and the curb face. Furthermore, any cracked concrete that is around valve covers and manhole covers shall be replaced prior to paving.

Asphalt materials shall not be produced or placed under any of the following conditions:

- during rainy weather or whenever moisture on the surface to be paved would prevent proper bond;

- when the subgrade or base course is frozen or wet;

- when temperatures, measured in the shade away from artificial heat at the location of the paving operation, do not meet the following criteria;

Material Type	Minimum Air Temperature	Minimum Ground Temperature
Prime & Tack Coat	40° F	40° F
Asphalt Base Course	40° F	40° F
Asphalt Intermediate Course	40° F	40° F
Asphalt Surface Course	50° F	50° F

- between December 15 and March 16 for surface course material that is to be the final layer of pavement;

- when intermediate or base course will not be covered with surface course during the same calendar year or within 15 days of placement if the plant mix is placed in January or February; a sand seal is required when the intermediate or base is not covered as required.

C. Curb and Sidewalk

The subgrade shall be excavated to the required depth, and shaped to the proper cross-section. Where tree roots are encountered, they shall be removed to a depth of 1 foot for the full width of the excavation. The subgrade shall be stable and thoroughly compacted.

Forms shall be set and maintained true to the required lines, grades, and dimensions. Forms shall be constructed with material of such strength and with such rigidity to prevent any appreciable deflection between supports. Straight forms shall be within a tolerance of 1/2-inch in 10 feet from a true line horizontally or vertically. Forms shall be thoroughly cleaned of all dirt, mortar and foreign material before being used. All inside form surfaces shall be thoroughly coated with commercial quality form oil.

Contraction joints shall be cut to a depth equal to at least 1/3 of the total slab thickness. The contraction joint shall be no less than 1/8 inch in width. Contraction joints shall be spaced at 5-foot intervals for sidewalk and spaced at 10-foot intervals for curb and gutter, or 15-foot intervals when a machine is used. A 1/2-inch expansion joint filled with joint filler shall be placed between all rigid objects and placed no farther than 50 feet apart for sidewalks and curb and gutter, extending the full depth of the concrete with the top of the filler 1/4-inch below the finished surface. The surface of sidewalks shall be finished to grade and cross-section with a float, troweled smooth and finished with a broom. Refer to the Standard Detail.

D. Utility Conduits

Buried conduits for low voltage utility installations shall be installed in accordance with the Standard Detail. All residential and commercial driveways shall have at minimum one 3-inch diameter Schedule 40 PVC conduit installed across the entire width of the driveway, extending 1 foot beyond the edges of the driveway. Conduits shall be sealed at each end with an unglued PVC cap.

For all lots that require sidewalk along the road frontage, conduits shall be installed below the sidewalk in accordance with the Standard Detail. All sidewalks, along a lot frontage, shall have at minimum 2 individual 3-inch diameter Schedule 40 PVC conduits installed across the entire width of the sidewalk, extending 1 foot beyond the edges of the sidewalk. Sidewalk conduits shall be installed on both sides of the lot and at a location of approximately 1 foot inside of the lot's property line. Conduits shall be sealed at each end with an unglued PVC cap.

All conduits shall be marked with a 2-inch brass cap, cast into the concrete curb and/or the sidewalk to indicate the location of the buried conduit. Brass caps shall be stamped with the words "Utility Conduit Crossing" in ⅜-inch tall lettering. All caps shall be held true to final elevation, within the forms, prior to and during placement of concrete, by the use of a 12-inch long rebar stake. One cap shall be installed at each individual utility conduit installation.

E. Pavement Markings

All pavement markings shall be thermoplastic material meeting NCDOT specifications, unless otherwise directed by the Engineer.

304 Inspection

A. Proof-Rolling

Street embankments shall be graded and compacted as described in Section 200 of these Specifications. After all utilities and storm sewers have been installed, the subgrade shall be fine graded and restored to required grade, and then proof-rolled by using a fully loaded tandem dump truck or a fully loaded water truck. Should any "pumping" or displacement be observed during the proof-rolling, the defective area(s) shall be repaired by replacing defective material w/suitable material, alternative stabilization methods such as fabric, Geo-Grid, lime, etc., or any combination thereof to the satisfaction of the TOWN and thoroughly compacted. The proof rolling shall be repeated until there is no evidence of "pumping" or displacement.

Recommendations from outside sources such as soils engineers and technicians may be suggested. However, the TOWN shall have authority for approval of additional measures.

B. Compaction Testing - Subgrade

Upon completion of the proof rolling, the DEVELOPER/CONTRACTOR shall furnish to the ENGINEER a report from a certified soils testing laboratory. The report shall present the results of a Proctor analysis demonstrating that the subgrade compaction is acceptable in accordance with standard requirements of NCDOT in all of the significant fill areas. The subgrade shall then be inspected by the INSPECTOR, and upon its acceptance and approval, the stone base course may be placed. However, no stone base may be placed prior to backfilling behind the curb.

The cost of laboratory testing of subgrade compaction shall be borne by the DEVELOPER/ CONTRACTOR.

C. Base Course & Surface Course Inspection Requirements

The Town reserves the right to require that quarry tickets be presented to the INSPECTOR to enable a check for yield at the specified final thickness. The base material shall then be inspected by the INSPECTOR, and upon acceptance and approval, the surface course may be placed.

Surface course shall be placed and compacted in accordance with NCDOT requirements. Copies of delivery tickets shall be furnished to the INSPECTOR to enable a check for yield at the specified final thickness. Density testing shall be performed for each lift of asphalt and reports shall be furnished to the INSPECTOR.

Should there be a question as to the final thickness of aggregate base course or surface course, the INSPECTOR reserves the right to require the DEVELOPER/CONTRACTOR to provide random core samples by an independent testing laboratory to demonstrate actual thickness of base and surface courses. A certified testing laboratory shall take core

samples and the results shall be presented to the INSPECTOR. Should the cores reveal insufficient thickness, the CONTRACTOR shall provide additional surface course as may be required or shall furnish other remedial measures as may be acceptable to the INSPECTOR. The cost of compaction testing and coring work shall be borne by the DEVELOPER.

D. Curb and Sidewalk

No concrete shall be placed until the forms, necessary conduits, and subgrades have been inspected and approved by the INSPECTOR. Where stone is used underneath the driveway and/or over conduits, it shall be compacted ABC stone. Washed stone shall not be permitted.

Conduits shall be installed to the depths and locations indicated in the Standard Detail prior to inspection. Conduit trenches shall be left open until inspection. Trenches shall be backfilled with excavated material after inspection and prior to placing concrete. Brass location caps shall be in place prior to inspection.

NO EXCEPTION: For all lots that require sidewalk along the road frontage, sidewalk shall be formed and ready for inspection at the time of the driveway inspection. Sidewalk may be installed prior to, but under no circumstances later than the time of the driveway installation.

305 Certification

The Town of Apex shall require the following certification from an engineer registered in the state of North Carolina prior to final acceptance of any TOWN maintained streets:

I _____, PE hereby certify that the construction of *(Street Names)* in *(Phase #)* of *(Development Name)* is/are in accordance with the minimum pavement design standards and layout submitted and approved by the Town of Apex on *(Date of Approval)*.

_____
Name

S E A L

_____
Date

SECTION 500
STORM DRAINAGE

501 Design
- A. General
- B. Location
- C. Easements
- D. Depth of Cover

502 Materials – Storm Drainage Pipe
- A. General
- B. Reinforced Concrete Pipe (RCP)
- C. Corrugated Polypropylene Pipe (CPP)
- D. Corrugated Aluminized Steel Pipe - Type 2 (CSP)
- E. Corrugated Aluminum Pipe (CAP)

503 Materials - Storm Drainage Structures
- A. General
- B. Concrete Brick Masonry Units
- C. Precast Concrete Manholes
- D. Mortar
- E. Castings
- F. Portland Cement Concrete
- G. Reinforcing Steel
- H. Connections

504 Miscellaneous Materials
- A. Rip Rap

505 Inlets and Outlets
- A. Headwalls, Endwalls, and Flared End Sections
- B. Dissipaters and Scour Protection

506 Stormwater Control Measures (SCMs) within the Primary and Secondary Watershed Protection Overlay Districts

507 Construction Methods
- A. Trenching & Bedding for Storm Sewers
- B. Pipe Laying
- C. Backfilling
- D. Masonry Structures
- E. Concrete Construction
- F. Installation of Precast Concrete Structures

508 Inspection Prior to Acceptance

509 Maintenance of Municipal Separate Storm Sewer System (MS4)

501 Design

A. General

Storm drainage facilities shall be designed to dispose of stormwater generated upon or passing through the project location. The determination of the quantities of water which must be accommodated will be based upon peak flows from storms having the following return periods:

Drainage Structure	***Design Storm Event - Return Frequency***
Roadside Ditches	10-year storm
Curb Inlet	4 inches/hour
Storm Sewer Collector	10-year storm
Cross Street Storm Drainage	25-year storm
Greenways	25-year storm
Structures in Floodplain	100-year storm*

*Drainage structures in the floodplain should pass 100-year storm without over-topping the roadway -- or in the alternative, the structures may be designed to pass only the 25-year event, in which case, the downstream roadway embankment shall be fully protected from the residual flow which may overtop the roadway during a 100-year event.

1. Runoff rates shall be calculated by the Rational Method (for drainage areas less than 2 square miles), SCS Method (for drainage areas greater than 2 square miles) or other acceptable procedures. Runoff computations shall be based on rainfall data for the last 30 years published by the National Weather Service for this area.
2. Time of concentration (t_c) shall be determined using standard acceptable methods and the storm duration shall equal t_c.
3. Pipe shall be sized in accordance with the Manning Equation and applicable nomographs to carry the design flow and to provide a velocity of at least 2.5 feet per second during the 2-year storm event.
4. Culverts shall be sized in accordance with the Energy Equation and applicable nomographs to carry the design flow and to provide a velocity between 2-10 feet per second during the 2-year storm event.
5. Channels and ditches shall be designed to carry the design flow at nonerosive velocities. Calculations indicating design velocities shall be provided along with

typical channel cross-sections. The maximum allowable design velocity in grass channels is 4 feet per second.

6. A Hydraulic Grade Line (HGL) study shall be performed for all public storm drainage systems. Where the public storm drainage system conveys stormwater into a private SCM, the Q_{10} staging elevation shall be used as the starting point for the study. The study shall include profiles that show inverts, slopes, proposed finished grade and HGL. The HGL shall be required to stay within the pipe to ensure no surcharge on the system. ASTM Standard C443 (O Ring or Single Groove) water tight sealed pipe shall be used in cases where it is not practicable.
7. Stream crossings will necessitate a backwater study on the 100-year storm event. The localized 100-year flood elevation at each crossing is not allowed to stage onto an individual lot.
8. The minimum allowable slope is 0.50% or the slope which will produce a velocity of 2.5 fps when flowing full, whichever is greater for all proposed pipes and culverts.
9. The following criteria for headwater shall be used (based on the design storm):
    a. Minimum 12 inch freeboard for culverts up to 36”
    b. Minimum 18 inch freeboard for culverts greater than 36”
    c. Elevations established will delineate localized floodplain
    d. HW/D ≤ 1.2

Prediction of the peak flow rates shall be calculated using the procedure in the USDA Soil Conservation Service Method, the Rational Method, or other acceptable calculation procedures as determined by the TOWN. The size of stormwater conduits shall be determined by utilizing the standard energy equation for inlet control or outlet control and headwater nomographs as published by various federal agencies – US FHWA - H.E.C. #5, Soil Conservation Service, etc. The minimum pipe size to be used shall be 15-inch diameter.

Discharge from the stormwater drainage systems shall not be of such a velocity as to cause damage after leaving the pipe. Maximum allowable outlet velocity will be 2.5 feet per second (refer to “Code of Ordinances, Town of Apex, North Carolina”; Chapter 5, Article X, Sec. 5-149). Exiting velocities shall be in conformance with the sedimentation and erosion guidelines and outlet protection used whenever the velocity exceeds the allowable limit. Pipe outlets, flared end sections and head walls shall be provided, with rip-rap aprons designed to reduce velocity and dissipate energy so that downstream damage from erosion does not occur. Calculations shall be submitted with plan review.

B. Location

Manholes or structures shall be installed at each deflection of line or grade. Acute angle junctions (angles less than 90 degrees) between pipe runs should be avoided. No inaccessible junction boxes shall be permitted. The maximum distance between access openings shall not exceed 400 feet for pipes 30 inches and smaller. For pipes 36 inches

and larger, the maximum distance between access openings may be increased to 500 feet.

Stormwater shall not generally be allowed to flow across the roadway. Any deviation shall require pre-approval by the ENGINEER. Catch basins shall be provided to intercept the flow prior to the radius of an intersection, or the design of the roadway shall indicate a continuous grade around the radius to allow the flow to continue down the intersecting street. Inlet spacing shall be sufficient to limit spread to no more than half of a through lane during a 4-inch per hour rain storm. No catch basin shall be installed in the radius of a curve.

Stormwater that is piped or is conveyed as open channel flow and originates within or passes through the public street rights-of-way shall be conveyed through a contiguous public drainage easement. The public drainage easement must extend from the public street rights-of-way through points downstream, to the point of open discharge.

In natural drainage ways, a storm drain main shall be extended to the property lines to readily enable future connection to adjoining upstream property. Storm design shall account for future upstream development based on the current land use plan and shall include an evaluation of the existing downstream storm capacity.

Private storm drainage systems will be permitted, provided that: (1) such systems collect and discharge impounded stormwater wholly within the same lot; or (2) such systems collect water from one single lot and discharge into the public storm drainage system; or (3) such systems are properly engineered and approved on the signed set of construction drawings. Private storm drainage systems that connect to the public storm drainage system shall have the connecting leg of such a system, which crosses into the public street rights-of-way or easement, constructed in accordance with TOWN specifications, including but not limited to: the necessary easements, piping, inlets and junction boxes. Connection of plastic pipe to TOWN infrastructure is prohibited. Piped private storm drainage systems may not cross property lines, convey stormwater from one lot to another unless criterion #3 is met, or point discharge adjacent to curb. Where permitted by topography and site conditions, storm drainage systems that serve a single non-residential lot (i.e., parking lots, private streets, vehicular use areas), shall be privately maintained.

C. Easements

All storm sewers shall be installed in dedicated street rights-of-way or easements. Minimum width of permanent storm drainage easements for public storm drain pipe shall be 20 feet. Where storm drain pipes are installed at a depth in excess of 10 feet or for pipes greater than or equal to 36-inch diameter, the easement widths shall be increased in accordance with the following table:

Pipe Diameter (in)	*Pipe Depth (D, ft)*	*Easement Width (ft)*
36 -- 48	10 < D ≤ 15	30
54 -- 72	15 < D ≤ 20	40
> 72	> 20	To be determined by the TOWN

No structures or equipment such as buildings, fences, playsets, pools, HVAC units, etc. shall be placed within any public easement. The Town of Apex is not liable for any damage to personal property located on public easements that may occur resulting from enactment of official duties.

Where multiple pipes are installed, the edges of the easement shall be a minimum of 10 feet from the centerline of the outside pipe with 3 feet clearance between the exterior of the parallel storm sewer pipes. Pipes shall not outfall in the front yard of a lot, but should extend to the rear third of the lot or property line in residential subdivisions.

D. Depth of Cover

Cover heights shall be as follows:

- Reinforced Concrete Pipe (RCP)
- Corrugated Polypropylene Pipe (CPP)
- Corrugated Aluminized Steel Pipe - Type 2 (CSP)
- Corrugated Aluminum Pipe (CAP)

	RCP	
CLASS	*MIN (ft)*	*MAX (ft)*
III	2	20
IV	1	30

	CPP		*CSP*		*CAP*	
Pipe Diameter (in)	*MIN (in)*	*MAX (ft)*	*MIN (in)*	*MAX (ft)*	*MIN (in)*	*MAX (ft)*
15	12	28	12	158	12	98
18	12	28	12	131	12	81
21			12	113	12	69
24	12	26	12	98	12	60
30	12	26	12	79	12	57
36	12	20	12	65	12	47

42	12	20	12	55	12	40
48	12	20	12	48	12	35
54			12	56	15	31
60	24	20	12	50	15	28

502 Materials – Storm Drainage Pipe

A. General

All storm sewer pipes to be installed in projects within the jurisdictional limits of the TOWN shall conform to the specifications presented herein. In special cases where material other than those listed below is requested, the applicant's plan submittal must contain a formal request to use other material and complete background data to justify its use.

B. Reinforced Concrete Pipe (RCP)

RCP shall be as per ASTM C76 (or the latest revision), Class III or Class IV with a minimum 15-inch diameter. All joints shall include rubber gaskets conforming to ASTM C 1628. All RCP installed on thoroughfare routes shall be approved and stamped by the NCDOT Materials and Tests Unit at the manufacturer's facility prior to delivery.

Any of the following criteria will be grounds for rejection of RCP material:

1) Any fracture or crack that visibly passes through the wall of pipe;
2) Any fracture or crack that is 0.01 inch wide or greater at the surface and 12 inches or longer regardless of position in the wall of the pipe;
3) Offsets in form seam that would prevent adequate concrete cover over reinforcing steel;
4) Delamination in the body of the pipe when viewed from the ends;
5) Evidence of inadequate concrete cover for reinforcing steel;
6) Any severe surface condition that affects the majority of the pipe section surface and could reduce the durability and service life of the pipe;
7) Damaged or cracked ends where such damage would prevent making a satisfactory joint.

C. Corrugated Polypropylene Pipe (CPP)

The pipe and fittings shall be an annular corrugated wall and a smooth interior wall (double-wall) or pipe and fittings with an annular corrugated wall and a smooth interior and exterior wall (triple-wall), conforming to the requirements of ASTM F2764 and AASHTO Specifications M330 (latest edition) for Corrugated Polypropylene Pipe.

Bell and spigot joints are required on all pipes. Bells shall cover at least two full corrugations on each section of pipe. The spigot shall be double-gasketed. The bell and spigot joint shall have "O"-ring rubber gaskets meeting ASTM F477 with the gaskets

factory installed and placed on the spigot end of the pipe. Pipe joints shall meet all requirements of AASHTO M330. Transitions from CPP to RCP shall be made with the appropriate adapter. Refer to Section 505 A.

D. Corrugated Aluminized Steel Pipe - Type 2 (CSP)

Aluminized Steel Type 2 pipe shall be 14 gauge minimum for 15-inch and 18-inch diameters, 12 gauge for all other sizes. Coils shall conform to the applicable requirements of ASTM A929. CSP shall be manufactured in accordance with the applicable requirements of ASTM A760. All fabrication of the product shall occur within the United States. Coupling bands shall be made of the same base metal and coatings as the CSP to a minimum of 18 gauge.

E. Corrugated Aluminum Pipe (CAP)

Aluminum pipe shall be 14 gauge minimum. Coils shall conform to the applicable requirements of ASTM B744. CAP shall be manufactured in accordance with the applicable requirements of ASTM B745. All fabrication of the product shall occur within the United States. Coupling bands shall be made of the same base metal and coatings as the CAP to a minimum of 18 gauge.

503 Materials - Storm Drainage Structures

A. General

All structures (manholes, curb inlets, catch basins, junction boxes, etc.) shall be constructed of concrete brick masonry units, cast-in-place reinforced concrete, or pre-cast concrete. Structures shall be repaired and re-built with solid concrete brick and mortar. Materials such as broken concrete pipe, clay brick, and rock are prohibited. Structure walls shall be repaired to original manufacturer conditions. Waffle boxes are not permitted. All pre-cast boxes shall be solid boxes.

Curb inlets in streets with curb and gutter shall be NCDOT type standard frame, grate, and hood.

B. Concrete Brick Masonry Units

Concrete brick masonry units shall be solid units meeting the requirements of ASTM C55, Grade S-II. Clay brick shall not be permitted for any drainage structure.

C. Precast Concrete Manholes

Pre-cast concrete manholes shall meet the requirements of ASTM C478. Manholes shall

have joints sealed with a pre-formed rope-type gasket per ASTM C990. Manhole base diameters shall conform to the following for the various storm sewer pipe sizes:

Pipe Diameter (in)	*Manhole Base Diameter (ft)*
15 - 36	5
42 - 48	6
54	8

For pipes greater than 54 inches, manhole base sections shall be sized as required and shall be approved by the ENGINEER. All precast manholes installed on thoroughfare routes shall be approved and stamped by the NCDOT Materials and Tests Unit at the manufacturer's facility prior to delivery.

Transition reducing slabs may be used to enable the use of 4-feet diameter eccentric cones at the top. All pre-cast manholes for storm sewers in traffic areas shall be of the eccentric type for ease of access. Manholes in non-traffic areas shall be flat-top type.

D. Mortar

Mortar shall be proportioned as shown below for either Mix No. 1 or Mix No. 2. All proportions are by volume. Water shall be added only in the amount required to make a workable mixture.

MIX NO. 1	1 part Portland Cement 1/4 part Hydrated Lime 3 3/4 parts Mortar Sand (maximum)
MIX NO. 2	1 part Portland Cement 1 part Masonry Cement 6 parts Mortar Sand (maximum)

Portland cement shall be ASTM C-150, Type 1. Hydrated lime shall conform to ASTM C207, Type S. Masonry cement shall meet the requirements of ASTM C91. Mortar sand shall be standard size 4S, per requirements of the NCDOT.

E. Castings

1) General – All castings shall meet the requirements of ASTM A48, Grade 35B iron and shall be manufactured in the USA. Country of origin shall be embossed on each casting.

At a minimum, manufacturers shall submit the following to substantiate to the ENGINEER that castings meet the minimum criteria:

a. Bar tensile test reports from an independent testing laboratory. The results must confirm that the material meets ASTM A48 Class 35B.
b. Casting proof load test report on the subject casting. Proof load tests shall be conducted in accordance with AASHTO M306, Section 7.0. During proof load testing, castings shall maintain a 40,000 lb proof load for one minute without experiencing any cracking or detrimental deflection.
c. A written statement of certification by a qualified licensed engineer, employed by the producing foundry, that castings meet these specifications.

2) Curb Inlet - Grates, frames, and hoods shall be in accordance with NCDOT Standard 840.02 and 840.03. Curb inlet hoods shall be embossed with “Dump No Waste! Drains to Waterways”.

3) Grates & Frames - Cast iron grates and frames for yard inlets shall be of the size indicated on the approved plans. Grates and frames shall be in compliance with NCDOT Standards.

4) Manhole Rings & Cover - Cast iron manhole rings and covers shall be in compliance with the Standard Detail with the words “STORM SEWER” cast on the cover. Covers shall have two 1-inch holes. Manhole castings shall be machined to provide a continuous bearing around the full periphery of the frame.

F. Portland Cement Concrete

Portland cement concrete used for storm drainage structures, end walls, etc. shall conform to the technical requirements presented in Section 200 of these Specifications, and shall have a minimum compressive strength of 3,000 psi at 28 days. Primary structures, such as box culverts, may require concrete having a compressive strength greater than 3,000 psi, and may require the submission of mix designs and testing of the concrete by an independent laboratory. These special requirements may be imposed by the ENGINEER for all such structures where deemed necessary.

G. Reinforcing Steel

Reinforcing steel shall be new billet steel conforming to ASTM A615 for grade 60. Reinforcing steel shall be deformed per current ASTM standards.

H. Connections

All storm drain connections shall be made with non-shrink grout.

504 Miscellaneous Materials

A. Rip Rap

Riprap shall be large aggregate of the size and class shown on the approved drawings. Stormwater calculations shall be submitted with the construction plan review application.

505 Inlets and Outlets

A. Headwalls, Endwalls, and Flared End Sections

Headwalls, endwalls, and flared end sections shall be constructed of structural cast-in-place concrete or pre-cast concrete in accordance with NCDOT Roadway Standard Drawings and shall be installed at all discharge points and inlets where there is not a structure. Details and design of headwalls, endwalls, and flared end sections shall be in accordance with NCDOT requirements. Details shall be shown on all plan submissions.

Flared end sections shall be installed on single pipe culverts up to and including 36 inches in diameter, and on multiple pipe culverts less than 30 inches in diameter. Flared end sections shall also be installed at the outlet point of all storm drainage systems. Dissimilar pipe couplers shall be used to connect CPP, CSP, or CAP pipe to end sections.

Headwall and endwall shall be installed on single pipe culverts greater than 36 inches in diameter, and on multiple pipe culverts greater than and including 30 inches in diameter.

For non-jurisdictional channels, ~~The~~ the slope from ~~pipe invert to~~ top of berm shall not exceed 2:1 to the top of pipe (preferably flatter). For jurisdictional stream and/or riparian buffer crossings, the slope from top of berm shall not exceed 2:1 to the top of pipe or top of roof slab or box (not headwall). Any deviation from NCDOT standard drawings requires pre-approval of the Transportation & Infrastructure Development Director.

B. Dissipaters and Scour Protection

Energy dissipaters shall be installed at all discharge points and shall be properly sized to ensure that stormwater is released at a non-erosive velocity.

Scour protection shall be provided for all drainage ways where, in the opinion of the ENGINEER, erosive velocities or other factors require the use of protective measures. All protective measures shall be shown on all plan submissions.

Additional information on the impact of stormwater discharge onto adjacent properties may be required by the ENGINEER.

506 Stormwater Control Measures (SCMs) within the Primary and Secondary Watershed Protection Overlay Districts

Stormwater Control Measures (SCMs) shall be designed and constructed per the guidelines and minimum design criteria (MDC) presented in the State of North Carolina Department of Environmental Quality (NCDEQ) Stormwater Design Manual, latest revisions. These structures shall be designed to meet all stormwater requirements presented in Section 6.1 of the TOWN Unified Development Ordinance (UDO).

In addition to the guidelines and MDC presented in the NCDEQ Stormwater Design Manual, the following specifications shall be used for all SCMs:

- The invert elevation for the inlet to the SCM shall be set no lower than the normal/permanent pool elevation controlled by the water quality orifice(s). Refer to Section 501.B.6 of this document for inlet pipe network HGL requirements.
- The outlet structure shall be constructed of precast reinforced concrete and the outlet pipe shall be either reinforced concrete pipe (RCP) or corrugated polypropylene pipe (CPP).
- All vegetated side slopes and tops of dams shall be sodded with non-clumping turf grass.
- All SCM side slopes stabilized with vegetated cover shall be no steeper than 3:1 (horizontal to vertical).
- When the proposed impervious area is unknown for residential subdivision projects, a 70% impervious assumption per lot should be made when sizing proposed SCMs.

Prior to the approval of a final plat (with respect to a subdivision), issuance of a certificate of occupancy (with respect to a site plan), or commencement of a use for any development upon which an SCM is required, the applicant shall certify that the completed project is in accordance with the approved stormwater management plans and designs, and shall submit actual “as-built” plans and corresponding as-built supplements for all SCMs. See Section 106 of this document for additional “as-built” submittal requirements.

The “as-built” plans shall show the final design specifications for all SCMs and practices and the field location, size, elevations, and planted vegetation of all measures, controls, and devices, as installed. The designer of the SCMs shall certify, under seal, that the as-built SCMs, controls, and devices are in compliance with the approved plans and designs as required by the TOWN UDO.

A final inspection and approval by the TOWN Environmental Engineering Manager or his/her designee must occur before the release of any performance and/or maintenance

securities.

507 Construction Methods

A. Trenching & Bedding for Storm Sewers

The trench shall be constructed per the Standard Detail. Where the foundation is found to be of poor supporting value, the pipe foundation shall be conditioned by undercutting the unacceptable material to the required depth as directed by the INSPECTOR, and backfilling with stone or other approved material. Where necessary, surface water shall be temporarily diverted in order to maintain the pipe foundation in a dry condition. The flow of water from such temporary diversions shall be directed into suitable erosion control devices.

B. Pipe Laying

Concrete pipe culverts shall be laid carefully with bells or grooves upgrade and ends fully and closely jointed.

C. Backfilling

The trench shall be backfilled per the Standard Detail. The backfill materials shall be moistened when necessary in the opinion of the INSPECTOR to obtain maximum compaction. Water setting or puddling shall not be permitted.

All trash, forms, debris, etc., shall be cleared from the backfill material before backfilling. Backfilling around structures shall be done symmetrically and thoroughly compacted in 6-inch layers with mechanical tampers to the specified 95% density (Standard Proctor).

D. Masonry Structures

Excavations shall be made to the required depth, and the foundation, on which the brick masonry is to be laid, shall be approved by the TOWN. The brick shall be laid so that they will be thoroughly bonded into the mortar by means of the “shove-joint” method. Buttered or plastered joints will not be permitted. The headers and stretchers shall be so arranged as to thoroughly bond the mass. Brickwork shall be of alternate headers and stretchers with consecutive courses breaking joint. All mortar joints shall be at least 3/8 inches in thickness. The joints shall be completely filled with mortar. No spalls or bats shall be used except for shaping around irregular openings or when unavoidable to finish out a course. All details of construction shall be in accordance with approved practice and to the satisfaction of the ENGINEER.

Steps as shown on the plans shall be placed in all catch basins and inlets when they are greater than five feet in depth. The steps shall be set in the masonry as the work is built

up, thoroughly bonded, and accurately spaced and aligned.

Inverts in the structures shall be shaped to form a smooth and regular surface free from sharp or jagged edges. They shall be sloped adequately to prevent sedimentation. The castings shall be set in full mortar beds. All castings when set shall conform to the finish grade shown on the drawings. Any castings not conforming shall be adjusted to the correct grade.

Two (2) 2-inch diameter weep holes shall be installed above the upstream pipe invert in all storm drain structures. Protect weep holes with screen wire or fabric outside the structure to prevent clogging.

E. Concrete Construction

The forming, placing, finishing, and curing of Portland cement concrete shall be performed in strict accordance with all applicable requirements as contained in the Standard Specifications for Road & Structures latest edition, as published by the NCDOT and pertinent ACI (American Concrete Institute) codes and guidelines.

F. Installation of Precast Concrete Structures

Pre-cast concrete manholes, junction boxes, etc. shall be installed level and upon a firm, dry foundation, approved by the INSPECTOR. Structures shall be backfilled with suitable materials, symmetrically placed and thoroughly compacted so as to prevent displacement. Castings shall be set in full mortar beds to the required finished grade. Refer to the Standard Detail.

Two (2) 2-inch diameter weep holes shall be installed above the upstream pipe invert in all storm drain structures. Protect weep holes with screen wire or fabric outside the structure to prevent clogging.

508 Inspection Prior to Acceptance

Prior to acceptance of any development with public storm drainage infrastructure, the utility contractor shall arrange a camera inspection of all public storm drainage lines with a 3rd party camera service and then coordinate the results with the Infrastructure Inspector or Manager within the *Water Resources Department*. Any discrepancies found in violation of these Specifications shall be repaired to the satisfaction of the INSPECTOR prior to acceptance and prior to issuance of any Certificates of Occupancy. When inspection indicates possible excessive deflection in CPP, CSP, or CAP, the contractor shall complete a deflection test by mandrel using a rigid device approved by the INSPECTOR. The mandrel size shall be clearly labeled and shall be sized so as to provide a diameter of at least 95% of the inside pipe diameter. If deflection exceeds 5%, the pipe shall be evaluated to determine what corrective measures are required.

Video Assessment and Cleaning

a) As a final measure required for acceptance the Contractor shall clean and televise all newly installed public storm drain lines installed from the upstream to downstream manhole with no reverse setups or cutaways. Throughout shooting, the camera shall be panned and tilted for a complete view of the line, including panning at each joint. Lighting shall be adequate to view the entire storm drain line from beginning to end. The video inspection shall be submitted to the Town on a CD/DVD and formatted with software compatible and readable by the Town. The Town shall not be responsible for purchasing additional software necessary to view the CD/DVD.

b) The camera shall be advanced at a uniform rate not to exceed 20 feet per minute that allows a full and thorough inspection of the new storm drain line. The camera shall be a color, pan and tilt camera capable of producing a five hundred line resolution picture. Lighting for the camera shall be sufficient to yield a clear picture of the entire periphery of the pipe. The picture quality shall be acceptable and sufficient to allow a complete inspection with no lapses in coverage. The length of the storm drain line shall be measured and recorded on the video screen. The distance counter shall be calibrated before shooting the inspection video.

c) The Contractor shall clean the storm drain lines ahead of video inspection with a high-velocity water jet. The video inspection shall take place within 2-hours of cleaning operations as witnessed by the Town. All construction debris shall be collected in the downstream manhole and shall not be released into the storm drain system.

d) The TOWN shall be present throughout the cleaning and televising of the storm drain lines to verify that the video work complies with the Specifications. The camera operator shall stop, reverse, pan, and tilt the camera to view any area of interest during the inspection as directed from the Town.

e) It is recommended that site grading and all utilities be installed and complete prior to final inspection to ensure that damages to the storm drain lines do not occur. Damages found after final inspection would requiring re-inspection by the Town.

f) Prior to submitting the CD/DVD to the TOWN, the Contractor shall label the CD/DVD with the following information:

- Name of the Project/Development.
- Name and contact information of responsible party.
- Date of televising.
- Manhole identification as shown on the design plans.

509 Maintenance of Municipal Separate Storm Sewer System (MS4)

The TOWN shall maintain all piping and structures within TOWN identified easements. The easements must be labeled as the following: “Town of Apex Public Utility Easement” or “Town of Apex Drainage Easement”. Easements labeled as “Drainage Easement” or “Private” shall be maintained by the responsible party or property owner where such system is located.

TOWN maintenance will stop just beyond one half the distance of the total recorded easement width which is measured from the end of the pipe or the center of a flared end section. TOWN maintenance responsibilities are summarized in the following table.

Easement Width (ft)	***Maintenance Distance (ft)***
20	10
30	15
40	20

When an approved private drainage system is designed and installed onto private property and connects to the TOWN street rights-of-way, a TOWN approved stormwater structure will be required and placed no further than 10 feet from the recorded or proposed street rights-of-way. A TOWN approved easement will be placed around the stormwater structure that meets the current TOWN specifications. The TOWN shall stop all maintenance activities at this point. A private easement boundary shall be shown beyond this point and recorded to describe and allow ownership inspection and maintenance activities. The TOWN shall not be responsible for any infrastructure, grassed swales, or other stormwater conveyances located within private easements.

SECTION 700
WASTEWATER COLLECTION SYSTEMS

701 Gravity Sewers
- **A. Design**
- **B. Materials**
- **C. Sewer Main Installation**

702 Manholes
- **A. Design**
- **B. Materials**
- **C. Installation**

703 Service Connections
- **A. Design**
- **B. Materials**
- **C. Installation**

704 Testing and Inspections
- **A. General**
- **B. Sewer Main and Service Connection Testing**
- **C. Manhole Testing**

705 Aerial Crossings
- **A. Design**
- **B. Pipe Materials**
- **C. Installation**

706 Repairs, Modifications, and Abandonment
- **A. Sewer Main Repairs**
- **B. Installation**
- **C. Draining Sewer Mains**
- **D. Abandonment of Existing Sewer Mains**

701 Gravity Sewer

A. Design

1. Main Location

a) All public sanitary sewer mains shall be installed in dedicated street right of way or in dedicated utility easements. Mains within easements shall be centered within the easement. Mains located along NCDOT roads shall be placed outside of NCDOT right of way.

b) In preparing engineering design plans, all elevations shall be tied to NC grid system and the benchmark shall be described on the plans. A field survey of all waterways and waterbodies within project area must be performed, including but not limited to: creeks, streams, rivers, lakes, ponds, ditches, and culverts. Survey must include adequate points to accurately represent the cross section of the waterway/waterbody, i.e. top of bank, toe, centerline, etc.

c) Construction Drawings shall be prepared by or under the direct supervision of a professional engineer, licensed in North Carolina. Design shall conform to all standards and guidelines established by the Town and NCDEQ. Any design that does not meet minimum requirements set forth by NCDEQ and 15A NCAC 02T rules shall require a variance approval from NCDEQ. Plans shall indicate deflection angles at all manholes.

d) All private sewer collection mains inside the Town service area that will connect or are planning to discharge into the Apex sewer system shall comply with all Town of Apex design, siting and installation criteria outlined herein. The Owner of the private sewer collection system shall meet all State design requirements and obtain a State permit to operate the private system.

e) Gravity mains shall be installed in dedicated public right of way (not alleys or roundabouts) or in dedicated utility easements as follows:

Pipe Depth*	Permanent Easement Width	Town Road R/W
8-ft or less	20-ft	Allowed
8-ft – 15-ft	30ft	As Specified by the WR Department
15-ft – 20-ft	40-ft	Not Allowed
Deeper than 20 ft	As Specified by the WR Department	Not Allowed

*Depth of the sewer main shall be measured from the top of the pipe to the final grade or road subgrade at the deepest point between manholes.

Dedicated easements for sewer mains and appurtenances shall be recorded as “Town of Apex Public Sanitary Sewer Easement”. Town of Apex sewer easements shall contain only Town of Apex utilities unless otherwise approved by the site plan or an encroachment agreement. Sewer mains shall be centered in the easement. Easements shall be acquired by the Developer (unless utility is designed as part of a Capital Improvement Project) prior to construction approval.

Easements must be clearly labeled as “public” or “private”.

If the sewer main is located within the road right-of-way, a clear width equal to or greater than the easement width required must be available. If adequate width is not available within the right-of-way, additional easement outside of the right-of-way must be maintained. For example, if a sewer main normally requiring a 20 foot easement is installed 5 feet inside of the right-of-way, an additional 5 feet of easement must be obtained outside of the right-of-way to provide a clear total width of 10 feet on each side of the pipe.

f) The minimum width of a permanent easement that contains sanitary sewer and storm sewer shall be 30 feet. There must be a separation of 10 feet between the outside of each pipe and 10 feet from the centerline of the pipe to the easement line.

g) The minimum width of a permanent easement that contains sanitary sewer and greenway shall be 15 feet in addition to the width required in the table above. There must be a separation of 10 feet between the sewer main and the edge of pavement and at least 10 feet from the centerline of the pipe to the easement line.

h) No structures, equipment, retaining walls, embankments, impoundments, pavement, landscaping, fill, or other elements that would inhibit maintenance operations shall be constructed within a sewer main easement as outlined in Section 200. Fences may be allowed across easements provided that appropriate access gates or removable panels have been installed to allow utility maintenance. Fences shall not be installed parallel within utility easements. In all cases, Town of Apex Operations Staff shall have access to secured access gates. Fill or cut slopes are not allowed to extend into easements without full development plan approval or an approved encroachment agreement from the Town of Apex, see Section 200 for further information. All such pre-existing or planned conditions as noted herein that would impact operations and maintenance within the noted sewer main easement shall be noted and disclosed during the site plan approval process. Pre-existing conditions that are not disclosed during

the site plan review may nullify the approval and require relocating the sewer easement where there are no existing conflicts. If sewer main is located within road right-of-way or on Town owned property there shall be no permanent structures, equipment, retaining walls, embankments, impoundments, landscaping, or other elements that would inhibit maintenance operations unless approved by the Water Resources Director.

i) Where public sanitary sewer mains are installed within easements crossing private property, the Town's Water Resources Department shall have the right to enter upon the easement for purposes of inspecting, repairing, or replacing the sewer main and appurtenances. Where paved private streets, driveways, parking lots, etc. have been installed over public sewer mains, the Town of Apex shall not be responsible for the repair or replacement of pavement, curbing, landscaping, etc. which must be removed to facilitate repairs. The Water Resources Department shall excavate as necessary to make the repair, and shall backfill the disturbed area to approximately the original grade. Replacement of privately owned pavement, curbing, walkways, etc. shall be the responsibility of the property owner and/or Homeowner's Association.

j) Easements shall be accessible from public rights-of-ways. If easement is not accessible perpendicular from right-of-way due to steep slope, environmental feature, or other obstacle, additional easement may be necessary.

k) Sewer line easements shall be graded smooth, free from rocks, boulders, roots, stumps, and other debris, and seeded and mulched upon the completion of construction. Easements across sloped areas shall be graded uniformly across the slope to no steeper than a 4 to 1 ratio.

l) Mains paralleling a creek shall be of sufficient depth to allow lateral connections below the stream bed elevation. The top of the sewer main and laterals shall be at least three feet below the stream bed. Concrete encasement and ductile iron pipe shall be required when the cover between the top of the pipe and the stream bed is less than 3 feet.

m) Mains shall not be installed under any part of water impoundments or area to be impounded. Sewer mains shall not be installed through, above, or below any retained earth structure. Sewer main location and depth shall not be within the theoretical 1:1 slope of any impoundment dam or structure, or shall maintain a minimum of 10’ horizontal separation from the toe of slope, whichever is greater. The entire

easement shall be outside of the toe of slope, unless prior approval is obtained from the Water Resources Director.

n) Sewer profile shall follow natural topography and road grade. Sewer designed against natural grade or road grade shall only be allowed if approved by the Water Resources Director and no practical alternative is available.

o) The following minimum horizontal separations shall be maintained:

1. 100 feet from any private or public water supply source, including wells, WS-1 waters or Class I or Class II impounded reservoirs used as a source of drinking water (except as noted below)

2. 50 feet from wetlands and any waters (from normal high water) classified WS-II, WS-III, B, SA, ORW, HQW or SB (except as noted below)

3. 20 feet from any other stream, lake, or impoundment (except as noted below)

4. With approval directly from PERCS, the following separations may be acceptable when water main standards are implemented:

    a. All appurtenances shall be outside the 100 foot radius of wells.

    b. 50 feet from private wells (with no exceptions)

    c. 50 feet from public water wells (with no exceptions)

    d. Where the required minimum separations cannot be obtained, ductile iron pipe shall be used with joints equivalent to water main standards.

p) Sewer mains shall always be extended along any and all natural drainage courses/draws that are located within the property line boundaries of the proposed development. This sewer shall be extended to all adjacent upstream property lines.

    1) Sewer design shall account for future upstream development based on the current land use plan.

    2) Project shall include evaluation of existing downstream sewer capacity. <u>This evaluation shall address the capacity of all sewer collection and truck sewer systems that will be</u>

impacted downstream of the new development and/or redevelopment. If any downstream sewer segments exceed 50 percent full, but are less than 65% full, the Town will evaluate and determine if upsizing is required. If any downstream sewer segments exceed 65 percent full, the sewer main must be upsized or re-installed at a greater slope to allow for greater flow through the pipe. All improvements must be made the full length, from manhole to manhole.

3) The most upstream manhole shall be designed and located so that all upstream properties will have access to connect with future sewer mains. Depths shall be evaluated so that streams, roads, culverts, and any other features that must be crossed by future upstream sewer mains can do so and still achieve the required minimum cover on top of the sewer main.

q) Gravity sewer mains shall be deep enough to serve the adjoining properties and allow for sufficient slope in lateral lines. Gravity sewer pipe shall have the following minimum covers:

1) 3 feet from the top of pipe to finished subgrade in roadways.

2) 3 feet from the top of pipe to finished grade outside roadways.

r) Sewer mains that do not meet minimum cover stated above or the table in section A.1.e) are required to be ductile iron for the entire run between manholes. Steel casing and/or concrete may also be required for protection, at the direction of the Water Resources Director.

s) In all cases where fill material is added above existing sewer mains, the Engineer of Record shall prepare a structural analysis of the existing pipeline and determine if it is capable of supporting additional loading. If the additional fill material exceeds AWWA, DIPRA, UNIBELL and/or manufacturer standards for loading, the pipeline shall either be reinforced to adequately support the additional loading or replaced with a ductile iron pipe rated to support the added loading.

t) Separation Between Sanitary Sewer and Storm Water Pipes:
Sewer mains shall have a minimum vertical separation of 24 inches between storm pipes when the horizontal separation is 3 feet or less. Where sanitary and storm sewers cross with a vertical separation of less than 24 inches, the entire leg of sanitary sewer shall be made of standard ductile iron pipe with joints rated for water main service and the void space between the pipe crossing shall be backfilled with 3000-psi concrete or quick setting, minimum 500-psi, non-

excavatable flowable fill that meets or exceeds NCDOT Specifications.

u) Separation Between Sanitary Sewer and Sewer Force Main:
There shall be a minimum 7 foot horizontal separation between parallel gravity and force mains when the depth of installation is 8-ft or less. Otherwise, the minimum horizontal separation between pipelines shall be 10-ft up to 10-ft depth of installation.

v) Separation Between Sanitary Sewer and Water Main

1) Parallel Installations: 10-ft lateral separation (pipe edge to pipe edge) or minimum 5-ft lateral separation, and water line at least 18-inches above sanitary sewer line measured vertically from top of sewer pipeline to bottom edge of water main.

Crossings (Water Main Over Sewer): All water main crossings of sewer lines shall be constructed over the sewer line in conformance with Town of Apex Specifications. At a minimum, 18-inches of clearance shall be maintained between the bottom edge of the water main and the top edge of the sewer main. If 18-inches of clearance is not maintained, the water main and sanitary sewer main shall:

a. Both lines shall be constructed of ductile iron pipe with joints in conformance with water main construction standards.
b. The sanitary sewer pipe shall be ductile iron the entire run from manhole to manhole.
c. The void space between the pipes shall be filled with minimum 500-psi, quick setting non-excavatable flowable fill extending 3-ft on both sides of the crossing. Regardless of pipe material, at least 12-inches of vertical separation is required for sanitary sewer crossings of potable water mains.

2) Crossings (Water Main Under Sewer Line): Allowed only as approved by Town of Apex, when it is not possible to cross the water main above the sewer line. At a minimum, 18-inches of separation shall be maintained, (measured from pipe edge to pipe edge) and the sanitary sewer shall be constructed of ductile iron in conformance with water main construction standards the entire run from manhole to manhole. If local conditions prevent providing 18-inches of clearance, then at least 12-inches of clearance shall be provided and the void space between the pipes shall be filled with minimum 500-psi, quick setting, non-excavatable flowable fill extending at least 3-ft on both sides of the crossing.

w) Where concentrated sources of runoff (e.g., SCM discharge, FES discharge outlets, natural drainage ways, etc.) convey across existing or proposed Town of Apex Sanitary Sewer Easements, the applicant must design a rip rap lined channel across the full width of the easement.

x) All retaining walls shall have a separation from the easement boundary of at least 1:1, vertical to horizontal. For example, if the retaining wall is 10 feet tall, it shall be placed no closer than 10 feet from the adjacent easement boundary.

2. Main Size, Slope and Design Criteria

a) Public gravity mains shall be a minimum of 8 inches in diameter.

b) Major interceptors shall be sized in accordance with the "Town of Apex Sewer Master Plan". In areas not included in the master plan, interceptors shall be designed based on the proposed land use (according to the Town's Comprehensive Growth Plan), using the following flow factors. At a minimum, all gravity sewer mains shall be designed and sized to serve the ultimate tributary buildout of the drainage basin.

Residential flow rates:

Land Use	**Flow Factor**
Single Family Residential	300 gpd per dwelling unit
Multi-Family Residential	250 gpd per dwelling unit

Non-residential flow rates:

Use flow factors as required by the North Carolina Department of Environmental Quality (at the time of this Specification revision, these flow rates are contained in 15A NCAC 02T .0114).

For all other flow rates not listed in Section ii above, use:

Land Use	**Flow Factor**
Office and Institutional	0.09 gpd/sq.ft bldg. space
Commercial	0.12 gpd/sq.ft bldg. space
Industrial	0.20 gpd/sq.ft bldg. space

c) The ratio of peak to average daily flow shall be 2.5.

d) Sanitary sewers shall be designed to carry the projected average daily flow at no more than 1/2 full. The minimum velocity for sanitary sewer lines shall be 2.5-fps.

e) Sanitary sewers shall be sized based on the Manning's Equation with Manning's roughness coefficient "n" = 0.013 or greater. Pipe diameter sizes used in the calculation of Manning's Equation shall be nominal pipe sizes.

f) The minimum grades for public sanitary sewers shall be as follows:

Minimum Slopes for Gravity Sewer Mains

Main Size *(diameter in inches)*	Minimum Slope V=2.5ft/s, depth 1/2 full *(feet per 100 feet)* *{standard required velocity}*
8	0.52
10	0.39
12	0.30
14	0.25
15	0.23
16	0.21
18	0.18
21	0.15
24	0.12
27	0.11
30	0.09
36	0.07
42	0.06
48	0.05

Note1: All minimum slopes based on Manning's Equation
Note2: Manning's coefficient n = 0.013 used for all computations

g) The minimum grade for the uppermost reach of a sanitary sewer line shall be 1% regardless of sewer line size.

h) The maximum grade for sanitary sewers is 10%. The maximum velocity in sanitary sewers is 15 ft/sec. These limits may only be exceeded with the approval of the Director of Water Resources and the incorporation of the following provisions, which apply to all sewers either designed or installed at grades equal to or exceeding 10%:

1) All sewers with a grade of 10% or higher must have the downstream run of pipe installed with ductile iron pipe.

2) High velocity manholes shall be used on all sewers with a grade of 10% or higher. High velocity lines cannot tie directly to an existing

line and must proceed 180º through the invert into the downstream line.

3) Concrete thrust collars shall be installed on all sewers designed at grades of 10% or higher. The anchors shall be installed at the following spacing:

    a. Not over 36' center to center on grades from 10% to 25%
    b. Not over 24' center to center on grades from 25% to 40%
    c. Not over 16' center to center on grades exceeding 40%

4) The Town reserves the right to require all high velocity requirements outlined herein for sewer lines either designed or installed at grades of 10% or greater, regardless of the flow velocity. In cases where the design grade established on the sewer design plan is exceeded during construction and the 10% threshold is exceeded, all high velocity requirements shall apply without waiver.

i) 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.

j) All pipe diameter changes shall occur only in manholes, with the invert of the larger pipe lowered sufficiently to maintain the same energy gradient. An approximate method of obtaining this result is to place the crown of the incoming pipes may be designed for an elevation at or above the crown of the outgoing pipe.

k) All transitions of pipe material, pipe separations, grade changes, pipe thicknesses and all angular deflection changes shall occur only at manholes.

l) Pipe trench excavation and backfilling shall be performed in accordance with Section 0450 of these Specifications.

m) Gravity sewer downstream from a connection point with a force main shall be lined with 401-type ceramic epoxy for a minimum of 1,200 linear feet.

n) The minimum angle between inlet and outlet pipes in a manhole shall be 90 degrees.

B. Materials

Materials specified herein are acceptable for sewer service as described. Sanitary sewer mains shall conform to the following criteria:

Diameter (in)	Depth (ft)*	Material
Any	≤ 4	DIP
8 – 15	4 ≤ 13	PVC SDR 35 or C900 DR 18
8 – 20	4 < D ≤ 20	PVC C900 DR 18 or DIP
> 20	Any	DIP
Any	> 20	DIP

*Depth of the sewer main shall be measured from the top of the pipe to the final grade or road subgrade at the deepest point between manholes.

1. Ductile Iron Pipe

Material Specifications

Ductile Iron Pipe shall be designed and manufactured in accordance with AWWA C150 and C151 and provided in nominal 20-ft lengths. The minimum requirements for ductile iron pipe and required laying conditions are tabulated below. For all other installations other than specified, the laying condition, bedding requirements or the minimum pressure class rating and/or thickness class shall be increased in accordance with AWWA C151. A pipe thickness design shall be submitted for external loading in all cases where the pipe depth exceeds the specified range of depths outlined in the following table.

Pressure Class, Max. Depth and Laying Condition for DIP Sewer Mains

Pipe Diameter	AWWA C-150, Laying Condition	Pressure Class	Maximum Depth of Cover
8 -inch	type 1	350 psi	3-16 feet
8 -inch	type 4	350 psi	> 16 feet
10-12 -inch	type 1	350 psi	3-16 feet
10-12 -inch	type 4	350 psi	16-20 feet
10-12 -inch	type 5	350 psi	> 20 feet
14-20 -inch	type 4	250 psi	3-20 feet
14-20 -inch	type 5	250 psi	> 20 feet
14-20 -inch	type 5	350 psi	As Directed
24-30 -inch	type 4	250 psi	3-20 feet
24-30 -inch	type 5	300 psi	> 20 feet
24-30 -inch	type 5	350 psi	As Directed
36-42 -inch	type 4	300 psi	3-20 feet
36-42 -inch	type 5	350 psi	> 20 feet

Note: For cases not specified, a ductile iron pipe and bedding design certified by a Professional Engineer licensed in the State of North Carolina shall be required in compliance with AWWA C150 and the Ductile Iron Pipe Research Association.

In cases where thickness class designation of ductile iron pipe is specified, the corresponding thickness class designations are as outlined in the following table.

The following table lists approved manufacturers of DIP and DIP fittings that are allowable for installation within the Town's system.

Product Category	Approved Manufacturer	Model/Series	Pressure/Load Rating	Reference Standard	Requirements
Ductile Iron Pipe 8-inch & 10-inch Diameter (and 4-inch and 6-inch services) Cement Mortar Lined	US Pipe	Tyton Joint	350 psi	AWWA C150 and C151	Cement mortar lined with exterior bituminous coating. McWane pipe stamped "McWane by Atlantic States or Clow" only
	American (ACIPCO)	Fastite Joint			
	McWane	Tyton Joint			
Ductile Iron Pipe 12-inch and Larger Diameter Protecto 401 Lined	US Pipe	Tyton Joint	250-350 psi	AWWA and DIPRA Standards	40-mils of Protecto 401 Lining (lining must be less than 1 year old); McWane pipe stamped "McWane by Atlantic States or Clow" only
	American (ACIPCO)	Fastite Joint			
	McWane	Tyton Joint			
Ductile Iron Fittings 8-inch & 10-inch Diameter (and 4-inch and 6-inch services) Cement Mortar Lined	Sigma	Mech. Joint	350 psi	AWWA C110/C111 and AWWA C153	Shall always meet or exceed pipe pressure rating
	Tyler Union	Mech. Joint			
	SIP Industries	Mech. Joint			
	Star	Mech. Joint			
	American	Mech. Joint			
Ductile Iron Fittings 12-inch and Larger Diameter Protecto 401 Lined	Sigma	Mech. Joint	250-350 psi	AWWA and DIPRA Standards	Shall always receive interior Protecto 401 Lining to meet or exceed main line pipe standards. (401 lining must be < 1yr old)
	Tyler Union	Mech. Joint			
	SIP Industries	Mech. Joint			
	Star	Mech. Joint			
	American	Mech. Joint			

Ductile Iron Pipe Thickness Class

Pipe Diameter	Pressure Class	Nominal Thickness (inches)	Minimum Corresponding Thickness Class
8	350	0.25	50
10	350	0.26	50
12	350	0.28	50
14	250	0.28	50
16	250	0.30	50
18	250	0.31	50
20	250	0.33	50
24	250	0.37	50
24	300	0.40	51
30	250	0.42	51
30	300	0.45	52
36	300	0.51	52
36	350	0.56	53
42	300	0.57	52
42	350	0.63	53

Pipe joints shall be of the push-on type as per AWWA C111.

For 10-inch diameter and smaller gravity sewer mains, pipe lining shall be cement mortar with a seal coat of bituminous material, all in accordance with AWWA C104.

For 12-inch diameter and larger gravity sewer mains, all ductile iron pipe and fittings for sewer construction shall receive an interior ceramic epoxy coating, consisting of an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment, as manufactured by Protecto 401. The interior coating shall be applied at a nominal dry film interior thickness of 40-mils. All DIP bells and spigots shall be lined with 8-mils of joint compound by Protecto 401 or approved equal applied by brush to ensure full coverage. All pipe supplied with Protecto 401 interior lining shall be provided free of holidays. Pipe installed with defects in the lining will be rejected and required to be replaced. Patching of Protecto 401 coating defects after installation shall not be approved. Protecto 401 lined pipe must be installed within one year of the application date on the pipe.

All buried DIP and fittings shall have bituminous coating on the exterior surface in accordance with AWWA C151/ANSI A21.51. The seal coat

shall be a coal tar epoxy lining and shall be Indurall Coating, Inc. “Ruff-Stuff”, Kopper’s Company, Inc. “Bitumastic No. 300-M” or approved equal. Pipe shall be supplied in minimum 20-ft lengths.

All ductile iron pipes shall be marked in conformance with ASTM A-746.

Pipe material and manufacturer must have a supplier within 200 miles of the Town of Apex.

2. Solid Wall PVC Pipe

Material Specifications

PVC Pipe shall be solid wall and made of PVC plastic having a cell classification of 12454 or 12364 (with minimum tensile modulus of 400,000 psi) as defined in Specification D1784. PVC pipe shall have integral wall bell and spigot joints for the conveyance of domestic sewage and shall be supplied in 20 ft lengths. Fittings shall be made of PVC plastic having a cell classification of 12454-B, as defined in ASTM D1784.

All PVC gravity sewer pipe and PVC fittings up to 15-inches in diameter shall be manufactured in accordance with the latest version of ASTM D3034. All solid wall PVC pipe installed at diameters from 18-inches to 27-inches in diameter shall be manufactured in conformance with ASTM F679 and provided at minimum pipe stiffness of 115-psi. Fittings must be manufactured by pipe supplier or approved equal, and have bell and/or spigot configurations compatible with that of the pipe. PVC pipe shall be installed in accordance with the requirements of this Specifications manual and ASTM D2321.

All PVC pipe up to and including 15 inches in diameter shall have a maximum Standard Dimension Ratio (SDR) of 35 for depth of installation no shallower than 4-ft of cover from the pipe crown and no deeper than 13-ft measured from the bottom of the pipe. All solid wall PVC pipe for depth of installation greater than 13-ft shallbe C900 DR18. Solid wall PVC pipe shall not be approved for depths of installation greater than 20-ft. All solid wall PVC pipe shall be marked and certified in conformance with ASTM D3034 or ASTM F679 and all AWWA standards.

C. Sewer Main Installation

1. General Requirements

a) Pipe trench excavation and backfilling shall be performed in accordance with Section 0450 of these Specifications.

b) Transitions of pipe material, pipe separations, grade changes and all angular deflection changes shall occur only at manholes. Pipe crowns shall be matched for changes in pipe sizes.

c) All sewer mains installed with less than 4 ft of cover or deeper than 20-ft shall be ductile iron pipe.

d) Pipe and fitting interiors shall be protected from foreign matter and shall be inspected for damage and defects prior to installation. In the event foreign matter is present in pipe and fittings, it shall be removed before installation. Open ends of pipe shall be covered and protected when pipe laying is not in progress to prevent debris from entering the pipe.

e) Pipe shall be laid on true lines as directed by the Engineer. Trenches shall be sufficiently wide to adjust the alignment. Bell holes shall be dug at each joint to permit proper joint assembly. The pipe shall be laid and adjusted so that the alignment with the next succeeding joint will be centered in the joint and the entire pipeline will be in continuous alignment both horizontally and vertically. Pipe joints shall be fitted so that a thoroughly watertight joint will result. All joints will be made in conformance with the manufacturer's recommendations for the type of joint selected.

f) Prior to beginning construction, the Contractor shall contact local utility companies and verify the location of existing utilities. The Contractor shall be completely and solely responsible for locating all existing buried utilities inside the construction zone before beginning excavation. The Contractor shall be solely responsible for scheduling and coordinating the utility location work. When an existing utility is in conflict with construction, it shall be exposed prior to beginning construction to prevent damage to the existing utility.

g) No bells or connections shall be within any waterway crossing area.

h) Sewer mains shall not be installed within roundabouts.

702 Manholes

A. Design

1. Manhole Location, Siting and Design

a) Manholes shall be spaced at a maximum distance of 400 feet.

b) Manholes shall be installed at each deflection of line and/or grade. The flow channel through manholes shall have a uniform and smooth finish free of irregularities or obstructions. The invert channel shall conform to the shape and slope of the entering/exiting sewer line. Either pre-cast or brick and mortar inverts may be used. Mortar shall be mixed in a clean, tight mortar box, or in an approved mechanical mixer and used within 45 minutes of mixing.

c) A minimum drop of 0.2 feet must be maintained between the invert into and out of the manhole. The benches shall be sloped so as to prevent sedimentation. The inverts from intercepted cross lines shall be tied into the main flow line wherever possible, so as to provide a smooth transition. Wherever such cross lines tie-in at a substantially higher elevation than that of the downstream invert, the connecting line shall extend into the manhole a sufficient distance to enable the flow to spill into the flow line rather than onto the invert bench.

d) On dead-end manholes receiving service connections, the invert must be constructed and the invert flow line shall extend through the manhole so that all flow entering the manhole shall be readily conveyed downstream.

e) Free falls of wastewater flow into the manhole invert from incoming sewer mains shall not be allowed, except under limited circumstances.

f) In certain isolated circumstances standard free drops may be allowed, not exceeding 24-inches.. If different size pipes, the smaller diameter pipe crown shall be positioned no higher than the larger diameter pipe crown to limit the drop. When free drops are necessary due to pipe size changes, the Contractor shall take preventive measures to prevent free drops into the manhole invert, such as building a flume or trough up to the incoming invert, or piping the flow to the primary invert flow channel.

g) Drop manholes are not allowed without the written approval of the Water Resources Department. While certain physical constraints may dictate the need for drop manholes, they may not be used merely to decrease trenching depth. Upstream slope changes shall be used to avoid the need for drop manholes.

h) Manholes shall not be obstructed from view or access. It is illegal to bury or obstruct access to manholes. Manholes shall not be installed within roundabouts.

i) Manhole covers shall be elevated as follows:

1) Roadways: Manholes installed in roadways and road shoulders shall be installed with the cover flush with the top of pavement.

2) Outside of Roadways: Manholes installed outside of roadways shall be elevated at least 12 inches above the surface grade and/or at the same elevation of the road travel lane unless otherwise approved by the Water Resources Director.

3) Wooded Outfalls: All manholes installed in wooded, forested or brushy areas shall be elevated at least 24 inches above the surface elevation.

4) 100-Year Flood Zone: All manholes located within the 100-year flood elevation shall be elevated at least 24 inches above the 100-year flood elevation or specify watertight covers and vents that extend at least 24 inches above the 100-year flood elevation.

5) 100-Year Culvert Headwater Depth: All manholes located within a 100-year culvert headwater staging area shall be elevated at least 24 inches above the 100-year flood elevation or specify watertight covers and vents that extend at least 24 inches above the 100-year flood elevation.

6) Well Maintained Areas: All manholes installed in well maintained areas, such as yards, sidewalks or otherwise inside an improved right-of-way shall be installed flush with the finished surface.

j) Manholes used in outfalls and other non-traffic bearing areas shall be constructed with a flat top and outside steps.

k) Manholes shall be provided without interior steps.

l) When connecting a new sewer main to an existing main, the connection shall be established with a “Doghouse” type of manhole inserted over the existing main. Doghouse manholes shall only be installed on existing DIP or PVC mains.

m) Grade rings shall not exceed 6 inches.

2. Manhole Sizing

Manholes shall be sized as shown in the following table. The next larger size shall be required if the pipe size, depth, or number of main line connections warrants a larger size. In consideration of main line connections, all will be considered regardless of type, whether inside drop, outside drop, force main or standard connection.

Manhole Sizing Guide

Manhole Size	**Maximum Allowable Pipe Size, Single In**	**Maximum Allowable Pipe Size, Multiple In**	**Maximum Depth**
(diameter)	*(diameter)*	*(diameter)*	*(invert to rim)*
4-ft	8-12 inches		12-ft[1]
5-ft[4]	14-24 inches	8-12 inches	12-ft to 18-ft
6-ft[4]	30-36 inches	14-24 inches	18-ft to 24-ft
8-ft[4]	≥42 inches	30-36 inches	24-ft to 30-ft
10-ft[4]		≥42 inches	>30-ft

[1]Depths beyond 14-ft in roadways shall require a 5-ft diameter manhole with extended base.
[4]Due to the limited manhole wall area that could exist between the invert in and out, some manholes may require upsizing as directed by the Water Resources Department.

All manholes 5-ft in diameter shall be extended to surface elevation with no further reduction in diameter until the eccentric cone section.

Manhole transitions for 6-ft and larger diameter manholes are only allowed in the top 5-ft of the manhole. In no case shall the smallest barrel size be less than 5-ft diameter. At least 5-ft of vertical clearance shall be maintained above the pipe crown before transitioning to a smaller diameter riser, or transition shall not be utilized. An eccentric flat slab reducer from 6-ft diameter or larger manhole base sections to 5-ft diameter risers (non-paved areas) or eccentric cones (paved areas) shall be used to make any transition.

Manholes outside of paved areas that are 6-ft in diameter and greater and are too shallow to maintain 5-ft of vertical clearance above the crown of the pipe shall maintain the full manhole diameter up to the design surface elevation and be provided with a flat top slab cover with eccentric hole.

Manholes inside of paved areas that are 6-ft in diameter and greater shall be constructed with an eccentric, flat top reducer to 5-ft diameter and provided with a 5-ft diameter eccentric, tapered cone at the finished grade. When the depth of the manhole is too shallow to maintain 5-ft of vertical

clearance above the crown of the pipe a 3-ft tall eccentric, tapered cone shall be used without any additional 5-ft diameter risers.

B. Materials

1. Concrete Manholes

a) Manholes shall be precast concrete with a minimum compressive strength of 4000-psi and utilize minimum grade 60 rebar in compliance with ASTM C478. All 4-ft and 5-ft diameter manholes and all 6-ft diameter manholes in paved areas shall be provided with eccentric cone sections. Flat top manholes are required in outfall areas and for 6-ft and larger diameter manholes.

b) Precast concrete manholes shall meet all design and manufacturing requirements of ASTM C478 and all H-20 loading requirements. Minimum wall thickness shall be 5-inches and shall increase with depth and diameter in accordance with ASTM standards. The standard joint shall be sealed with a plastic cement putty meeting Federal Specification SS-S-00210, such as Ram-Nek or a butyl rubber sealant. All lift holes must be plugged with non-shrinking grout after installation.

c) All manholes greater than 5-ft diameter shall have minimum 8-inch (6-inch for 4-ft diameter manholes), 4,000-psi concrete bottoms resting on a minimum of 12 inches of #57 stone. Sewer mains shall enter and exit radially through the manhole. Inverts shall be constructed with a width equal to the effluent pipe and a height equal to 1/2 that of the effluent pipe. Inverts shall be so finished with sufficient drop across the manhole to compensate for all resulting energy loss across the invert. Flat invert channels shall not be allowed. At each inlet and outlet of 8 inches or greater, resilient connectors or manhole boots shall be provided in conformance with ASTM C923. Rings and clamps are to meet standards of ASTM A167 and/or ASTM C923.

d) Precast manhole components shall not be installed, transported, or removed from the casting yard prior to reaching the minimum compressive strength of 4,000-psi and at least 7 days have elapsed since casting.

e) Manhole flat slab, eccentric reducers provided for 6-ft diameter and larger manholes shall be provided with minimum slab thickness of 12-inches. Flat slab, eccentric reducers shall not be allowed for manhole diameters less than 6-ft.

f) Manhole flat top slab covers for outfall manholes 6-ft diameter and greater shall be designed and manufactured for H-20 loading and

provided in minimum slab thickness of 8-inches. Manhole flat top covers shall be provided with a minimum clear opening of 36-inches when utilized with a 36-inch clear span manhole frame and cover.

g) Manhole benches shall slope upwards from the spring line of the pipe to the projected level of the pipe crown at the manhole wall, or 8-inches above the spring line, whichever is less. Bowl type inverts recessed inside of precast benches shall not be accepted.

2. Manhole Frame and Cover Materials

a) Manhole Frames and Covers shall be Class 35 gray iron with "Sanitary Sewer" and the Town symbol forged into the cover as indicated in the details. Ring and cover shall be stamped with make and model. All manhole frames and covers shall be domestically made and manufactured in the USA from domestic iron.

b) Types

1) Manhole Frames and Covers in Paved Areas and some Unpaved Areas: For all installations in roadways or within the right of way, use Type 1 ring and cover, and place sufficient depth of concrete below the pavement around the ring to ensure contact with manhole. Type 1 covers shall be provided with 1 vent hole. Type 1 covers shall be designed for a proof load of 40,000 lbs. and be provided in Class 35B gray iron in conformance with ASTM A48. At a minimum, Type 1 manhole rings shall weigh 190 lbs. and the cover shall weigh 120 lbs.

2) Manhole Frames and Covers for Outfalls: For installation in outfall areas, with 4-ft and 5-ft diameter manholes use Type 2 ring and covers. Type 2 covers shall not be installed in areas subject to traffic loading. Type 2 covers shall be provided with an integrated frame and cover assembly in which the cover rotates away from the frame for access. The rotating assembly shall be provided with a cast in stainless steel rod assembly. Type 2 covers shall be provided with a minimum 24-inch clear span opening along the axis with the stainless steel rod assembly. Security shall be provided by 3 exterior cast lugs at ¾-inch thickness that allow padlock installation or bolting with 3 stainless steel bolts with stainless steel zinc plated nuts. Type 2 covers shall be made of Class 35B iron in conformance with ASTM A48 and designed for a proof load of 12,000 lbs. The frame and cover weight shall not be less than 60-lbs for the cover and 80-lbs for the ring. The Type 2 frame and cover assembly shall be provided with a gasket that makes the cover assembly watertight when

bolted at all three lugs. Type 2 covers shall be provided inside the 100-year flood elevation or other areas subject to flooding.

c) All castings shall be machined to give even and continuous bearing on the full length of the frame. Castings shall be free of porosity and blow holes. All manhole frames shall be bolted to the manhole, except in paved streets.

d) Manhole ring and cover shall be made by East Jordan Iron Works, US Foundry, Neenah Foundry Company, or approved equal.

e) Where deemed necessary in low areas of streets, solid manhole covers may be required to prevent surface water inflow into the sewer.

C. Installation

1. General Requirements

a) The downstream side of the last manhole(s) of a sanitary sewer line extension under construction shall be plugged by constructing a brick/block wall to prevent the passage of groundwater, runoff and sediment into the sanitary sewer system. All water upstream of the wall shall be pumped out of the sanitary sewer line and all sediment and solids shall be removed and properly disposed of by the Contractor. Water, sediment, and solids shall be removed every 30 days, or sooner if necessary, for the duration of the project. The wall shall not be removed until the line has been inspected by the Town to ensure that all possible points of inflow or infiltration have been eliminated. Failure to meet these requirements will be deemed a violation with fines up to $1,000.00 per day.

b) Manholes shall not be buried or hidden, which is a violation and subject to penalty by fines.

c) All manhole penetrations, whether sewer main or service lateral, shall be cored with a concrete coring machine. All pipe connections must be made with flexible watertight couplings or boots.

For new manholes, there shall be a minimum of 9-inches or ½ the pipe outside diameter (OD), whichever is greater, between the pipe hole openings. (Pipe hole opening is typically 4” greater than the pipe OD.) When the adjacent pipes are different sizes, the OD of the smaller pipe shall be used to determine the spacing requirement, but shall never be less than 9-inches.

For connections to existing manholes, there shall be a minimum of 9-inches or 3.5-inches plus ½ the OD of the existing pipe, whichever is greater, between the pipe hole openings.

d) All manhole sections shall be standard tongue and groove with rubber "O" ring or butyl rope sealant. All external manhole joints shall be wrapped with an approved joint seal material.

e) Each connection to a manhole shall be sealed watertight by means of a flexible sleeve or gasket type sealing system. The flexible sleeve type system, if used, shall be equal to Flexible Manhole Sleeve as manufactured by the Interpace Corporation. The gasket type system, if used, shall be equal to the PSX system as manufactured by the Press Seal Gasket Corporation. The sealing system shall be furnished by the manhole manufacturer.

f) Manholes shall be set on a base of 57 stone that is a minimum of eight (8) inches thick for four (4) foot diameter manholes and twelve (12) inches for five (5) foot diameter.

g) Backfill around manholes shall be placed uniformly in shallow layers and thoroughly compacted with mechanical tampers and with care taken to ensure against displacement of the structure.

h) All manhole rings shall be set in full mortar beds and bolted down. The rings with covers shall be set to the final grade indicated on the plans or as may be directed by the Town. Any rings and covers not conforming to the correct grade shall be adjusted by the Contractor as required. The exterior surface of all manholes shall be thoroughly cleaned of all grease, dirt, etc. All lifting lugs shall be removed and holes patched thoroughly with non-shrink mortar, color to match that of the manhole where such patches are exposed.

2. Manholes Subject to Inundation

a) Manholes subject to flooding shall be watertight and vented 24 inches above the 100-YR flood elevation. In flood prone areas, the manholes shall be vented at least every 1000-ft or every other manhole, whichever is greater.

b) The exterior of all manholes within the 100-year flood elevation and in wetland areas shall receive an exterior coating of an approved bitumastic coal tar epoxy or an approved epoxy coating at 40-mils to prevent weepage or attack by acidic soils. Individual joints shall be wrapped with Conwrap, Conseal, or approved equal and approved by the Town prior to backfilling.

c) Anti-flotation design measures shall be implemented as required in flood prone areas.

3. Manholes Located on Large Collection Mains

The Town reserves the right to require all manholes located on interceptor or outfall mains 24-inches in diameter and larger to have the manhole interior and bench coated with an approved epoxy coating at 80-mils thickness. The epoxy coating shall be field applied and tested as described herein.

4. Force Main Discharge Manholes

All manholes located on gravity mains that serve or will serve as discharge points for sanitary sewer force mains shall receive an interior epoxy coating at 80-mils thickness. In addition to the receiver manhole, the Town reserves the right to require epoxy coating of the next two consecutive manholes downstream of the receiver manhole or all downstream manholes within 1200-lf of the receiver manhole,—See Section 800 for further information on force main discharge manholes.

5. Epoxy Coating

a) Surface Preparation: Concrete manholes must be well cured prior to application of the protective epoxy coating. Generally, 28 days is adequate cure time for standard Portland cement. If earlier application is desired, compressive or tensile strength of the concrete can be tested to determine if acceptable cure has occurred. (Note: Bond strength of the coating to the concrete surface is generally limited to the tensile strength of the concrete itself. An Elcometer pull test to determine suitability of concrete for coating may be required).

Surface preparation shall be based on the requirements of the manufacturer of the epoxy coating and applicable NACE International standards.

b) Installation: A minimum 80-mils thickness shall be field applied to new manholes (120-mils for existing manholes). During application a wet film thickness gage, meeting ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used to ensure a monolithic coating and uniform thickness during application.

Temperature of the surface to be coated should be maintained between 40° F and 120° F during application. Prior to and during application,

care should be taken to avoid exposure of direct sunlight or other intense heat source to the structure being coated. Where varying surface temperatures do exist, care should be taken to apply the coating when the temperature is falling versus rising or in the early morning. The humidity should also be observed to ensure compliance with the epoxy manufacturers' recommendations.

Manufacturer approved heated plural component spray equipment shall be used in the application of the specified protective epoxy coating. The spray equipment shall be specifically designed to accurately ratio and apply the specified protective coating materials and shall be regularly maintained and in proper working order.

If necessary, subsequent top coating or additional coats of the protective coating should occur as soon as the basecoat becomes tack free, ideally within 12 hours but no later than the recoat window for the specified products. Additional surface preparation procedures will be required if this recoat window is exceeded.

c) Manholes manufactured by Armorock (or approved equal) may be used as an approved alternate to manholes that require epoxy coatings

6. Labeling

a) The interior of each manhole shall be labeled during construction. Labels can be from the manufacturer (stencil, tag, etc.) or by the contractor (tag, permanent marker, paint pen, etc.). Label must include the manhole number according to the record drawings and must consist of letters at least 3 inches tall and must be located approximately 12 inches above the shelf of the manhole.

703 Service Connections

A. Design

1. General Requirements

a) All residential subdivision lots shall be served by gravity unless otherwise approved. If a pump is approved, it shall be privately maintained and must pump into either a service connection placed on the lot. The pump and force main (if needed) must have a note on the recorded plat indicating the following: "Privately maintained sewer pump and force main is required to serve this lot".

b) Service connections to the main lines shall be perpendicular to the main line and shall extend to the edge of the right of way or easement line.

Direct taps shall be within the top quarter of the main, or within a manhole. All single family residences and businesses shall have individual connections to the public sewer main. Sewer services may not cross private property if the Development is subject to UDO requirements.

c) Multiple service connections located outside public right of way or public easements are for private use only and will not be maintained by the Town. A private sewer permit from NCDEQ shall be required on all private collection systems prior to construction plan approval. A cleanout or manhole shall be installed within each serviced lot's right of way or easement for the Town's use, and shall extend a minimum of 6 inches above the finished grade.

d) Cleanouts are required on all services with a maximum spacing of 50 feet for four (4) inch lines and 100 feet for six (6) inch lines. The first cleanout from the main/manhole shall be maintained by the Town and shall be installed one (1) foot inside the right of way line or edge of easement. All cleanouts shall extend a minimum of 6 inches above finished grade with brass caps or meet the optional cleanout method requirements in accordance with the Standard Details. Town maintenance of sewer services shall terminate at the first cleanout.

e) Sewer cleanouts located in paved areas, which bear vehicle loading, must have ductile iron risers, ductile iron fittings and a traffic rated cast iron cover assembly.

f) All 4 inch services shall connect directly into a public sewer main or manhole, in the fronting street or into an easement within the property. All 6 inch service connections shall be into a manhole.

g) Service lines connected to manholes shall not be through the cone section or manhole joints. Service lines shall be installed so that the crown of the service line matches the crown of the invert line (or higher) or shall be installed with a standard drop. Multiple service connections shall not be maintained by the Town. For 6-ft diameter and larger manholes no service is allowed in the reduced diameter riser sections of the manhole. All services shall be made via a boot connection when at a manhole.

h) The use of in-line wyes for service connections shall be required for all new construction. When connecting to existing sewer mains, service saddle taps will be allowable. Taps shall be at the 10 or 2 o'clock position, and shall not be top taps.

i) Service connections to mains at depths of 14-ft and greater shall utilize ductile iron pipe between the main and the cleanout, including a ductile iron wye for the cleanout stack. Location and angle of fittings shall be as shown in the standard detail drawings.

j) Where the flood level rims of plumbing fixtures are below the elevation of the manhole cover of the next upstream manhole in the public sewer, such fixtures shall be protected by a backwater valve installed in the *building drain*, *branch of the building drain* or *horizontal branch* serving such fixtures. Plumbing fixtures having flood level rims above the elevation of the manhole cover of the next upstream manhole in the public sewer shall not discharge through a backwater valve.

B. Materials

1. Pipe Materials

a) PVC Pipe shall be C900, schedule 40, or greater supplied in minimum 20-ft lengths. Schedule 40 PVC pipe shall be manufactured with a cell classification of 12454 in conformance with ASTM D1784. Schedule 40 pipes shall be manufactured to dimensional tolerances as specified in ASTM D1785 and rated for service conditions up to temperatures of 140-degrees Fahrenheit. The pipe may be joined by solvent weld in conformance with ASTM D2564.

Schedule 40 PVC pipe may be used for sewer services between 4 and 13 feet and shall require 4-inches of stone bedding extended to the springline.

PVC pipe and fittings for sewer laterals shall conform to ASTM D2665 “PVC Plastic Drain, Waste & Vent Piping” and shall be NSF approved. Laying lengths may be 10 or 20 feet with solvent weld type joints for Schedule 40 pipe or gasketed joint for PVC C900 DR18 pipe.

PVC C900 pipe shall be used in depths between 13 and 20 feet and shall require 6-inches of stone bedding extended 6-inches above the pipe crown.

b) Ductile Iron Pipe may be used for any depth sewer service but must be used for sanitary sewer services with less than 4 feet of cover or in excess of 20 feet of cover. Ductile iron services shall also be used in all cases where a well is located within 100-ft of the sewer service line. Ductile iron service piping shall be provided in conformance with the ductile iron piping standards outlined herein including cement mortar lining.

c) Any sewer service lateral deeper than 20 feet shall be pre-approved by the Director of Water Resources.

2. Sewer Service Fittings, New Construction

a) DIP Main with DIP Service
In-line wye fittings for ductile iron main lines joined with ductile iron service lines shall be typical ductile iron mechanical joint fittings as specified herein. In this case all fitting sizes shall conform to AWWA C153. Wye fittings through 10-inches in diameter shall be provided with cement mortar lining in accordance with AWWA C104 and provided with exterior asphaltic coating per AWWA C151. Wye fittings for lines larger than 10-inches in diameter shall be provided with Protecto 401 lining as specified herein for ductile iron pipe of the same sizing.

b) DIP Main with PVC Service
For ductile iron sewer mains to be joined with PVC service lines, the in-line wye fittings shall be slip joint ductile iron with an IPS sized branch for PVC schedule 40 service lines. Ductile iron fittings for connecting PVC service lines shall be deep bell, gasketed joint and air test rated. Gasket grooves shall be machined. Bell depths shall meet the minimum socket depth requirements of ASTM D3034 and ASTM F1336. Wall thickness shall meet the requirements of AWWA C153. Ductile iron wye fittings through 10-inches in diameter with IPS connections shall be provided with cement mortar lining in accordance with AWWA C104 and provided with exterior asphaltic coating per AWWA C151. Ductile iron wye fittings for PVC lines larger than 10-inches in diameter shall be provided with Protecto 401 lining as specified herein.

c) PVC Main with PVC Service
For PVC sewer mains to be joined with PVC service lines, PVC in-line wye fittings shall be provided. Typical Schedule 40 PVC fittings shall be provided at the cleanout wye and stack.

d) PVC Main with DIP Service
A ductile iron tee/wye shall be provided when the service line is required to be ductile iron due to a crossing or other obstruction. The fitting shall be specifically manufactured for ASTM 3034 PVC pipe such that a smooth flow way exists on the main line through the fitting. The branch shall be gasketed to receive the 4-inch DIP service line without additional fittings. The ductile iron tee/wye fitting shall be Protecto 401 lined.

3. Service Saddle Connections, Existing Sewer Mains

a) PVC service saddles shall be of the same material as the main, 45 degree deflection, and shall be solvent welded and fastened with single stainless steel bands. The saddle service branch shall be stubbed slightly into the sewer main so that when installed, the saddle shall not slip or rotate.

b) For existing DIP main lines, ductile iron service saddles shall be used. The saddle assembly shall consist of a virgin SBR or NBR gasket compounded for sewer service, a ductile iron saddle casting, a 304 stainless steel adjustable strap for fastening the gasket and the saddle casting to the sewer main and a 304 stainless steel adjustable circle clamp for securing the service line into the rubber gasket. The saddle shall be furnished with adapters as required to properly receive the service pipe.

C. Installation

1. General Requirements

a) Sewer laterals shall not be located in easements when gravity service can be provided to the property frontage at the street.

b) Each separately owned structure requires a separate tap to a public sewer.

c) Four inch lines shall have a minimum slope of ¼ inch per foot and 6 inch lines shall have a minimum slope of 1/8 inch per foot.

d) Service connections to new mains shall include the use of wye (not tee) connections. Saddle taps onto new lines shall not be allowed.

e) Saddle taps into existing PVC mains shall be made at the 10 o'clock or 2 o'clock position of the main with the wye saddle angled 45-degrees towards the direction of flow in the main. Taps shall only be made by a mechanical circular cutting saw providing a smooth and uniform cut for the saddle installation.

f) Service connections shall be made using an approved sewer saddle when the existing sewer line is 8", 10", or 12" in diameter. This service connection shall not be used when the sewer main material is truss sewer pipe. The opening in the sewer main for the sewer saddle shall be cut with a hydraulically or pneumatically driven circular tapping saw of the same nominal diameter as the sewer service line.

g) Service laterals to be maintained by the Town shall not be located beneath a driveway or curb, nor shall a clean-out be located in a sidewalk area without prior written approval from the Director of Water Resources.

704 Testing and Inspections

A. General

The Contractor shall furnish all materials, labor, and equipment to perform all testing. The Contractor may arrange to obtain water for testing purposes from the Town. The Contractor shall reimburse the Town for all water used for construction at current inside utility rates.

B. Sewer Main and Service Connection Testing

1. Visual Testing and Observation

a) All materials used must be approved by the Town prior to installation. Rejected materials shall be immediately removed from the job site.

b) Gravity sanitary sewer lines shall be clean and free from obstructions, and shall be visually inspected from every manhole. Lines which do not exhibit a true line and grade or which have structural defects shall be corrected. Sanitary sewer service connections shall be visually inspected prior to backfilling.

The Town may re-inspect the line at any time prior to final acceptance if any damage or displacement is suspected to have occurred subsequent to the initial inspection

2. Air Testing

a) Low-pressure air testing in accordance with ASTM F1417 shall be performed on all sewer mains before the laterals or stubs are installed on the line, and after the trench has been backfilled to finished grade. Plugs shall be installed at each manhole to seal off the test section. Prior to testing, the sewer line shall be clear of debris and flushed with water as necessary. The line will be pressurized with a single hose and monitored by a separate hose connection from the plug. Air then shall be slowly introduced into the sealed line until the internal air pressure reaches 5.0 psig. The air pressure shall then be allowed to stabilize for a minimum of 2 minutes. The line shall be "acceptable" if the pressure does not drop in the time prescribed for the test in the table below.

Length of Test Section (ft)	Nominal Pipe Diameter (in)											
		8	12	15	16	18	21	24	30	36	42
50		7:33	11:20	14:10	15:11	17:00	19:48	22:40	28:19	34:00	39:40
100		7:33	11:20	14:10	15:11	17:00	19:48	22:47	35:37	51:17	69:48
150		7:33	11:20	14:10	15:12	19:14	26:10	34:11	53:25	76:55	104:42
200		7:33	11:24	17:48	20:16	25:39	34:54	45:35	71:13	102:36	139:36
250		7:33	14:15	22:16	25:20	32:03	43:37	56:58	89:02	128:12	174:30
300		7:35	17:06	26:43	30:23	38:28	52:21	68:22	106:48	153:54	209:25
350		8:52	19:57	31:10	35:27	44:52	61:05	79:46	124:42	179:30	244:19
400		10:07	22:48	35:37	40:31	51:17	69:48	91:10	142:30	205:06	279:13
450		11:23	25:39	40:04	45:35	57:42	78:31	102:36	160:18	230:48	314:07
500		12:39	28:30	44:31	50:39	64:06	87:15	114:00	178:06	256:24	349:02

b) If the section fails to meet these requirements, the source of leakage shall be repaired and the pipe section re-inspected

c) The Contractor shall furnish all plugs, compressors, hoses, gauges, and any other equipment necessary to conduct the low-pressure test.

3. Infiltration Tests

a) Portions of the sewer lines, which exhibit a higher ground water table during construction, shall be tested for infiltration. The portions of the line to be infiltration tested shall be determined by the Town.

b) The portion of the sewer line designated by the Town shall be tested for infiltration by installing a V-notch measuring weir or other suitable measuring device in the downstream end of the pipe to be tested. When a steady flow occurs over the weir, the rate of flow (infiltration) shall be measured. The rate thus measured shall not exceed 100 gallons per 24 hours per inch of sewer pipe diameter per mile of pipe. The Contractor shall furnish weirs and other equipment required for infiltration tests and the tests shall be performed in the presence of the Town.

c) Should the infiltration tests reveal leakage in excess of the allowable, the leaking joints shall be re-laid if necessary or other remedial construction shall be performed by and at the expense of the Contractor. The section of sewer thus repaired shall then be retested to determine compliance with the Specifications.

4. Deflection Testing for Flexible Pipe

a) The mandrel (go/no-go) deflection test shall be performed on each line prior to acceptance and no sooner than 30 days after installation. The pipeline shall be thoroughly clean and free of debris and/or sediment prior to testing. The Contractor shall supply the mandrel used for this performance test. The mandrel device shall be cylindrical in shape having 9 or 10 possible contact points with the pipe. The mandrel's length and diameter (ID of proving ring) shall be in accordance with the following tables, and shall be subject to the Town's approval.

b) For flexible pipes (such as PVC), the following shall apply:

Nominal Diameter (inches)	Pipe Class	Average Inside Pipe Diameter (inches)	5% Deflection Mandrel Diameter (inches)	Length of Mandrel (inches)	Minimum Fins Included with Mandrel
8	C900	7.98	7.58	10	9
8	SDR 35	7.891	7.496	10	9
10	C900	9.79	9.30	10	9
10	SDR 35	9.864	9.371	10	9
12	C900	11.65	11.07	10	9
12	SDR 35	11.737	11.150	10	9
15	SDR 35	14.374	13.655	10	9
16	C900	15.35	14.58	10	9
18	C900	17.20	16.34	24	9
24	C900	22.76	21.62	24	9

Note: Calculated 5% deflection allowance does not include additional manufacturing tolerances provided by pipe manufacturers. For the purposes of testing, 5% deflection shall be calculated from standard pipe inside diameter as published in ASTM D3034 and ASTM F679.

c) The mandrel shall be advanced through the pipeline to determine if bedding and embedment has been provided in compliance with ASTM D2321 to assure joint deflection of less than 5%. If the mandrel becomes obstructed for any reason while being pulled through the line with less than 100-lbs of force, the location of the defect shall be noted and the mandrel shall be removed from the pipeline. Under no circumstances shall heavy equipment be utilized to force the mandrel through the pipeline. Deflection testing may be done concurrently with sewer televising inspections, provided the mandrel is kept within visible range of the camera. The mandrel diameter shall have a tolerance of +/- 0.01 inch. Contact length shall not be less than 2 inches.

Any lines not meeting this test shall be corrected by the Contractor and the test repeated. The Town shall approve the mandrel. The Contractor

shall furnish drawings of the mandrel with complete dimensions to the Town upon request.

5. Video Assessment and Cleaning

a) As a final measure required for acceptance, the Contractor shall clean and televise all newly installed sewer mains prior to acceptance by the Town. A 3rd party CCTV Contractor shall televise the sewer main and all lateral connections installed from the upstream to downstream manhole with no reverse setups or cutaways. This shall be done at the Contractor's expense. Throughout shooting, the camera shall be panned and tilted for a complete view of the main, including panning at each joint. Lighting shall be adequate to view the entire sewer main and service connections from beginning to end. The video inspection shall be submitted to the Town on a CD/DVD and formatted with software compatible and readable by the Town. The Town shall not be responsible for purchasing additional software necessary to view the CD/DVD.

b) The camera shall be advanced at a uniform rate not to exceed 20 feet per minute that allows a full and thorough inspection of the new sewer main. The camera shall be a color, pan and tilt camera capable of producing a five hundred line resolution picture. Lighting for the camera shall be sufficient to yield a clear picture of the entire periphery of the pipe. The picture quality shall be acceptable and sufficient to allow a complete inspection with no lapses in coverage. The length of the sewer main shall be measured and recorded on the video screen. The distance counter shall be calibrated before shooting the inspection video.

c) The Contractor shall clean the sewer mains ahead of video inspection with a high-velocity water jet. The video inspection shall take place within 2-hours of cleaning operations as witnessed by the Town. All construction debris shall be collected in the downstream manhole and shall not be released into the sewer system. No other work shall be performed on the Sewer lines after cleaning and prior to video inspection

d) The Town shall be present throughout the cleaning and televising of the sewer mains to verify that the video work complies with the Specifications. The camera operator shall stop, reverse, pan, and tilt the camera to view any area of interest during the inspection as directed from the Town. Dye may be required in order to see dips in the pipe and for approval by the Inspector.

e) It is recommended that all site grading and all utilities must be installed and complete prior to final inspection to ensure that damages to the

sewer main do not occur. Damages found after final inspection would requiring re-inspection by the Town.

f) CCTV inspection date must be acknowledged and approved by the Water Resources Department prior to inspection. All structures must be physically labeled by the contractor with number shown on the video. Punch list items from the inspection must be submitted on the Town's approved 3rd Party CCTV Report form and all vides files uploaded to One Drive (flash drives and CD/DVDs are also acceptable).

g) The contractor may not perform CCTV inspections on any utilities that they have installed.

6. Marker Tape Testing

Testing of the marker tape shall be performed by the Contractor at the completion of the project to assure it is working properly and completely detectable. It is the Contractor's responsibility to provide the necessary equipment to test the markers. Any defective, missing, or otherwise non-locatable segments shall be replaced.

C. Manhole Testing

1. Vacuum Testing

a) All newly installed manholes shall pass a vacuum test in accordance with ASTM C 1244. The Contractor shall supply all equipment and materials necessary to vacuum test the manholes.

b) Vacuum Testing shall be completed prior to any specified coating and lining materials being installed.

c) The Town shall be present and witness all vacuum testing.

d) The following vacuum testing criteria shall apply for compliance with the testing procedure.

1) A vacuum of 10-inches of mercury shall be drawn with an approved vacuum testing unit.

2) The testing time shall not be measured until after the vacuum pump has been shut off.

3) The time required for the vacuum to drop from 10-inches to 9-inches of mercury shall meet or exceed the values listed in the following table.

Manhole Vacuum Testing Time

Depth	Manhole Diameter (inches)		
(feet)	48	60	72
Time (seconds)			
8	20	26	33
10	25	33	41
12	30	39	49
14	35	48	57
16	40	52	67
18	45	59	73
20	50	65	81
22	55	72	89
24	59	78	97
26	64	85	105
28	69	91	113
30	74	98	121

2. Holiday Testing of Lined Manholes

All manholes that require an epoxy coating shall undergo discontinuity testing. This shall be a high-voltage spark test conducted in accordance with NACE International Standard Practice 0188. All areas of the manhole coated shall be tested. The spark tester shall be set at a minimum of 100 volts per mil of coating thickness applied. The Contractor shall supply the spark tester and all testing equipment and labor needed to perform this test.

All holidays identified must be repaired. The epoxy coating must be abraded and cleaned prior to re-coating. All touch-up work shall be in accordance with the epoxy manufacturers guidelines.

705 Aerial Crossings

A. Design

Aerial crossings shall only be utilized in cases where buried crossings are not feasible due to stream crossings, compliance with riparian buffer standards, minimizing impacts to wetlands, preventing excessive depth of installation, or as otherwise directed by the Town of Apex. All aerial crossings shall have prior approval by the Water Resources Director and will only be considered if there are no practical alternatives available, cost shall not be considered justification for aerial crossings

In cases where aerial crossings are utilized to cross streams, the bottom of the pipe shall be installed above the 25-year flood elevation of the stream. Piers shall generally be located at a uniform spacing of 20-ft or 1 pier for every joint of pipe. Piers shall be provided in accordance with the standard details or as otherwise designed by a licensed NC Professional Engineer.

All pier footings shall be designed by a licensed NC Professional Engineer and the assumptions provided in the footing design shall be included on the plans. At a minimum, the footing design shall include: 1) the allowable soil bearing capacity, 2) design concrete compressive strength, 3) plan for reinforcing steel with sizing and location of bars, 4) force diagram including buoyant forces, stream velocity impacts 5) depth of installation to prevent frost heaving, 6) bedding design to prevent differential settlement and 7) factors of safety for unanticipated loads such as trees falling across the aerial crossing.

At a minimum all pier foundations shall be constructed on a base of 12-inches of washed stone. The soil conditions under the pier shall be evaluated by a licensed NC Geotechnical Engineer to determine if the allowable soil bearing capacity meets or exceeds the design assumptions included in the structural design. If the soil conditions fail to meet the specified bearing capacity requirements, a pile foundation shall be provided or the soils shall be undercut and replaced in conformance with the recommendations of the geotechnical engineer of record.

Piers installed in stream beds shall be avoided in lieu of spanned crossings. Spanned pipe crossings greater than 20-ft shall be provided in accordance with the pipe manufacturer's specifications and shall not exceed 40-ft for ductile iron pipe. Spanned pipe crossings shall be designed such that all flanges and exterior pipe connections are located above the 25-year flood elevation.

Spanned crossings greater than 40-ft without piers shall be provided in a steel encasement pipe and the entire crossing including piers, foundation, truss and/or beam supports and pipe thickness design shall be provided by a licensed NC Structural Engineer.

B. Pipe Materials

1. **Ductile iron pipe** for aerial crossings shall be interior lined with Protecto 401 at 40-mils regardless of pipe diameter from manhole to manhole. All joints for ductile iron pipe utilized in aerial crossings shall be restrained with a US Pipe Mech-Lok joint, American MJ Coupled joint, or other as approved by the pipe manufacturer, the Water Resources Department and the Engineer of Record. Ductile iron pipe utilized for spanned crossings greater than 20-ft without a pier shall typically be provided with flanged connections. All bolts and fasteners for flanged or bolt locking restraining systems shall be provided in stainless steel and installed in a manner to prevent seizing.

2. **PVC pipe** shall not be approved for aerial crossings.

3. **Steel pipe** provided for aerial crossings shall be fabricated with grade B steel that has minimum yield strength of 35 KSI in accordance with ASTM A139. Steel pipe for aerial crossings shall be provided with minimum wall thickness consistent with a pressure class of 200-psi or greater. Steel pipe for aerial sewer crossings shall be provided with 40-mils of interior ceramic coating, such as Ceramaline and provided with an exterior tape wrap approved by the manufacturer. All steel pipe joints shall be welded in conformance with manufacturers' specifications.

C. Installation

Aerial crossings are often utilized to span sensitive environmental areas and installation shall be consistent with plans to preserve the sensitive areas.

Joints of bolt lock or coupled restrained pipe shall be located within 2-ft of each pier as outlined by the detail drawings. Contractor shall ensure the length of pipe joints allows for this spacing.

Pipe shall be secured to each pier with 1/4-inch by 2-inch width steel straps fastened to 4; ½-inch stainless steel lugs anchored and adhered with epoxy to the concrete pier. The steel straps shall receive a weather resistant painted finish to prevent long term corrosion.

Precast piers may be submitted for approval provided the footing and foundation designs are completed by licensed structural and geotechnical engineers.

In cases where soil conditions cannot be sufficiently stabilized to provide an adequate foundation for concrete piers, a pile foundation designed by a licensed NC structural engineer and approved by the Town shall be provided.

Reinforcing steel for concrete piers shall be grade 40 and shall be constructed in conformance with the latest edition of the "Recommended Practice for Placing Reinforcing Bars" or other documentation as published by the Concrete Reinforcing Steel Institute.

In cases where rock exists at the foundation elevation, the footing shall be drilled and connected with dowels into the rock layer.

706 Repairs, Modifications, and Abandonment

A. Sewer Main Repairs

1. Vitrified Clay Pipe - replace damaged section with DIP and install a Fernco coupling at each end encased in concrete.

2. PVC Pipe - replace damaged section with PVC Pipe and install a Fernco coupling at each end encased in concrete.

3. ABS/PVC Truss Pipe - replace damaged section with DIP and install a Fernco coupling at each end encased in concrete.

4. Asbestos Cement Pipe - Replace damaged section with DIP and couplings encased in concrete.

B. Installation

1. All repairs to damaged sanitary sewer lines in paved areas shall be backfilled with ABC stone (crusher run) to a density of 95 percent Standard Proctor.

2. All repairs to damaged sanitary sewer lines shall be bedded with 6-inches of washed stone and compacted to a minimum of 95% Standard Proctor density before installing the new joint of ductile iron or PVC pipe.

C. Draining Sewer Mains

A detailed bypass pumping and emergency plan shall be required for any sewer line draining event.

All sanitary sewer mains and sewer force mains 20-inches and larger, active, inactive, or abandoned shall begin to be drained by tapping the bottom half of the pipe. A corporation stop or other valve shall be provided to control flow. All effluent shall be pumped to a downstream manhole (when available) or other containment tank utilizing continuous piping. The use of a sump pit on lines 20-inches and larger is not allowed.

In sensitive environmental areas and in other various scenarios the Water Resources Department may require lines less than 20-inches also be tapped in order to be drained.

D. Abandonment of Existing Sewer Mains

1. Existing sewer mains and casings located outside of road sections shall be removed, unless otherwise directed by the Town. All materials and labor shall be provided by the contractor.

2. Grout filling and abandoning in place may be allowed with prior approval from the Director of Water Resources.