# SECTION 400
# SOIL EROSION & SEDIMENTATION CONTROL



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## 401 General Requirements

Temporary soil erosion and sedimentation control (S&E) measures shall be provided in accordance with the S&E plan approved by the Town of Apex. After the performance guarantee has been paid and the perimeter silt/tree fence has been inspected by the zoning compliance officer the S&E letter of plan approval will be issued to permit the CONTRACTOR to grade only enough as to install the S&E measures. The contractor/developer must receive a certificate of coverage from the North Carolina Department of Environmental Quality (NCDEQ) prior to installing measures. Once the S&E measures are installed and found to be acceptable with the approved S&E plan, a certificate of compliance will be issued so the CONTRACTOR can continue land disturbing activities on the applicable phase of the site. The S&E plan shall be in accordance with the North Carolina Division of Energy, Mineral and Land Resources (NCDEMLR) Erosion and Sediment Control Planning and Design manual (latest revisions) and the Town of Apex Standard Specifications and Details. The CONTRACTOR/DEVELOPER should also be familiar with the Town of Apex S&E Ordinance. The approved S&E Plan shall be kept on site by the CONTRACTOR at all times while work is being performed. For land disturbing projects equaling 1 acre or more, the NPDES Stormwater Discharge Permit (NCG 010000) issued by the NCDEQ shall be maintained on site and adhered to. The Town Construction Site Waste Management Plan is issued with the letter of plan approval and must be followed for the life of the project.

For areas of single-family development within a project, all logging and grading activities are limited to a maximum of 20 acres at one time.

Prior to logging and grading operations, ~~All~~ all S&E measures shall be installed ~~prior to clearing operations~~ in order to be issued a Certificate of Compliance by the TOWN.~~, and~~

~~in no case shall an area, where work is completed, remain denuded~~ Areas where active construction ceases, meaning no substantial or significant progress is made in any area for more than 14 calendar days, all disturbed areas must be seeded and mulched unless written approval is granted by the TOWN. Ground cover shall be established in graded slopes and fills within 14 calendar days for slopes 3:1 or flatter and within 7 calendar days for slopes steeper than 3:1. Incidental grading shall not constitute substantial or significant progress in construction activity.

S&E measures shall be coordinated with all other work on the project to ensure economical, effective, and continuous S&E throughout the construction and post construction period and to minimize siltation of streams, lakes, reservoirs, and other water impoundments, ground surfaces, roadways, or other properties.

Minimum design criteria for S&E devices shall be the following:

1. Required Volume – 3600 $ft^3$ per disturbed acre.
2. Required Surface Area – Shall be based on 435.6 $ft^2$/cfs and the peak flow rate from a 25-year, 24-hour storm event ($Q_{25}$).
3. The outlet structure from a sediment basin shall only withdraw water from the surface.
4. Prior to the issuance of the Certificate of Compliance, the permanent outlet structure for all temporary sediment basins (future Stormwater Control ~~Structures~~Measures - SCM's) must be installed with the skimmer attached to the bottom drain.

## 402 Construction Sequence and Schedule

The PROJECT ENGINEER will include a construction sequence schedule or work schedule that coordinates the timing of the land-disturbing activities and the installation of erosion and sedimentation control measures. See the Town's website for ~~a sample~~the standard construction sequence.

## 403 Seeding & Mulching

Seeding and mulching shall be carried out immediately behind construction in accordance with the following specifications:

**SHOULDERS, SIDE DITCHES, SLOPES (3:1 ~~MAX.~~and Flatter)**

| Date | Type | Planting/Acre |
|---|---|---|
| Aug 15 - Nov 1 | Tall Fescue | 300 lbs. |
| Nov 1 - Mar 1 | Tall Fescue & Abruzzi Rye | 300 lbs. |
| Mar 1 - Apr 15 | Tall Fescue | 300 lbs. |
| Apr 15 - June 30 | Hulled Common Bermuda grass | 25 lbs. |
| July 15 - Aug 15 | Tall Fescue ***and*** | 35 lbs. |

| | | |
|---|---|---|
| | *** Brown top Millet ***or*** | |
| | *** Sorghum-Sudan Hybrids | |

**SHOULDERS, SIDE DITCHES, SLOPES (3:1 to 2:1)**

| Date | Type | Planting/Acre |
|---|---|---|
| Mar 1 - April 15 | ~~ADD~~ Tall Fescue ***and*** | 120 lbs. |
| Mar 1 - June 30 | ADD ~~Weeping Love grass~~German or Browntop Millet ***or*** | 10 lbs. |
| Mar 1 - June 30 | ADD Hulled Common Bermuda Grass | 25 lbs. |
| June 1 - Sep 1 | *** Tall Fescue ***and*** | 120 lbs. |
| | *** Brown top Millet ***or*** | 35 lbs. |
| | *** Sorghum-Sudan Hybrids | 30 lbs. |
| Sep 1 - Mar 1 | ~~Sericea Lespedeza (unhulled-unscarified) ***and***~~ | ~~70 lbs.~~ |
| | Tall Fescue | 120 lbs. |
| Nov 1 - Mar 1 | ADD ~~Abruzzi~~ Rye Grain | 25 lbs. |

***Temporary~~--~~ – Re-seed according to optimum season for desired permanent vegetation. Do not allow temporary cover to grow over 12 inches in height before mowing, otherwise fescue may be shaded out.

A Conservation Engineer or ~~Soil~~ Natural Resources Conservation Service (NRCS) shall be consulted for additional information concerning other alternatives for vegetation of denuded areas. The above vegetation rates are those which do well under local conditions; other seeding rate combinations are possible. Any variation from this list shall be pre-approved by the TOWN.

## SEEDBED PREPARATION

1. Chisel compacted areas and spread topsoil 3 inches deep over adverse soil conditions, with stockpiled topsoil. CONTRACTOR shall reserve sufficient topsoil for seedbed preparation.

2. Rip the entire area to 6 inch depth.

3. Remove all loose rock, roots, and other obstructions leaving surface reasonably smooth and uniform.

4. Apply agricultural lime, fertilizer, and super-phosphate uniformly and mix with soil (see below*).

5. Continue tillage until a well-pulverized, firm, reasonably uniform seedbed is prepared 4 to 6 inches deep.

6. Seed on a freshly prepared seedbed and cover seed lightly with seeding equipment or cultipack after seeding.

7. Mulch immediately after seeding and anchor mulch.

8. Inspect all seeded areas and make necessary repairs or reseedings within the planting season, if possible. If stand is less than 60% established, the entire area shall be reseeded according to specifications using the original lime, fertilizer and seeding rates.

9. Consult a Conservation Inspector on maintenance treatment and fertilization after permanent cover is established.

*Apply: Agricultural Limestone - 2 tons/acre (3 tons/acre in clay soils)
Fertilizer - 1,000 lb/acre - 10-10-10 (Fall) – 5-10-10 (Spring)
Super-phosphate - 500 lb/acre - 20% analysis
Mulch - 2 tons/acre - small grain straw
Anchor - Asphalt Emulsion @ 300 gals/acre

## 404 Construction Entrances

Gravel construction entrance pads (see detail 400.06) shall be constructed at each point of construction access to the site, including residential lots. The gravel pads shall be maintained in such a manner as to prevent the deposition of mud and debris onto existing public roadways or properties adjacent to the site.

*Special Note*: It shall be the developer's responsibility to see that the construction entrance pads are properly maintained so that mud is not tracked onto adjacent streets. In the event that the gravel construction entrances are not properly maintained, or are otherwise ineffective, 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 pads are restored and replenished and until any resulting mud and debris has been removed from the adjacent streets by the CONTRACTOR.

## 405 Inlet Protection

In addition to the inlet protection standard details presented herein and to further protect the water quality of receiving streams, filtering inlet protection devices shall be used at all catch basins along roadways that have just received the first lift of asphalt. The devices shall be installed across the grate and throat and must be a product approved by the ~~Town's *Stormwater Engineering Manager*~~ TOWN Stormwater Engineering Manager or his/her designee. The filtering inlet protection device will be subject to periodic inspection and must be properly maintained throughout construction.

For stub streets and street phasing lines draining away from the site, and other areas as directed by the TOWN, asphalt diversions or other TOWN approved alternative shall be installed to direct runoff into inlets until the final lift of asphalt is installed. Cold patch asphalt shall not be used.

Unless inlets are located at the street stub, erosion control measures shall be installed at the edge of stub streets draining away from the site to prevent erosion.

## 406 Computations

All computations and assumptions used to formulate an S&E plan shall be reviewed by the T~~own~~OWN. S&E measures, structures and devices shall be planned, designed and constructed to control the calculated peak runoff from a 25-year frequency storm. Runoff rates shall be calculated using the USDA Soil Conservation Service Method, the Rational Method or other acceptable calculation procedures. Runoff computations shall be based on rainfall data published by the National Weather Service for this area.

## 407 Temporary Matting/Blankets

All temporary matting/blankets used shall be made of biodegradable materials that do not contain plastic netting.

# SECTION 500
# STORM DRAINAGE

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- E. Corrugated Aluminum Alloy Pipe (CAAP)
- F. Reinforced Concrete Box Culvert (RCBC)

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**508 Inspection Prior to Acceptance**

## 509 Maintenance of Municipal Separate Storm Sewer System (MS4)

## 501 Design

### A. General

The following Standard Specifications and associated Standard Detail Drawings shall apply to all storm drainage system development. Any deviations from this specification, or sections noting approval required by the ENGINEER, shall require submittal of an Exception Review Request for consideration.

Storm drainage facilities shall be designed to ~~dispose of~~convey 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 Gutter Spread | 4 inches/hour |
| Drop Inlet Ponding (sag condition) | 100-year |
| Storm Sewer Collector | 10-year ~~storm~~ |
| Cross Street Storm Drainage | 25-year ~~storm~~ |
| Greenways | 25-year ~~storm~~ |
| Offsite Bypass System | 25-year |
| Structures in Floodplain | 100-year ~~storm~~* |

*Drainage structures in the floodplain, and all culverts under roads located at stream crossings ~~should~~shall 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~~100 acres), 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 NOAA Atlas 14 for this area.

2. Time of concentration (tc) shall be determined using standard acceptable methods and the storm duration shall equal tc.
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 using the design storm table in 501.A. 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 or plans shall include storm pipe profiles that show inverts, slopes, proposed finished grade and HGL. The HGL shall be required to stay within the crown of 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 orAccessableAccessible drainage structures shall be installed at each deflection of line, or grade, and change in pipe material. Acute angle junctions (angles less than 90 degrees) between pipe runs should be avoided. No inaccessible junction boxessdrainagedrainage structures shall be permitted. Open-throated yard inlets shall have a manhole lid incorporated into the concrete lid for accessibility. The maximum distance between access openingsstructures 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 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 gutter spread to no more than half the width of a through lane during a 4-inch per hour rain stormevent. The width of the gutter may be added to the width of the lane. For curb inlets located in a sag condition, a 50% clogging factor shall be applied when calculating spread. No catch basin shall be installed in the radius of a curvean intersection corner radius or in a driveway apron. Proposed driveway locations shall be shown on construction drawings to demonstrate they do not conflict with catch basin locations.

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 shall extend from the public street rights-of-way the minimum distance needed directly from public street right-of-way through points downstream, to the a point of open discharge adjacent to the public street right-of-way. Stormwater conveyance systems that originate within or pass through the public street right-of-way shall be designed to minimize distance crossing through private property to the discharge point. At the discretion of the TOWN, if the point of open discharge extends into private property greater than that minimal distance needed to daylight, a drainage structure shall be provided within 10 feet of the public street right-of-way to transition the public drainage easement to a private drainage easement. Pipes shall not outfall in the front yard of a lot but should instead extend to the rear third of the lot or property line in residential subdivisions.

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. To the maximum extent

practicable, the storm drainage system in these natural drainage ways shall be designed to bypass the off-site flow around the on-site SCMs, and to where the natural drainage way currently discharges.

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 right~~s~~-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, such as HDPE or PVC, 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. Private storm drainage systems, whether piped or open channel flow, that cross more than two lots shall be located within a private drainage easement. 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 right~~s~~-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~~encroachments are allowed within any public easement, unless approved in accordance with Section 200. 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)
- Polypropylene Pipe (PP)
- Corrugated Steel Pipe - Type 2 (CSP)
- Corrugated Aluminum Alloy Pipe (CAAP)

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

| | ***PP*** | | ***CSP*** | | ***CAAP*** | |
|---|---|---|---|---|---|---|
| ***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. Pipe producer/supplier shall be on the NCDOT approved producer/supplier list.

### 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~~marked by the NCDOT Materials and Tests Unit at the manufacturer's facility prior to delivery.

Inspection, evaluation, and acceptance of RCP materials shall be guided by AASHTO R73.

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. Polypropylene Pipe (PP)

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 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 PP to RCP shall be made with the appropriate adapter. Refer to Section 505 A.

## D. Corrugated 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 Alloy Pipe (CAAP)

Aluminum pipe shall be 14 gauge minimum. Coils shall conform to the applicable requirements of ASTM B744. CAAP 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 CAAP to a minimum of 18 gauge.

### F. Reinforced Concrete Box Culvert (RCBC)

RCBC shall conform to ASTM C1433, C1504, or C1786. Joints shall be sealed in conformance with ASTM C990 (preformed flexible sealant) and/or C877 (external sealing bands), based on manufacturer's recommendations for the specific application.

Inspection, evaluation, and acceptance of RCBC materials shall be in accordance with AASHTO R73.

## 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~~marked 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<br>1/4 part Hydrated Lime<br>3 3/4 parts Mortar Sand (maximum) |
| MIX NO. 2 | 1 part Portland Cement<br>1 part Masonry Cement<br>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 PP, CSP, or CAAP 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.

The slope from pipe invert to top of berm shall not exceed 2:1. 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:

1. 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.
2. The outlet structure shall be constructed of precast reinforced concrete and the outlet pipe shall be either reinforced concrete pipe (RCP) or polypropylene pipe (PP).
3. All vegetated side slopes (interior & exterior) and tops of dams shall be sodded with non-clumping turf grass.
4. All SCM side slopes stabilized with vegetated cover shall be no steeper than 3:1 (horizontal to vertical).
5. 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.

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. Dam compaction geotechnical reports, and photographic evidence of the outlet pipe cradle and anti-seep device installation shall be included with the SCM as-builts. See Section 106 of this document for additional "as-built" submittal requirements.

A final inspection and approval by the TOWN Stormwater 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. When backfilling around corrugated pipe, the maximum stone diameter of the fill shall be less than the width of the pipe corrugations.

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 PP, CSP, or CAP, the contractor shall complete a deflection test using a laser profiler device, or 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. Cracks and gaps shall be measured during video inspections using a laser micrometer, or similar with prior approval by the INSPECTOR.

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. 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 street right-of-way and Town of Apex Public Drainage Eeasements.identified easements. The easements must be labeled as the following: "Town of Apex Public Utility Easement" or "Town of Apex Public 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 900
# GREENWAY TRAILS

6) **Fabrication**
7) **Railings and Accessories**
8) **Finishes**
9) **Delivery and Erection**
10) **Quality**
11) **Pre-Engineered Bridges**

**B. Underpasses, Tunnels, and Culverts**

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## 901 General

All construction shall conform to the requirements and dimensions on the approved construction plans, Town Standard Details, the Unified Development Ordinance, the latest edition of AASHTO Guide for the Development of Bicycle Facilities, Section 405 of 2009 ANSI A117.1., and the Shared Use Path Accessibility Guidelines as published by the United States Access Board, or as stated in these Specifications, whichever, in the opinion of the ENGINEER, is applicable. Any conflicting requirements or lack of information shall be brought to the attention of the Town prior to construction.

## 902 Greenway Design Plans

### A. General

Greenway designs shall be on a separate plan and profile sheet. Plan view grading shall be at a maximum scale of 1 inch equals 40 feet with 1 foot contours shown. Cross sections shall be provided at a minimum of every 50 feet. Plan and profile for greenway trails, and an Engineer-sealed estimate of probable cost, which is approved by the Director of Parks, Recreation, and Cultural Resources, and the Director of Water Resources or their designee, are required for Construction Plan approval. The total length of greenway trail to be constructed shall be listed on the plan sheet. The length of each trail section with a running slope in excess of 5 percent shall be indicated, and the overall percentage of the designed trail that exceeds 8.33 percent shall be indicated. All trail amenities, fences, storm drainage, proximate utilities, easements, details, notes, and any other requirements shall be shown on these plans.

### B. Record Drawings

Record drawings will be required prior to acceptance of routine maintenance/warranty of the greenway by the Town (refer to Unified Development Ordinance Section 14.1.5.C.5 Performance Guarantee).

### C. Easements, Encroachments, and Permits

Greenway easements shall be dedicated with the first final subdivision plat submitted for the development. All easements, encroachments, and/or permits required for on-site and

off-site facilities must be obtained by applicant prior to beginning work. Easements within which shoulders, swales, or appurtenances are not contained will require amendment via recorded plat. All required permitting, certifications, and geotechnical reports shall be submitted to the Town prior to the Town's acceptance of routine maintenance/warranty on public or private greenway trails.

## D. Plan Notes

The following notes shall be included on all greenway design plans:

1. Contractor shall confine construction activity within limits of disturbance.
2. Contractor shall retain a North Carolina Professional Land Surveyor to stake centerline of the trail as shown on the Layout Plan. The trail shall be staked at 50 foot intervals in the field.
3. Staked centerline of the trail shall be approved by the Parks and Greenways Planner or designee for Town projects.
4. Erect tree protection fence along limit of disturbance for approval by Site Inspector.
5. Install required erosion control measures prior to construction.
6. Contractor shall call for utility locations prior to construction.
7. All disturbed areas shall be seeded per North Carolina Department of Environmental Quality Temporary and Permanent Seeding Specifications.
8. Grade side slopes and adjacent ground to drain. Ensure that there is no standing water on the uphill side of the trail. Install a diversion ditch as needed to direct water to culverts.
9. Additional culverts will be added as needed during construction to prevent erosion and standing water on the greenway trail.
10. The Infrastructure Inspector shall inspect proof-roll of Town maintained greenway trails prior to placement of fabric and stone. The trail shall also be proof-rolled prior to paving. A minimum of 100 percent compaction is required. All private greenway trails shall be proof-rolled by a NC-licensed Geotechnical Engineer who shall provide a report to the Infrastructure Inspector.
11. All trails that intersect with a curbed road shall have an accessible Greenway Curb Ramp as specified on plans. Ramp widths shall be same width as trail, and include a level landing at top of ramp in accordance with the Standard Detail. If intersecting a road with no curb and gutter, a detectable warning surface shall be installed in accordance with the Detail. The centerline of all Greenway Curb Ramps perpendicular to roadway shall align with centerline of trail.
12. The contractor shall ensure that all access points leading to the trail are posted with signs that read Trail Closed for Construction. Barriers shall be installed at the ends of any incomplete greenway segments that have a longitudinal slope greater than 3:1, or other hazardous conditions.
13. Asphalt technicians shall verify asphalt depth on site and provide certification in writing to the Infrastructure Inspector via email for review and approval.
14. All greenway bridges, boardwalks, and retaining walls will require Town of Apex building permits.

15. All trail intersections with roadways, sidewalks, or other trails shall include 3.5 feet minimum edge radii.
16. One trash and recycle receptacle with concrete slab and one dog station with concrete slab shall be installed at each access entrance after trail has been paved prior to trail acceptance by Town, and benches may be provided along trails.
17. Developer/applicant shall obtain Wake County and NCDOT Rail Division approval for trail connections and alterations within the American Tobacco Trail corridor; if any changes are requested by Wake County or NCDOT, these changes must be reviewed and approved by Town of Apex Technical Review Committee staff as a revision to approved plans. See NCDOT Rail Corridor Preservation Policy, Adopted Policy # A.09.0102, as updated.
18. Adequate sight distance shall be provided for trail users at trail entrances and intersections.

## 903 Greenway Trails

### A. General

All proposed greenways shall conform to the Bicycle and Pedestrian System Plan Map. Town greenway trails are intended to accommodate multiple user types including pedestrians, bicyclists, non-motorized scooters, and rollerbladers among others.

### B. Easements

Public Greenway Easements (PGE) shall be 20 feet minimum width with the trail centered within the easement and encompass swales and culverts for maintenance. Trail connections to neighborhoods shall be publicly owned and maintained. PGEs may not be located within residential lots. Shared public greenway and water or sanitary sewer easements shall be 30 feet minimum width, but could be greater depending on the utility line size and depth in accordance with Section 700. No greenway trails or easements shall be co-located within any stormwater control measures (SCMs) or access easements, except private trails as approved by Town staff. No shrub or tree plantings, or private fences are allowed within the greenway easement.

### C. Design Speed

In establishing horizontal and vertical curvature for paved greenway trails, a design speed of 18 mph shall be used. For greenway connector trails (short lengths of publicly maintained paved trail from a neighborhood to the main greenway trail), street-side greenways, and private trails, a design speed of 12 mph may be used.

### D. Horizontal Alignment

All public greenway and private trails shall be designed with a centerline alignment and stationing every 100 feet. All tangent sections of public greenways shall be connected

with horizontal curves. Greenway trail alignments shall have a minimum horizontal curve radius of 60 feet to meet the 18 mph design speed at a 20 degree lean angle. Greenway connector trails and street-side greenways shall have a minimum horizontal curve radius of 27 feet to meet the 12 mph design speed at a 20 degree lean angle. Minimum lateral clearances shall be met on all horizontal curves to provide adequate stopping sight distance.

## E. Cross Slope

All public greenway and private trails shall have 1 percent minimum and 2 percent maximum cross slope with slope towards the downstream side. On vertical slopes with grades in excess of 5 percent, cross slopes shall be sloped to the inside of downhill curves.

## F. Vertical Alignment

All vertical tangent sections shall be connected with vertical curves. Vertical curves shall be designed to provide adequate stopping sight distance on the trail. Unless necessitated by exceptional topography, greenway trail grades shall not be less than ½ percent. Maximum grades on greenways shall be 5 percent. Where topography necessitates grades to be in excess of 5 percent, Shared Use Path Accessibility Guidelines shall be applied to determine maximum length of grade and spacing of flat landings:

- Grades greater than 5 percent and up to a maximum of 8.33 percent shall be allowed for a maximum of 200 feet before requiring a landing 10 feet long with maximum slope of 2 percent in all directions.
- Grades greater than 8.33 percent and up to a maximum of 10 percent shall be allowed for a maximum of 30 feet before requiring a 10-foot landing.
- Grades greater than 10 percent and up to 12 percent shall be allowed for a maximum of 10 feet before requiring a 10-foot landing.
- No more than 30 percent of a greenway may exceed 8.33 percent.
- Grades that approach roadway or greenway crossings shall be limited to 5 percent maximum at least 10 feet ahead of the intersection or back of landings associated with curb ramps.

In all instances where grades exceed 8.33 percent, a metal handrail shall be installed on both sides, offset 1 foot from the edge of the trail.

## G. Side Slopes

Side slope should be 3:1 or flatter. Where fill slopes are steeper than 3:1, or where the trail is adjacent to a body of water, provide 5 feet graded shoulder width adjacent to the edge of paved trail for recovery, graded at 6:1 or flatter. Where a recovery area of 5 feet cannot be provided, a physical barrier such as safety rail shall be provided in the following circumstances:

- Slopes 3:1 or steeper, with a drop of 6 feet or more;
- Slopes 3:1 or steeper, adjacent to a parallel body of water;
- Slopes 2:1 or steeper, with a drop of 4 feet or more;
- Slopes 1:1 or steeper, with a drop of 1 foot or more.

Fill slopes steeper than 3:1 shall be engineered. Safety rail shall be located 1 foot minimum offset from trail edge where required.

## H. Pavement Structure

Public greenway trails shall be constructed from either hot-mix asphalt (HMA) material or Portland cement concrete (PCC). For asphalt greenway construction a woven geotextile fabric shall be used below the aggregate base course, with the following properties:

| | TYPICAL | TEST |
|---|---|---|
| Tensile Strength | 200 lbs | ASTM D4632-86 |
| Elongation at Break | 15% | ASTM D4632 |
| Puncture Strength | 100 lbs | ASTM D0751 |
| Mullen Burst | 400 psi | ASTM D0751/3786 |
| Trapezoid Tear | 75 lbs | ASTM D4533 |

After asphalt surface course is installed, the ~~top 2 inches of granite screenings~~ edge of pavement shall be ~~placed~~ backfilled with 2 inches of aggregate base course and seeded using an approved seed mix. All ~~granite screenings~~ aggregate base course as part of the 2-foot shoulder shall be compacted to at least 95 percent of their standard Proctor maximum dry density. ~~Crushed Granite Screenings shall meet the following minimum gradation criteria:~~

| ~~SIEVE SIZE~~ | ~~PERCENT PASSING~~ |
|---|---|
| ~~1"~~ | ~~100%~~ |
| ~~0.50"~~ | ~~100%~~ |
| ~~#4~~ | ~~95-100%~~ |
| ~~#10~~ | ~~60-85%~~ |
| ~~#40~~ | ~~20-50%~~ |
| ~~#200~~ | ~~4-12%~~ |

## I. Drainage

Site drainage should be collected on the uphill side of the trail in a grassed diversion ditch sized appropriately with minimum 1 foot depth, and piped to direct water under the trail to a creek or storm drain culvert, to eliminate flow across the trail. A Class B rip-rap dissipater with filter fabric shall be installed at upstream and downstream ends of all culverts. When culverts are located within the Town of Apex 100 foot Riparian Buffer area, properly sized culverts will be permitted to address natural swale and drainage draws.

SCM outlets/culverts shall be extended under greenways located at toe of slope of SCMs with a yard inlet or catch basin installed on the upstream side of the greenway. When dealing with drainage situations that cannot meet the requirements stated above due to topography or regulatory issues, a series of 8-inch pipes may be considered as an alternative solution.

### J. Clearances

A minimum lateral clearance of 5 feet shall be maintained from the edge of the trail and vertical clearance of 10 feet from the trail surface, whenever possible. In shared greenway and utility corridors, the edge of pavement should be a minimum of 2 feet from the edge of any utility surface covers/plates (e.g. water valve covers, blow-offs, manholes), and boardwalk and bridge footings should be no closer than 4 feet from any utility.

Trees shall be limbed up a vertical distance of 10 feet from the forest floor, within 5 feet from the outside edge of the trail. Tree limbs and dead trees that present a danger to pedestrians utilizing the trail shall be removed during construction, as directed by the Parks and Greenways Planner or other Town staff. Minimum vertical clearance from trail surface to the lowest horizontal structural member of bridges shall be 10 feet.

## 904 Proof-Rolling of Subgrades for Greenways

The Infrastructure Inspector shall oversee the proof-roll of public greenway trails. Private trails shall be proof-rolled under supervision of a NC-licensed Geotechnical Engineer and a report shall be submitted to the Zoning Compliance Officer for acceptance. Public greenway and private trail proof-rolls shall be performed on the exposed subgrade soils along the full length of the proposed paved trail after clearing, grubbing, and topsoil removal are complete.

Proof-rolling shall be performed using a fully-loaded tandem-axle dump truck or equipment with minimum 10 ton static weight approved by Geotechnical Engineer. The Infrastructure Inspector for public trails, or Geotechnical Technician for private trails, shall assess problems including rutting, deflection, or pumping of subgrade soils and shall determine if the subgrade soils are suitable to allow placement of geotextile fabric and stone base. The Geotechnical Technician may require an NC-Licensed Geotechnical Engineer to evaluate and determine the need for remedial measures. The aggregate base course shall also be proof-rolled prior to asphalt or concrete placement. A minimum of 100 percent compaction is required.

## 905 Trail Amenities

All trailhead/trail access points shall have one trash receptacle, one recycling receptacle, and one dog station per Standard Detail which shall be shown on the approved plans and

field located by the Parks and Greenway Planner or designee once the trail has been paved. Bollards shall be provided per Standard Detail.

## 906 Signage

### A. Regulatory and Warning

Greenway signage shall be established in accordance with MUTCD: Traffic Control for Bicycle Facilities, Part 9. Greenway signage shall be located where necessary in accordance with Standard Details and approved plans. Coordination with the Town Transportation and Engineering staff is required to determine vehicular sign needs for all greenway crossings of roadways.

### B. Wayfinding

All trail access points, intersections, and trailheads shall utilize the appropriate Wayfinding signs per Standard Detail. Wording on the sign and exact placement will be determined by the Parks and Greenways Planner. A proof of the proposed signage shall be submitted to the Parks and Greenways Planner for approval prior to ordering materials.

## 907 Street Crossings

### A. At-Grade Crossings

When greenway trails cross a major collector road or higher order facility it is preferred that the crossing occurs at a signalized intersection with a crosswalk or via grade-separated crossing. This may require that the trail be extended a longer distance than would typically be required. Greenway trail crossings at mid-block or at unsignalized intersections shall be evaluated on a case-by-case basis per the North Carolina Pedestrian Crossing Guidance. Final greenway trail mid-block and unsignalized crossing designs shall be approved by Transportation and Engineering staff. Where roadway crossings are approved, a 10 feet wide high-visibility crosswalk with fluorescent yellow-green pedestrian crossing warning signs and downward arrow plaques shall be used. Site-specific supplemental signage and markings may be required.

Where a pedestrian crossing island is deemed necessary per Town engineering review, the island shall be raised, 6 feet minimum width, and 6 feet across to meet Public Right-of-Way Accessibility Guidelines. Angled crosswalks in the median that orient a pedestrian’s attention toward oncoming traffic are preferred.

Crosswalk lighting needs shall be evaluated on a case-by-case basis. Where crosswalk lighting is deemed necessary, luminaires should provide 20 vertical lux at the crosswalk. Luminaries should be placed 10 feet in front of the crosswalk. On two directional roadways without the presence of a refuge median, 2 luminaries (1 on either side of the crossing) shall be provided.

### B. Grade-Separated Crossings

Grade-separated crossings such as pedestrian tunnels and bridges are required when crossing controlled access facilities such as interstates, highways, and railroads. Consideration for grade separated crossings shall also be given when all of the following conditions prevail:

- A significant greenway corridor with high user volumes;
- Crossing of a facility with speed limit of 45 mph or higher;
- Crossing of a facility with 4 or more travel lanes;
- Absence of a signalized crossing within 1,000 feet.

## 908 Retaining Walls

Refer to Section 200 for retaining wall specifications. Building permits for retaining walls must be obtained in accordance with local permitting authorities. Wherever possible, retaining walls should be located outside of Public Greenway Easements. In residential developments, retaining walls which cannot be located outside of the Public Greenway Easement shall be located in a Retaining Wall Easement and shall be privately maintained. All retaining walls shall be installed at the lines, grades, and depths as shown on the approved plans. The base block size shall be commercial grade block. Compact, mini-block, or garden size block is not acceptable. Block retaining walls shall have a cap unit on the top of the wall and shall be integrally tinted medium or dark brown or rust color (per UDO Section 8.1). The selected retaining wall system shall be joined, pinned, and/or secured in accordance with the manufacturer's recommendations. Retaining walls with a vertical drop of 1 foot or more located adjacent to a trail shall provide safety railing per Standard Detail. For retaining walls that require screening with plantings, no plantings shall be located such that they will encroach into the trail or the 2-foot shoulders when plant reaches maturity. Trails shall maintain 2-foot level shoulders free of walls or fencing with a 3:1 or flatter side slope beyond the shoulder to the top of the adjacent retaining wall.

## 909 Greenway Structures

Greenway structures are required to be certified by a North Carolina Professional Engineer and shall include all necessary plan documents with the final Construction Plan set for approval. Working drawings shall be submitted by the manufacturer to the Town for review prior to manufacturing of any pre-fabricated structure.

A Town of Apex building permit must be obtained and approved Construction Plans must be submitted with the building permit application for all greenway structures.

Site soil properties are assumed to support foundation loads. Prior to construction, the contractor shall submit a geotechnical report to the Infrastructure Inspector and building permit authorities, indicating that the soil properties can support the foundation loads.

All required geotechnical reports and a sealed certification from a Structural Engineer (stating that boardwalk and/or bridge structures, including to outside ends of boardwalk approach ramps, were constructed in accordance with sealed designs) shall be submitted to the Infrastructure Inspector prior to Town's acceptance of the structure for maintenance.

All pedestrian structures, underpasses, and tunnels crossing roads owned and maintained by the NC Department of Transportation must receive NCDOT approval prior to beginning any work within the right of way.

All trail overpasses (over roadways and railways) shall meet current AASHTO and ADA standards for slopes per Section 903 F.

## A. Boardwalks & Bridges

Boardwalks and bridges shall be designed in accordance with the AASHTO Standard Specifications for Highway Bridges, current edition. Design Live Load shall be for an AASHTO H5 vehicle with an evenly distributed load of 85 lbs/sqft or a concentrated load of 10,000 pounds at mid-span. Typical maximum longitudinal slope in any direction should not exceed 4 percent. Metal plaques shall be permanently affixed to both ends of structures indicating maximum weight capacity of structure and inside clear width.

Greenway bridges can either be constructed with a pre-engineered laminated beam construction or with structural steel with wooden decking and handrails. Typically, pre-engineered laminated beam bridges shall be utilized at locations that have adequate crane access for installation. Both styles of bridge shall be designed to meet or surpass the design requirements listed below.

Boardwalks and bridges that encroach FEMA floodway or non-encroachment area require a Conditional Letter of Map Revision prior to construction.

1) Clearance
   Abutments shall not be located within the FEMA floodway and shall be located a minimum of 5 feet from the top of the stream bank. Boardwalks/bridges and abutments shall not be located within a sanitary sewer easement where crossing a waterway. In shared utility and greenway corridors boardwalk structures shall be located a minimum of 10 feet from the center of all existing sewer lines, and bridges and abutments shall be located a minimum of 20 feet from the center of all sewer lines. The lowest horizontal component of structures shall be a minimum of 4 feet above normal water level, and shall be above the 25-year storm elevation; elevation above the 100-year storm should be evaluated for feasibility. Minimum pile penetration for piers shall be 10 feet or a depth recommended by a North Carolina Professional Engineer. Illustrate

how high-water levels will pass without damaging bridge. Provide a section of the proposed bridge with the construction documents.

2) Footings and Wing Walls

Footings and wing walls shall be constructed with reinforced concrete as designed and sealed by a North Carolina Professional Engineer. A representative of the Geotechnical Engineer's staff shall approve the footing excavation bottoms prior to constructing bridge footings and placement of rebar and concrete. Tops of footings shall be 2 feet below adjacent creek bed elevation. Rip-rap stone shall be used to armor slopes and protect wing walls for bridge crossings per Standard Detail.

3) Concrete Approach

Approach slabs and everything between slabs shall be included in all required bridge and boardwalk certifications, and shall be considered part of bridge/ boardwalk structure. Bridge and boardwalk railings shall extend 8 feet minimum beyond the ends of bridge/ boardwalk per Standard Detail. Rip-rap stone shall be used to armor slopes for bridge/ boardwalk crossings, including areas around wing walls and end bents to reduce erosion at structures per Standard Detail.

4) Handrails

A handrail shall be installed on the railing of both sides of bridges and boardwalks that exceed a 5 percent running slope (approved only on a case-by-case basis). Handrails shall be designed and located in accordance with ADA and AASHTO requirements. Handrails must be of uniform height, 34 to 38 inches from the finished surface.

5) Materials

All structural members shall have a minimum nominal thickness of material of at least 2 inches. All hardware and fabricated connections shall be hot-dipped galvanized after fabrication in accordance with ASTM A153. Small members shall have pre-drilled holes to prevent splitting during construction. All members shall be screwed or bolted together. Joist hangers shall be galvanized. Treated lumber shall be used and be in accordance with the most current NCDOT Standard Specifications for Roads and Structures (Section 1082). For boardwalks, Southern Yellow Pine, Grade No. 2, shall be used except for top rail and routed handrail which shall be Southern Yellow Pine, Grade No. 1. For bridges Southern Yellow Pine, Grade No. 1, shall be used.

Structural bridge components shall be fabricated from laminating lumber. Laminating lumber shall be Southern Pine Kiln Dried and graded to meet the requirements of Standard Specifications for Structural Glued Laminated Timber (AITC 117). Lumber combination shall be used for identification. Laminated

components shall be per AITC architectural appearance grade. Miscellaneous solid sawn lumber for decking shall be Southern Pine graded in accordance with Southern Pine Inspections Bureau. Preservative treatment for glulam components shall consist of pressure treated laminated lumber (treated prior to gluing) with pentachlorophenol type C in accordance with AITC 109 and AWPA C28. Exterior stringers and all other glulam components shall be 0.6 pcf retention. Solid sawn decking shall be pressure treated in accordance with C2 for above ground use. Laminated lumber handrail posts shall be fastened to the exterior beam with galvanized steel carriage bolts. Handrails must be metal and meet current requirements as stated in the ADA Accessibility Guidelines (ADAAG).

Adhesives shall be wet-use (waterproof) complying with ANSI/AITC A190.1 – latest edition. Each bearing and template shall be fabricated to accommodate 1¾-inch diameter anchor bolt. Anchor bolts shall be aligned longitudinally with the bridge. All steel for bearing connection plates shall be ASTM A36. Minimum yield ($F_y$) shall be greater than 36,000 psi. The manufacturer shall furnish all connecting steel and hardware. Decking shall be secured using stainless steel deck screws. Pre-engineered bridge manufacturer is not responsible for the template, setting plates, or anchor bolts.

6) Fabrication

Workmanship, fabrication, and shop connections shall be in accordance with the latest version of American Institute of Timber Construction and all related Interim Specifications. Bridges may be assembled at the site or at the manufacturer. At the End Bents, the bridge shall be fabricated to produce a 6-inch longitudinal distance from centerline of anchor bolts to end of beam. A 1-inch open joint shall exist between the end of the bridge and the end bent backwall.

7) Bridge Railings and Accessories

Structural bridge railings fabricated from laminated lumber shall have a smooth inside surface with no protrusions or depressions and all members, railings, corners, and ends of lumber shall be sanded smooth and edges eased. Finished railing height shall be 42 inches or higher in high hazard situations. Maximum spacing of railings shall be such that a 3½-inch sphere shall not pass between the members.

8) Finishes

All glulam materials shall receive one factory applied coat of clear penetrating sealer.

9) Delivery and Erection

Bridges or bridge components will be delivered by truck to a location nearest to the site accessible by roads. The contractor shall provide for the installation of anchor bolts to be installed. The information required to develop the template shall include the size, configuration, and spacing of the bolts as they shall be installed in the footing.

10) Quality

The bridge manufacturer shall maintain records assuring that all lumber, bolts, and materials used are in accordance with the material specified and certified by a North Carolina Professional Engineer. A copy of the records shall be provided to the owner. The bridge shall be identified and marked (on both ends) with a permanent metal nameplate showing the manufacturer's name, location, date of manufacture, maximum load carrying capacity, and inside clearance width. Structural materials shall be traceable to the bridge.

11) Pre-Engineered Bridges

The manufacturer shall have 5 years minimum experience in design and fabrication of pre-engineered pedestrian bridges. The design shall be in accordance with the American Institute of Timber Construction, AITC 117-2001, or latest edition, the total bridge dead load applied to the End Bent shall not exceed 37,000 pounds and shall be designed for a minimum wind load of 30 pounds (approximately 120 mph). The wind is calculated on the entire vertical surface of the bridge as is fully enclosed. All bridges shall be designed for seismic loads of the intensity required by local codes. Bridge camber at center of the bridge span shall be a maximum of 2.5 percent of the total bridge span. This should produce a localized deck slope of 12:1. Bridge shall be cambered to offset full dead load deflections. Bridge span shall be defined as the distance from center to center of the bearings. The bridge being designed shall have bearing elevations that are equal. Manufacturer shall provide for one deck plank at each end of the bridge to span the 1-inch gap as described below to prevent debris from falling through the gap. This deck plank shall match the decking of the bridge and shall be installed at the site after the backwall is installed.

12) Pedestrian Rail

Wherever the top grade of the boardwalk decking exceeds 30 inches from finished ground level or any other hazardous drop-off exists, pedestrian rails shall be provided. Where boardwalk decking height is 30 inches or less from finished ground level, a toe-rail may be installed per Standard Detail. Design considerations should be made to avoid multiple transitions between pedestrian rail and toe-rail.

## B. Underpasses, Tunnels, and Culverts

Greenway tunnels shall be 12 feet x 12 feet reinforced cast-in-place concrete structures as specified by NCDOT. Tunnels shall exhibit a 1 percent minimum longitudinal slope; 2 percent maximum cross slope. Headwalls with wing-walls are required at both ends of the tunnel.

Special consideration shall be placed on the drainage design at the entrance to the tunnel. Where necessary trench drains should be incorporated at the tunnel entrance to intercept water from pooling within the tunnel.

Contractor/applicant shall be responsible for coordinating review and approval by NCDOT (where crossing NCDOT roadways) and for obtaining any required encroachment permits prior to beginning any work.

All tunnels shall be lighted. Power meter for tunnel lighting shall be located above the 100-year flood elevation and minimum 10 feet above trail surface.