CITY OF DURHAM ADDENDUM
TO THE NC DIVISION OF WATER QUALITY
STORMWATER BEST MANAGEMENT PRACTICES MANUAL

This addendum shall be used in conjunction with the latest addition of the North Carolina Division of Water Quality *Stormwater Best Management Practices Manual* and its related BMP Manual Errata Sheet to regulate stormwater control measure design, operation, and maintenance. The latest edition of the North Carolina Division of Water Quality *Stormwater Best Management Practices Manual* and the BMP Manual Errata Sheet can be downloaded at the following web address: http://portal.ncdenr.org/web/wq/ws/su/bmp-manual. The addenda noted below are the City of Durham's additions, clarifications, and exceptions to the NC DWQ's stormwater BMP design manual.

Revisions to Existing Chapters in the NC DWQ's Stormwater BMP Manual

CHAPTER 1 INTRODUCTION

- Section 1.3. About This Manual – The City of Durham re-emphasizes this manual does not cover every aspect of engineering and structural design necessary for proper BMP system design and construction. The design professional is responsible for the design and construction of a properly functioning stormwater BMP. The City of Durham requires a licensed North Carolina Professional Engineer to prepare the stormwater impact analysis, calculations, and the stormwater control measure construction drawings when permanent structural stormwater control measures are required for development/redevelopment. Other professionals such as North Carolina Licensed Landscape Architects, Soil Scientists, and Professional Land Surveyors all have specific knowledge which is required for the design, construction, and/or as-built submittal of the stormwater control measure.

CHAPTER 2 NORTH CAROLINA'S STORMWATER REQUIREMENTS

- Section 2.11.2. Master Development Plans – Site plan requirements can be found in the City of Durham Unified Development Ordinance found at http://durhamnc.gov/ich/cb/ccpd/Pages/Durham-Unified-Development-Ordinance.aspx and in Section 1 of the City's *Reference Guide for Development*. The Stormwater Services Section in Durham follows the City/County Planning Department's requirements concerning master plans, site plans, plan amendments, plan revisions, etc.
- Section 2.11.3. Widening Existing Public Roads by Project Developer (not NCDOT) – It is the policy of NCDOT to not allow redirection of runoff from their right-of-ways. Therefore, capturing and treating stormwater from NCDOT maintained right-of-way will only become feasible when the existing point(s) of discharge are amenable for this.

CHAPTER 3 STORMWATER CALCULATIONS

- Section 3.2. Peak Flow Calculations – The City of Durham Code of Ordinances Sec. 70-738 outlines the requirements for peak runoff reduction for the 1-year, 2-year, 10-year, and other design storms. The Rational Method can be used for drainage areas up to 50 acres. Rational runoff coefficients in Section 8.0 of Durham's *Reference Guide for Development (RGD)* shall be used in lieu of Table 3-2. Rainfall intensities from the same section of the *RGD* shall be used in the design calculations.
- Section 3.3. Runoff Volume – Use Table 1 in Section 8.0 of Durham's *Reference Guide for Development* in lieu of Table 3-4 for the hydrologic soil groups of all the soil types in Durham.
- Section 3.8. Nutrient Loading – The City of Durham Code of Ordinances Sec. 70-740 outlines the options for reduction of nutrients in the Jordan Lake, Falls Lake, and the Lower Neuse Basins. The Jordan/Falls Lake Stormwater Load Accounting Tool, which can be found at http://portal.ncdenr.org/web/jordanlake/implementation-guidance-archive shall be used for the nutrient loading calculations.

CHAPTER 4 SELECTING THE RIGHT BMP

- No additions or revisions.

CHAPTER 5 COMMON BMP DESIGN ELEMENTS

- Section 5.5. Forebays – The forebay shall provide a means of drawdown for maintenance where allowed by BMP selected and the topography. A ten feet (10') wide rip rap center section or other approved means can be utilized to dewater the forebay on most wet detention ponds.
- Section 5.6. Earthen Impoundments, Embankments and Dams –
    - Earthen embankments less than 3' which permanently or temporarily impound water are not subject to the City's requirements for dam design other than accessibility concerns as appropriate.
    - All earthen fills shall be cleared, grubbed and stripped of all vegetative material, topsoil, and organic matter prior to construction. Note that full construction specifications are required in accordance with Chapter 21 of this addendum.
    - A cutoff trench (key trench) of a minimum width of five feet (5'), centered on the centerline of the dam, shall be incorporated. The cutoff trench shall extend to a minimum depth of two feet (2'), however in all cases it shall extend into soils suitable for the embankment foundation.
    - Soil materials used for earth fill which are considered permeable or which exhibit significant shrink/swell, shall not be used in the embankment unless a specific detailed design report from a geotechnical engineer is submitted and accepted as part of the plan approval.
    - All embankments shall be methodically back-filled with highly impermeable material and compacted to at least ninety-five percent (95%) of standard proctor density.
    - The minimum top width of the dam shall be ten feet (10') so unimpeded access around the facility can be obtained.
    - An additional five percent (5%) of the design height of an earthen embankment dam shall be added to the top of dam elevation during fill placement to negate future settlement of the embankment and underlying soils.
    - It is recommended from the standpoint of safety, ease of maintenance, and aesthetics that slopes flatter than 3:1 be used around the pond when possible.
    - All disturbed ground areas and embankments surrounding the pond shall have permanent ground cover established in accordance with Durham guidelines prior to final acceptance. Sericea Lespedeza, Weeping Lovegrass and Crown Vetch shall not be incorporated into the ground cover for the dam embankment, as these types of vegetation are difficult to maintain, encourage burrowing animal habitats, and prevent a thorough inspection of the dam embankment.
    - Concrete dams and concrete spillway structures shall be designed and built in accordance with the American Concrete Institute's (ACI) latest guidelines. Particular attention shall be paid to design and analysis, water tightness, concrete quality, and construction practices. Structures shall be designed and constructed to maintain water-tightness by controlling and limiting cracking with proper joint design and spacing.
    - When an earthen dam embankment is constructed within the limits of the 1% Annual Chance Floodplain (also known as the 100-year floodplain), the downstream toe of the embankment fill shall be at or above the 25-year (4% annual chance flood) water surface elevation. This design parameter will reduce the frequency with which flood waters could potentially erode the embankment toe or create a backwater influence on the functioning of the facility. The limits of the 25-year water surface elevation can be found in the detailed flood study for the water feature in question. If a detailed flood study has not been conducted or if the limits of the 4% annual chance flood have not been established, the dam should be located entirely outside of the limits of the 100-year floodplain. It should be noted that the placement of any dam or embankment fill in an established FEMA floodway or non-encroachment area is prohibited.
    - The Dam Safety Law of 1967 (15A NCAC 02K .0201) requires any person who proposes to construct, alter or remove a dam to file a statement with the State Dam Safety Engineer concerning the location of the dam, including the name of the stream and county, height, purpose, and impoundment capacity, at least 10 days before the start of construction. If the State determines that the dam is not exempt from the law, additional requirements in accordance with the Dam Safety Law of 1967 as amended will be imposed.

- Section 5.7. Underdrain Systems – Other types of underdrain pipe can be utilized as long as the pipe has an equivalent or greater area of openings (0.884 in^2/ft), the openings are sized sufficiently to prevent the adherence of minerals and bacteria which will restrict free flow, and the structural integrity will handle all anticipated loading conditions. Non-woven filter fabric shall be used to wrap all gravel jackets around the pipe when choking stone is not required. Pipe socks are not allowed.
- Section 5.8 Outlets –
    - If the outlet structures are anchored by dead weight alone, the buoyant weight shall be used for analysis and the minimum factor of safety shall be 1.15. If structures are anchored to soil or rock, the minimum factor of safety for that portion of the resistance provided by soil or rock anchorage shall be 2.0.
    - All riser structures, including weir wall type structures and flashboard risers, shall be constructed principally of reinforced concrete. Brick/concrete block and mortar type structures will not be accepted. The use of brick/concrete block in some elements of a riser structure may be acceptable. Such proposals will be considered on a case-by-case basis.
    - All riser structures shall be located such that direct access from the dam embankment can be achieved. Riser structures sited completely within the limits of the permanent pool will not be acceptable; at least one side of the riser shall be accessible by foot during permanent pool conditions.
    - To facilitate greater flexibility in regulating the normal pool water surface elevation in a wet pond, a stormwater wetland, or a dry pond with enhanced wetland components, an adjustable water surface regulating drawdown device should be considered.
    - Access shall always be provided to the inside and invert of the riser structure. This can be accomplished best with the provision of a trash rack access hatch or a manhole lid and the provision of steps down the inside face of the riser. When the top of the riser is greater than four feet above the adjacent ground surface, steps up the outside face of the riser shall be provided as well.
    - All impoundments shall have a spillway system with the capacity to pass the 100-year storm flow while providing one foot (1') of freeboard between the theoretical water surface elevation and the top of the dam. Freeboard (stage-storage) calculations shall begin at the elevation of the primary outlet (i.e. top of riser, invert of outlet channel/pipe, etc. as appropriate). The principal spillway shall be sized to convey at a minimum the ten-year design storm. If separate principal spillway and emergency spillway are used then adequate vertical head shall be provided such that the 10-year design storm is conveyed through the principal spillway before the emergency spillway operates.
    - Principal spillway pipes shall be a minimum of 15 inches in diameter, shall be reinforced concrete, and shall have a minimum pipe strength conforming to American Society for Testing and Materials (ASTM) C-76, Class III standards. The rubber gasketted joint pipe shall also be wrapped with a layer of geotextile filter fabric on the outside of the pipe at each joint. The fabric shall meet NCDOT specifications for Type II Filter Fabric. See Section 1056 (Table 1056-1) in the North Carolina Department of Transportation's 2012 Edition of the Standard Specifications for Roads and Structures. The fabric wrap shall be between two and three feet wide, shall be centered over each pipe joint, and shall cover a minimum of one-foot length of each pipe segment.
    - For seepage control around outlet conduits see Addendum section 10.4 for additional requirements for the outlet design concerning impoundments. The minimum riser size shall be four feet in diameter or width and in no case shall the minimum cross-sectional area of the riser section be less than 1.5 times that of the barrel section.
    - Regardless which required pipe end treatment is used at the terminus of the spillway pipe, whether a flared end section or an end wall, a concrete curtain wall a minimum of eighteen inches (18") in depth or to the bottom of the rip rap energy dissipation, whichever is greater, is required. Furthermore, the curtain wall shall be a minimum of six inches (6") in width and shall be integral to the design and construction.
    - Riser structures constructed with multiple barrel sections shall have watertight joints, and each section shall be bolted to adjacent sections with stainless steel straps and hardware.
    - Closed system riser structures (riser structures which outlet into a closed conveyance system) with multiple barrel sections shall have gasketted joints, and each section shall be bolted to adjacent sections with stainless steel straps and hardware.

- Section 5.8.7 - Trash Racks –
    - An underflow type trash guard is preferred over conical type trash guards. Experience has shown underflow type trash guards to be highly effective in preventing clogging and superior in preventing litter and debris from entering the spillway pipe. A hybrid type (partially conical and underflow) has been utilized on many facilities in the City and has proved useful. These are especially useful when large/heavy debris has potential to enter the impoundment area.
    - Top-mounted (overflow) trash racks shall be bolted to the top of the structure with stainless steel hardware. Mounting the trash rack to the riser in shear shall be prohibited.
    - All riser trash racks shall have a locking access hatch with a minimum clear space opening of 2' by 3'and an accepted design life of 75 years.

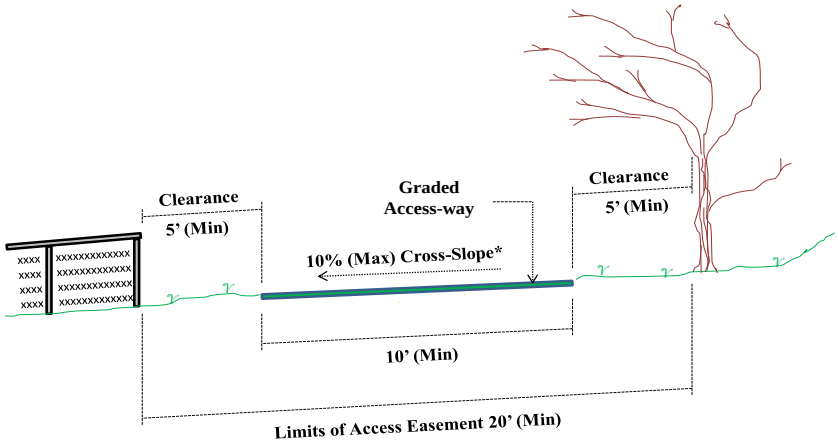
CHAPTER 6 LANDSCAPE AND SOIL COMPOSITION SPECIFICATIONS

- Section 6.4.1. Required Items in a Landscape Plan – Landscape plans shall be prepared by a North Carolina Licensed Landscape Architect. A one year (1 yr.) warranty period is customary and acceptable. This warranty shall be fully transferrable to any subsequent owner upon conveyance of the property prior to its expiration.
- Section 6.4.2. Guidelines for Plant Placement – Trees or shrubs shall not be planted on any portions of water impounding embankments, within their spillways/channels, and the required access and maintenance easement.

CHAPTER 7 BMP INSPECTION AND MAINTENANCE

- Section 7.1. The Importance of Maintaining BMPs – Annual inspection reports by individuals certified by the City of Durham as a BMP Maintenance Certifier (BMC) shall be submitted for each stormwater control measure by its established anniversary date.
- Section 7.2.1. Access and Maintenance Easements – All facilities shall be located on common open space property in residential areas with individually owned dwellings. In no instance shall the easement for the facility encroach upon individual residential lots. On multifamily and other property a blanket easement can be provided in lieu of a prescriptive easement. The easement(s) must provide unobstructed access from a public right-of-way to and around the stormwater control measure for inspections and maintenance. This maintained access to the facility and top of the dam shall be a minimum of 10 feet wide, shall have a maximum centerline grade and cross-slope of fifteen percent (15%) and ten percent (10%) respectively, and shall be placed in a 20-foot wide, cleared access easement (see Access to SCM Detail below). This access easement shall remain free of all trees, shrubs, or other impediments, including fences, mail boxes, and utility structures (i.e., pedestals, boxes, poles, guy-wire systems, etc.). At curb and gutter sections, a concrete driveway apron (or a mountable/roll curb) shall be provided. In ditch sections, a culvert with appropriate fill shall be provided. The principal access to the top of the dam and the riser structure should not cross the emergency spillway. The City may consider the provision of access across the control section of a separate emergency spillway provided that the access is designed with an acceptable traversable surface capable of supporting anticipated maintenance equipment. The side slopes of the spillway shall be no greater than a 5:1 slope when the spillway is to be used as part of the principal access. Retaining walls around the perimeter of an impoundment area shall not prevent adequate access for sediment removal by traditional means. This generally prevents one from providing retaining walls around the entire perimeter.

Access to SCM Detail
(Not to Scale)



CHAPTER 8 LEVEL SPREADER-VEGETATIVE FILTER STRIP SYSTEM

- Note that DWQ and the City will issue buffer authorizations for direct discharge into a stream/river from a stormwater BMP which removes at least 30% TN and 30% TP when the BMP is situated adjacent to or in the buffer and when the channel is adequately protected. This applies regardless of whether the slope and flow from the 1 in/hr storm are exceeded or not.

CHAPTER 9 STORMWATER WETLANDS

- Section 9.4. Construction – Safety Considerations: Fencing is not encouraged or discouraged by the City of Durham, thus it is not a requirement. In considering whether or not to fence stormwater control measures or certain components inherent to them, it is suggested that one consult their attorney and insurance provider as they would with any potentially attractive nuisance. Fencing shall not impede required access, and if a locking gate is provided, a key or more preferably a combination for the lock is required to be provided to the City.

CHAPTER 10 WET DETENTION BASIN

- Required by the NC Administrative Rules, major design element No. 13 – a 2:1 (horizontal to vertical) or flatter slope is required below the shelf unless excavated in rock or unless a retaining wall is provided.
- Section 10.1. General Characteristics and Purpose – Elongation baffles in lieu of appropriate pond length to width dimensions are discouraged and will only be considered if they are cast in place reinforced concrete. No other baffle materials will be considered. The design of the baffles shall include all loading conditions, which includes being struck by construction equipment while performing future sediment removal. Nothing herein shall prevent one from elongating the flow path by incorporating earthen berms in the grading of the facility.
- Section 10.3.3. Pretreatment and Inflow – Having an inlet pipe submerged is highly discouraged due to the need for proper inspections. This will only be considered when physical constraints limit other options.
- Section 10.3.4. Length, Width (Area), Depth, Geometry – The length used to calculate the minimum length to width ratio shall be the shortest distance between any inlet and the primary outlet of the pond.
- Section 10.3.9. Outlet Design – Only reinforced concrete pipe is acceptable for outlet pipes.
- Figure 10-4 – In lieu of the screw type plug in the top of the "T" type trash guard use a PVC cap and drilled hole to match the bottom of the trash guard.
- Section 10.3.11 – Safety Considerations: See Section 9.4 above.

- Section 10.4. Construction – Seepage control around conduits within the dam shall be incorporated.
    - Anti-seep collars can be utilized on all impoundments with very low head at normal water level, five feet (5') or less. All anti-seep collars shall form a watertight connection with the principal spillway barrel. The anti-seep collars shall extend a minimum of two feet (2') beyond the outlet barrel and increase the hydraulic length of travel by at least fifteen percent (15%). The collars shall be spaced no closer than 10' and no further than 25' apart. A minimum of one collar shall be located downstream of the centerline of dam.
    - Articulating concrete cradles and a drainage diaphragm are required where the normal water level is or has the ability through prolonged clogging to be deeper than five feet. Concrete for the cradle shall have a 28-day compressive strength of 3,000 psi. The concrete for the cradle shall be consolidated primarily by internal vibration, and shall be finished "rough" so as to achieve a more adequate bond between the concrete in the cradle and the first lift of structural fill. Cradles constructed of other materials, such as flowable fill, may be considered on a case-by-case basis.
    - Where filter diaphragms are required (when the normal water depth is greater than 5'), the diaphragms must be designed specific to the adjacent soils used within the embankment and in accordance with current accepted engineering practices. A multi-stage sand and gravel filter which outlets through an internal drainage system is the industry standard. The outlet for the internal drainage system shall be visible and protected by an appropriate rodent guard. For filter diaphragm design refer to Chapter 45 "Filter Diaphragms", National Engineering Handbook Part 628 published by the Natural Resources Conservation Service. For the gradation requirements of a sand and gravel filter diaphragm design one should refer to Chapter 26 "Gradation Design of Sand and Gravel Filters, National Engineering Handbook Part 633 published by the Natural Resources Conservation Service.
    - The use of filter fabrics to replace graded filters is not allowed in any location within a dam except where repairs can be made easily, safely and relatively inexpensively, such as a downstream toe drain.
    - Eliminating a conduit through the embankment eliminates the requirement for seepage control around it.

CHAPTER 11 SAND FILTERS

- Section 11.3.5. Length, Width and Geometry – The maximum amount of head allowed over the top of the sand is four (4) feet. Underground sand filters, excludes buried trench or Delaware type, shall have a requirement of five feet (5') of clearance between the top of the sand bed and the roof of the underground sand filter.
- Figures 11-2a and 11-2b - In any construction drawings submitted, the equivalents of both of these figures shall show a perforated pipe extending the length of the sand filter chamber and not merely just a solid pipe stubbing into it. Furthermore, the perforated underdrain pipe shall be designed per the standards outlined in Section 5.7.
- General – All underground sand filters, excludes buried trench or Delaware type, shall include access hatches, including Bilco® doors, similar to that of an underground detention system (Chapter I).

CHAPTER 12 BIORETENTION

- Figure 12-3c – Detail shall include a 4" washed sand and 2" of #8 or #89 washed choking stone layers between the media and gravel layer. It shall also note that 18" of separation is needed between the elbow outlet and surface when placed in Group C & D soils.
- Section 12.3.5. Step 5: Determine the Soil Media Depth –
    - Soil media shall be a minimum of 30 inches deep for grassed bioretention cells. Choking stone shall be used instead of filter fabric.
    - Section 12.3.6. Step 6: Size the Underdrains – Clean out pipes must be provided at the end of each collection lateral and shall extend to the elevation of the top of the ponding depth.

CHAPTER 13 BMP TOOLBOX FOR PUBLIC AIRPORTS

- No additions or revisions

CHAPTER 14 GRASSED SWALE

- No additions or revisions

CHAPTER 15 RESTORED RIPARIAN BUFFER

- No additions or revisions

CHAPTER 16 INFILTRATION DEVICES

- This type of BMP has no application in the City of Durham based upon soil types.

CHAPTER 17 DRY EXTENDED DETENTION BASIN

- Section 17.3.5. Length, Width, Depth and Geometry – The length used to calculate the minimum length to width ratio shall be the shortest distance between any inlet and the primary outlet of the pond.
- Section 17.3.7. Plant and Landscape Requirements – A wet meadow or wetland seed mixture is required for the basin floor. The basin floor shall be over excavated six inches (6") in order to accommodate this. The bottom of the basin should not be mowed.

CHAPTER 18 PERMEABLE PAVEMENT

- Section 18.3.5. Design Step 5; Conduct In-situ Soil Testing – A licensed North Carolina Soil Scientist shall determine the infiltration rate of the soil as well as the elevation of the seasonal high water table.
- Durham does want to remind one that elevated decks constructed out of wood that bear foot traffic are not considered impervious. *Soft paving* materials such as mulch and other organic materials placed upon earth do not count as impervious area. Lastly, *porous turf*, used with flexible reinforcements (such as Grasspave^2) installed strictly in accordance with the manufacturer's guidelines could have application for non-required temporary parking, possibly fire lanes, etc. This type of grass cover, if applied for infrequent events that allow the grass time to regenerate between uses, is not considered impervious cover. However, it would still be required to be permitted and as-builted.
- Design engineers should remember that, due to the high percentage of Triassic Basin clay/HSG D soils, the opportunities for permeable pavement designed for infiltration are more limited in Durham than elsewhere.

CHAPTER 19 ROOFTOP RUNOFF MANAGEMENT

- No additions or revisions

CHAPTER 20 PROPRIETARY SYSTEMS

- One additional proprietary device is allowed in limited circumstances within the City of Durham. Guidelines for its use are as noted:

  Filterra® Units (http://www.filterra.com/)

1. Typically, since the Filterra® unit has not been approved for use in North Carolina by the North Carolina Division of Water Quality (NCDWQ), it should be used in the City of Durham only as a last resort in a retrofit or redevelopment scenario, where existing infrastructure severely limits the ability to implement a more conventional SCM such as a sand filter, a bioretention area, or a rainwater harvesting system. As such, the suitability of the use of a Filterra® unit shall be evaluated by the City of Durham on a case-by-case basis. Note that, at this time, City of Durham ascribed treatment efficiencies for the Filterra® unit shall be those of a bioretention area without an IWS zone.
2. Filterra® units must be designed (e.g., sized and configured) according to manufacturer specifications and guidelines. Plans must include the standard details recommended by the manufacturer. In particular, plans and design documents need to demonstrate that all Filterra® units have been sized per the manufacturer specifications for the drainage areas to be routed to the units.
3. Plans MUST show Filterra® Top of Curb (TC) and Flow Line (FL) spot elevations and also bypass TC (where applicable) and bypass FL spot elevations.
4. The Filterra® TC and FL elevations MUST be higher than the bypass TC and FL elevations for effective bypass.

5. Filterra® invert elevations must be shown (3.5' below TC).
6. Positive drainage of each Filterra® unit's effluent treatment pipe is required to prevent free standing water from accumulating in the system or underdrain. Plans must show effluent treatment pipe inverts.
7. The outlet drain pipe must be sized correctly per manufacturer requirements, and must exit perpendicular to the Filterra® wall.
8. Plantings allowed in the Filterra® units within the City maintained right-of-way are included in Tables 20-1 and 20-2. Note that some trees require the use of the Filterra® street tree-design box with holes on three sides for toot expansion.

Table 20-1

Filterra® Street Trees

Species	Cultivar	Common name	Availability	Notes
*Acer truncatum**	Any	Purpleblow or Shantung Maple	Limited, but improving	New cultivars being developed in NC nurseries
Acer palmatum	Numerous	Japanese Maple	Common	One of the larger/upright varieties (not weeping or mounding)
*Acer buergeranium**	*"Valynor"", "Aeryn" (upright varieties)*	*Trident Maple*	*Common*	
*Taxodium distichum**	"Peve Minaret"	"Peve Minaret" baldcypress	Limited	Available from Bold Spring Nursery
Lagerstroemia x indica	"Muskogee", "Dynamite", "Hardy Lavender", "Lipan", "Miami", "Biloxi", or "Byers Standard Red"	Crepe Myrtle	Common	Single stem only. Needs full sun
*Carpinus caroliniana**	Not applicable	Hornbeam, Ironwood or musclewood	Limited, but improving	
*Ostrya virginiana**	Not applicable	American hophornbeam	Unknown	
Cercis chinensis	"Avondale"	Chinese redbud	Limited	single-stem
Cercis canadensis var texensis	"Oklahoma", "Texas white", "Merlot"	Texas redbud	Limited, but improving	
Chionanthus retusis	Any	Chinese fringetree	Limited, but improving	Upright cultivars preferred
Cercis canandensis	"Forest Pansy"	Eastern Redbud		
Amelanchier arborea or laevis		Serviceberry		

*** Requires Filterra® street tree-design box**

Table 20-2

Filterra® Street Shrubs

Species	Cultivar	Common name	Notes
Viburnum davidii		David Viburnum	Sun to shade; Low-mounding; acid-loving; good in borders, as foundation planting.
Buxus microphylla var. japonica	"Winter Gem" or "Green Gem"	Japanese boxwood	Partial shade; More heat and nematode resistant than species.
Buxus sempervirens hybrid	"Green Mountain"	English Boxwood	Partial shade; Supposedly do not discolor much in winter.
Euonymus japonica 'Microphyllus'		Dwarf Japanese Euonymus	Sun to shade; Smaller-leaved variety.
Ilex cornuta 'Carissa'		Carissa holly	Sun, partial shade
Ilex cornuta 'Rotunda'		Rotunda holly	Sun, partial shade
Ilex crenata cultivars	"Compacta", "Green Luster", "Helleri", "Hoogendorn" and other dwarf hybrids	Dwarf Japanese holly	Sun to partial shade; Many of these are slow growing and may eventually need pruning to maintain low height.
Ilex vomitoria	Low hybrid cultivars (10+ available)	Yaupon holly	The Yaupon hollies should be the low-growing cultivars, usually a version of *Ilex vomitoria* 'Nana'
Ilex glabra 'Chamzin'		Nordic™inkberry holly	Sun, partial shade; Compact; hardy; good hedge plant.
Ilex glabra 'Compacta'		Compact inkberry holly	Sun, partial shade; Slow-growing, good hedge plant, can easily be maintained at 2 feet or taller.
Nandina domestica cultivars	"Compacta", "Sunray/Greray", "Gulf Stream", "Fire Power", "Wood's Dwarf"	Dwarf nandina	Sun, partial shade; Species under watch as invasive; cultivars with few or no berries are allowed.

CHAPTER 21 BMP CONSTRUCTION TECHNIQUES (FUTURE CHAPTER)

- Designers are required to specify all material types which are permanently incorporated into a project as well as all construction techniques required to achieve an acceptable product. There are many recognized sources for construction materials and specifications, some of the most widely used are the American Society for Testing and Materials (ASTM), the North Carolina Department of Transportation (NCDOT), and the Construction Specifications Institute (CSI).

CHAPTER 22 STORMWATER MANAGEMENT PLANS: SUBMITTAL REQUIREMENTS

- Plan submittal requirements can be found in the City of Durham Unified Development Ordinance and *Reference Guide for Development.*

APPENDIX A

- See additional links for stormwater and environmental related information on the City of Durham website at the web address: http://durhamnc.gov/ich/op/pwd/storm/Pages/SWDevReview.aspx

APPENDIX B

- No additions or revisions

APPENDIX C

- The City of Durham requires the stormwater control measure(s) and its access and maintenance easement to be platted.

New Chapters added to the NC DWQ's Stormwater BMP Manual

CHAPTER I UNDERGROUND DETENTION SYSTEMS

A. System Requirements (General)

1. Underground detention systems in Durham have evolved greatly over the past decade and many proprietary products are available for use in addition to the standard large diameter pipe configurations. Whichever product/material is used for detention it shall have a minimum design life of 75 years and provide for adequate access and maintenance. This shall mean that the detention structure shall have a minimum of a 60" vertical dimension.

2. Unobstructed maintenance vehicle access from a nearby public or private right-of-way (i.e., road, parking lot, etc.) shall be provided to the control structure and to all inlets for the underground detention system.

3. At a minimum, manhole access shall be provided at each end or each corner of the system depending upon layout. All access manholes shall be reinforced concrete manholes conforming to North Carolina Department of Transportation (NCDOT) Roadway Standards.

4. Spacing of the storage pipes or components shall be to manufacturer specifications.

5. Traffic bearing cleanouts shall be provided at 100-foot intervals, with a minimum of two provided in each pipe run or one provided for each 1000 sf of surface area or fraction thereof and one at each corner for non-linear configurations. Manhole access structures may be counted as cleanouts.

6. A Bilco® door (or an approved equivalent) shall be placed at the inlets and at the control structure for the underground detention system. If these access points occur in areas subject to vehicular traffic, the doors shall be of the traffic-bearing type.

7. The system shall remain water tight for the maximum hydrostatic pressure, calculated on the upstream side of the control structure, experienced during the 10-year storm event. This requirement can be satisfied by complying with one or both of the following evaluation methods:

a. Demonstrate, by manufacture certification and test results, that the underground detention system has been tested and shown to meet an acceptable water tightness standard as governed in the product design.

b. Plug or block all orifices and weirs that would activate during a ten-year storm, shut-off any pumps associated with the device, wait for a couple of storm events to fill up the device, measure the depth of water in the device, and then measure the depth of water in the device after 24 hours. If no appreciable water-loss (less than 1% by volume) has been measured/observed, the device will be deemed water-tight. If,

however, greater than 1% of the captured volume has been lost in 24 hours, the storage tanks shall be fixed such that compliance with this requirement has been achieved.

8. A bypass or emergency spillway (i.e., weir wall, etc.) is to be sized to safely convey the 100-year, 24-hour, post-development storm event. Where the outlet for the underground detention system discharges into a closed system, a bypass (of storms in excess of the appropriate design event) upstream of the system will be required. In fact, the best way to accomplish this is to design the underground detention facility as an offline system.

9. The entire underground detention system shall be contained in an access & maintenance easement. The limits of the easement shall be located a minimum of 10 feet from the outside face of any structural component associated with the facility plus an additional one foot for every one foot of depth over 5 feet. For example, the limits of the easement for a 10-foot deep underground detention system shall be located 15 feet from the structure. It should be noted that the easement shall be kept free and clear of all structural encroachments and all landscaping except grass and shallow-rooted shrubbery.

10. Underground detention systems shall not be permitted in residential areas where individual dwellings are owned and where a HOA will be financially responsible. An exception to this would be for high rise condominiums. Even with high rise condos the City asks that other viable options (i.e. green roofs, above ground cisterns, etc.) are exhausted prior to proposal. In other areas, such as schools, daycare centers, etc., all access shall have locking doors.

B. Maintenance and Annual Certification

1. All underground detention SCMs shall be maintained in accordance with the specific recommendations and requirements contained in the Operation and Maintenance Manual prepared for each facility and in accordance with the general recommendations contained in "The Owner's Maintenance Guide for Stormwater SCMs Constructed in the City of Durham." This document can be found on the Stormwater Services page on the City of Durham website.

2. All underground detention SCMs shall be certified annually in accordance with the City's BMC Program and the City's Annual BMP Maintenance Certification Protocol. These documents can be found on the Stormwater Services page of the City of Durham website.

CHAPTER II RAINWATER HARVESTING SYSTEMS

1. Minimum Requirements for Credit: To achieve a pollution removal/extraction credit, a rainwater harvesting system (cistern) installed in the City, must meet the following minimum criteria:

   a. The storage tank(s) and delivery system(s) for the cistern must be capable of capturing the runoff from the first inch of rainfall, multiplied by a factor of safety of 1.2, and of delivering this harvested rainwater to a "clear and dedicated use" within two to five days of capture. In some instances, a dosing time of harvested rainwater that far exceeds five days may be appropriate. Such design proposals will be considered on a case-by-case basis. For help in modeling a cistern, it is suggested that the water harvesting model developed by NCSU be used. There appear to be multiple ways in which a cistern can be modeled fairly simply, and the NCSU model, while useful, may not be suitable in all instances. The NCSU model and user's manual, however, are available and can be downloaded from the following webpage: http://www.bae.ncsu.edu/topic/waterharvesting/ .

   b. The initial inflow system (that which directly conveys rainfall runoff to the storage tanks) must include a heavy-gage debris screen with a reinforced mosquito screen below it to screen out trash, debris, and grit as well as to mitigate against the entry of mosquitoes into the storage tanks.

c. The storage tanks must include an overflow system that allows inflow volumes in excess of system capacity to discharge, non-erosively, into a grassed or natural area, a downstream storm system, a downstream SCM, or a downstream storm system that drains to an SCM when additional peak flow attenuation is required. The overflow mechanism should be fitted with a reinforced mosquito screen. Where overflows are routed to a downstream SCM, the design storage sizing calculations need not incorporate the drainage area to the cistern. Downstream spillways, culverts, swales, bypass channels, SCMs, etc., which are proposed to convey or manage cistern overflows must include the overflow rate in the conveyance calculations of the device or conveyance.

d. A "clear and dedicated use" for the captured rainwater must be demonstrated conclusively by the design professional in the site plan submittal documents. Examples of such clear and dedicated uses include the following: spray irrigation of ball fields, landscaped areas, or natural areas; toilet flushing; car washing; chiller cooling; etc. The dedicated use shall be a key component of the operation and maintenance agreement, which is to be executed by the owner of each proposed cistern during the construction drawings approval process. It should be noted that some "dedicated uses" may require approval by the North Carolina Department of Health and Human Services.

e. Direct connection of a potable water supply to the cistern demand plumbing line is prohibited. Where backup potable water is desired to ensure minimum water needs, the provision of an air gap and/or a backflow preventer and/or a two-stage float valve at the terminus of the potable discharge into the cistern storage tank is recommended and may be required.

2. Pollution Removal/Extraction Crediting: Cisterns that meet the aforementioned minimum criteria shall be granted nutrient treatment credits based on the volume reduction calculated through an annual water balance analysis minus a straight 5% for a factor of safety. As an example, if an annual water balance analysis concludes that there will be a 70% volume reduction, 65% will be allowed to be entered into the Jordan/Falls Stormwater Load Accounting Tool. Any period of time the system will be offline for needed/required shutdowns, such as winter or maintenance, must be accounted for in the analysis.