North Carolina Department of Environment and Natural Resources

Pat McCrory
Governor

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Secretary

MEMORANDUM

TO: ENVIRONMENTAL REVIEW COMMISSION
The Honorable Brent Jackson, Chairman
The Honorable Mike Hager, Co-Chairman

FROM: Brad Knott
Deputy Director of Legislative Affairs

SUBJECT: Final Report on Minimum Design Criteria for Stormwater Management

DATE: February 6, 2015

Pursuant to S.L. 2013-82 and amended by Senate Bill 734, the Department shall submit interim reports on its progress in developing the Minimum Design Criteria to the Environmental Review Commission no later than September 1, 2014 and December 1, 2014 and its final report by February 1, 2015. The attached report satisfies the final reporting requirement.

If you have any questions or need additional information, please contact me by phone at (919) 707-9335 or via e-mail at neal.robbins@ncdenr.gov.

cc: Tom Reeder, Assistant Secretary for Environment
Jennifer Hoffman, Fiscal Research Division
Tracy Davis, Director, Division of Energy, Mineral, and Land Resources

NC Department of Environment and Natural Resources

Division of Energy, Mineral, and Land Resources

Final Report on the Development of Minimum Design Criteria for Stormwater Management Pursuant to the Requirements of S.L. 2013-82 and S.L 2014-120

February 1, 2015

Since March 2014, the Minimum Design Criteria (MDC) Team has worked diligently to meet the regulatory requirements associated with Session Law 2013-82 (House Bill 480). This law requires DENR to convene a stakeholder team that includes industry experts, engineers, environmental consultants, faculty from the University of North Carolina and other stakeholders to develop MDC for stormwater management.

In summary, the Session Law 2013-82 tasks the MDC Team with the following:

1. To consult with DENR in developing MDCs that encompass all requirements for siting, design, construction and maintenance of stormwater BMPs. The MDCs shall be developed with the goal of generating state stormwater permits that comply with state water quality standards. DENR shall submit its recommendations to the Environmental Review Commission by September 1, 2014. (Session Law 2014-120 extended this deadline to February 1, 2015 with progress reports due to the ERC by September 1, 2014 and December 1, 2014)

2. To consult with the N.C. Environmental Management Commission (EMC) in developing a fast-track permitting process for issuing state stormwater permits without a technical review when all best management practices comply with all MDCs and the permit application is prepared by a qualified individual. The EMC shall adopt a fast-track permitting rule no later than July 1, 2016.

The MDC stakeholder team is comprised of 25 members who represent environmental consultants, the construction industry, local governments, university faculty, environmental groups, soil scientists, landscape architects, DOT and DENR. (See Appendix A for a list of team members.) The team has met for three to five hours once a month since March 2014 and has invested time between each meeting reading and preparing comments.

Despite the broad composition of the team, team members have been successful in reaching consensus and it has been a great opportunity to review and update stormwater design standards with a diverse and knowledgeable group of experts. In many cases, the work products of the MDC Team remove outdated design standards that are no longer believed to protect water quality. The efforts of the MDC Team are documented on the MDC Team web site at: http://portal.ncdenr.org/web/lr/state-stormwater/mdc-team.

Achievements of the MDC Team

The first achievement of the MDC Team was the approval of a charter to establish procedures and protocols. The second was to define "Minimum Design Criteria" (MDC) and several other terms that clarify the role that a design practice might have in addressing water quality standards:

- *Minimum Design Criteria (MDC):* Design standards that must be met to ensure that a stormwater treatment system functions in perpetuity to protect water quality standards and achieves the pollutant removal rates associated with the system. The MDC apply to stormwater treatment systems regardless of the geographical location of the system, the stormwater program requirements to which it is subject or whether the system is being reviewed under the fast-track or regular review process. Additional supplemental design standards (described below) may also be implemented to address watershed-specific concerns. The design standards to be adhered by are to be based on state statute or NC Administrative Code.
- *Recommendation:* Design standards that the MDC Team considers to be a good idea but are not required by statute or rule to obtain a stormwater plan approval. Recommendations do not play any part in permitting decisions; they are just suggestions for designers to consider and use or discard as they deem appropriate.
- *Nutrient Design Criteria:* Supplemental design standards in addition to the MDC to increase the Total Nitrogen (TN) and Total Phosphorus (TP) pollutant removal rates associated with the device. Each nutrient design criteria will have an associated increase in TN and TP reduction for the device.
- *Bacteria Design Recommendation:* Supplemental design recommendations in addition to the MDC to optimize the device's effectiveness in reducing bacteria concentrations in stormwater. (Note: The larger design storm required for SA waters is one means for addressing removal of bacteria.)

- *Temperature Design Recommendation:* Supplemental design recommendations in addition to the MDC to optimize the device's effectiveness in reducing temperature impacts from stormwater.

The MDC Team has completed MDC for the following:

- General MDC for all Stormwater Control Measures
- Wet ponds
- Stormwater wetlands
- Infiltration systems
- Bioretention cells
- Level spreader-vegetated filter strips
- Sand filters
- Disconnected impervious surfaces
- Permeable pavement
- Rainwater Harvesting
- Green Roofs

The list of MDC is included in Appendix B.

The Next Steps

DEMLR staff is incorporating the MDC into two important products:

- Updates to the DENR Stormwater Guidance Manual so that it is consistent with the MDC developed by the MDC Team.
- Rule-making to codify the MDC into the 15A NCAC 2H .1000 rules, which govern the design, construction and maintenance requirements for stormwater control measures.

The MDC Team is aware of DEMLR's efforts to update the Stormwater Guidance Manual and the 15A NCAC 2H .1000 rules. Team members have been invited to provide input in both of these processes.

Beginning in February 2015, the MDC Team will commence with developing a fast-track permitting process for issuing state stormwater permits with a minimized technical review when all best management practices comply with all MDCs and the permit application is prepared and certifed by a qualified individual. As a part of this process, the team will also better define compliance with the stormwater regular review process to determine what the

baseline compliance requirements are and how these baseline requirements will be addressed in the fast-track process.

DEMLR staff have begun discussing the rule-making process with both the DENR rule-making coordinator as well as staff attorneys for the Rules Review Commission. Based on these discussions, staff have drafted the following rule-making process for the fast-track program:

Jul 8, 2015	WQC approves rule text
Jul - Oct 2015	DEMLR develops fiscal note
Nov 1, 2015	OSBM certifies fiscal note
Nov 12, 2015	WQC (30 day wavier) / EMC approves rule & fiscal note
Nov 20, 2015	DEMLR's files rule & fiscal note in Register
Dec 15, 2015	Comment period begins (hearing after 12/29)
Feb 16, 2016	Comment period ends
June 2016	WQC (30 day waiver) / EMC adopts rule

DEMLR staff presented the progress of the MDC to the EMC's Water Quality Committee on November 12, 2014, so they are aware of the process and the proposed timeframe for rule-making.

Appendix A: MDC Team Membership

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Eng = Engineering/design community
Con = Construction
Env = Environmental Group
Ac = Academia
HBA = Home Builder's Association
LG = Local government
LA = Landscape Architect
Soil = Soil Scientist

Appendix B: Completed Minimum Design Criteria

GENERAL MDC FOR ALL STORMWATER CONTROL MEASURES (SCMs):

(1) SIZING. The required treatment volume shall take into account the runoff at the ultimate build-out potential from all surfaces draining to the system. Drainage from off-site areas may be bypassed.

(2) REQUIRED TREATMENT VOLUME. The required treatment volume for a development shall be calculated using one of the following methods:

   i. The post-development runoff volume computed using the Simple Method with a design storm depth of, the 1-year, 24-hour storm in SA waters, 1.5" in Coastal Counties and 1.0" elsewhere;

   ii. The difference between pre- and post-development runoff volume computed using the Natural Resources Conservation Service (NRCS) Curve Number Method with a design storm depth of the 1-year, 24-hour storm in SA waters and the 90th percentile storm depth elsewhere; or

   iii. Another engineering method if it is demonstrated to provide equivalent protection as (i) and (ii) above.

(3) SHWT. SCMs shall not include an outlet structure that is set more than six inches below the SHWT unless it can be demonstrated that the device will not dewater waters of the state and that the design volume of the SCM will not be compromised by groundwater inflow.

(4) CONTAMINATED SOILS. SCMs that infiltrate stormwater shall not be located on or in areas with currently contaminated soils.

(5) SEPTIC DRAINFIELD: SCMs shall not be sited in the initial septic drainfield or in the designated repair area.

(5) SIDE SLOPES. Side slopes stabilized with vegetative cover shall be no steeper than 3:1 (horizontal to vertical). Retaining walls or hardened slopes may be steeper than 3:1. Steeper vegetated slopes may be considered on a case-by-case basis provided that the applicant demonstrates that the soils and vegetation will remain stable in perpetuity.

(6) EROSION PROTECTION. The areas receiving flow from the inlet and outlet devices shall be protected from erosion resulting from stormwater discharges.

(7) EXCESS FLOWS. SCMs shall include an overflow or bypass device for inflow volumes in excess of the design volume, or, if applicable, the peak attenuation volume.

(8) DRAWDOWN DEVICES. All drawdown devices shall be designed to prevent clogging.

(9) DEWATERING. SCMs shall be designed with a device to draw down any water that is designed to pond water or that has the potential to pond water if soil media becomes clogged.

(10) CLEAN OUT AFTER CONSTRUCTION. SCMs impacted by sedimentation and erosion control during the construction phase shall be cleaned out and converted to their approved design state.

(11) COMPLIANCE WITH OTHER APPLICABLE REGULATORY PROGRAMS. Siting and design of SCMs shall comply with all applicable requirements under General Statutes 143-214.1, 143-214.7, and 143-215.3(a)(1).

(12) EASEMENTS. All SCMs except for those located on single family lots shall be located in recorded easements and shall have recorded access easements to the nearest public right-of-way. These easements shall be granted in favor of the party responsible for operating and maintaining the stormwater management system. On residential lots, the plat shall include a note that an SCM will be used on the property with a typical detail attached.

(13) OPERATION AND MAINTENANCE. An operation and maintenance (O&M) plan shall be provided for every SCM. An O&M plan shall cover all SCM components, including the perimeter of the device, inlet structure, pretreatment measures, main treatment area, outlet structure, vegetation, and discharge point. An O&M plan shall indicate the steps that shall be taken and who shall be responsible for restoring a stormwater system to design specification if a failure occurs. O&M plans shall include an acknowledgment by the responsible party and shall be signed and notarized. O&M plans shall be recorded on the plat.

MDC FOR INFILTRATION SYSTEMS:

(1) SEPARATION FROM THE SHWT. The bottom of infiltration systems shall be a minimum of two feet above the SHWT. However, the separation can be relaxed to one foot if the applicant proves that the water table will subside to its pre-storm elevation in five days or less.

(2) SOIL SUBGRADE SURFACE. The surface of the soil subgrade shall have a slope of less than or equal to two percent (level). Terraces and baffles may be installed to achieve a level subgrade.

(3) PRETREATMENT. Pretreatment devices shall be provided to prevent clogging, except for stormwater conveyed from a rooftop. Pretreatment devices may include measures such as sumps in catch basins, gravel verges, screens on patio drains, filters, filter strips, grassed swales and forebays.

(4) DRAW DOWN TIME AND SOIL INVESTIGATION. Infiltration systems shall be designed to completely dewater the design volume to the bottom of the infiltration device within 72 hours. A site-specific soil investigation shall be performed to establish the hydraulic properties and characteristics of the area in which the infiltration device will be sited.

(5) PLACEMENT OF INFILTRATION MEDIA. In-situ soils may be removed and replaced with infiltration media or infiltration media may be placed on top of in-situ soils if the applicant demonstrates that the modified soil profile allows for drainage of the design volume within 72 hours.

(6) OBSERVATION WELL. For infiltration devices located under the ground surface, a minimum of one inspection port shall be provided. Observation wells shall be capped.

MDC FOR BIORETENTION CELLS:

(1) SEPARATION FROM THE SHWT. The bottom of bioretention cells shall be a minimum of two feet above the SHWT. However, the separation can be relaxed to one foot when the applicant can prove that the water table will subside to its pre-storm elevation in five days or less.

(2) MAXIMUM PONDING DEPTH FOR DESIGN VOLUME. The maximum ponding depth for the design volume shall be 12 inches above the planting surface.

(3) PEAK ATTENUATION DEPTH. Bioretention cells may store peak attenuation volume at a depth of up to 24 inches above the planting surface. The peak attenuation outlet shall be a maximum of 18 inches above the planting surface.

(4) MEDIA DEPTH. The minimum depth of the media depends on the design and the receiving stream of the cell as follows:

i. Grassed cells with no internal water storage if the receiving water is class B, C, SB or SC with no supplementary classification: 18 inches;

ii. All other grassed cells with no internal water storage: 24 inches; or

iii. All tree/shrub cells and grassed cells with internal water storage: 36 inches.

(5) MEDIA MIX. The media shall be a homogeneous soil mix with approximate volumes of: 75 to 85 percent medium to coarse washed sand (ASTM C33), 10 percent fines (silt and clay), and 5 to 15 percent organic matter (such as pine bark fines). If total nitrogen is the target pollutant, it is recommended to use 10 to 15 percent fines in the media mix.

(6) MEDIA P-INDEX. The phosphorus index (P-index) for the media shall not exceed 30 in NSW waters and shall not exceed 50 elsewhere.

(7) NO MECHANICAL COMPACTION. The media shall not be mechanically compacted. It is recommended to either water it or walk on it as it is placed.

(8) MAINTENANCE OF MEDIA. The bioretention cell shall be maintained in a manner that results in a drawdown of at least one inch per hour at the planting surface.

(9) PLANTING PLAN. The planting plan shall be designed to achieve 50 percent coverage with either canopy, ground cover, or a combination of canopy and ground cover at five years after planting. If sod is used, then it shall be a non-clumping, deep-rooted species.

(10) UNDERDRAIN. An underdrain with internal water storage shall be installed unless it can be demonstrated that the in-situ soil infiltration rate is two inches per hour or greater immediately prior to the initial placement of the media. The internal water storage zone shall extend to a minimum of 18 inches below the planting surface.

(11) MULCH. For tree/shrub bioretention cells, double or triple shredded hardwood mulch shall be used for the portion of the cell that will be inundated. Mulch shall be uniformly placed two to four inches deep.

(12) CLEAN-OUT PIPES. At least one clean-out pipe shall be provided on each underdrain line. Clean out pipes shall be capped.

MDC FOR WET PONDS:

(1) PERMANENT POOL SURFACE AREA AND VOLUME. The permanent pool shall be sized using either:
   i. The Hydraulic Retention Time (HRT) Method;
   ii. The SA/DA and Average Depth Method; or
   iii. Another engineering method if it is demonstrated to provide equivalent protection.

(2) PERMANENT POOL DEPTH. The minimum depth of the permanent pool above the sediment storage elevation shall be three feet. The maximum depth of the permanent pool shall be 20 feet.

(3) SEDIMENT STORAGE. The forebay and main pool shall have a minimum sediment storage depth of six inches.

(4) LOCATION OF INLET AND OUTLET STRUCTURES. The inlet and outlet structures shall be located in a manner that avoids short circuiting.

(5) PRETREATMENT. A forebay shall be included; its volume shall be approximately 20 percent of the total permanent pool volume, leaving approximately 80 percent of the volume in the main pool. The water flowing over or through the separation structure shall be at a non-erosive velocity.

(6) VEGETATED SHELF. The pond shall be designed to provide for a vegetative shelf around the perimeter of the basin. This shelf shall be no steeper than 6:1 (horizontal to vertical) and shall consist of native vegetation. The minimum width shall be six feet.

(7) DRAWDOWN TIME. The design volume shall draw down to the permanent pool level between two and five days.

(8) DISCHARGE RATE. The pond shall discharge the storage volume at a rate equal to or less than the predevelopment discharge rate for the one-year, 24-hour storm. (Note the MDC team is still investigating this issue.)

(9) FOUNTAINS. Fountains shall be designed such that they do not resuspend sediment or cause erosion in the pond.

(10) TRASH RACK. A trash rack or other device shall be provided to prevent large debris from entering the outlet system.

(11) VEGETATION. The following criteria apply to vegetation in and around the wet pond (Note: The MDC Team is still studying this item.):
   i. Trees and woody shrubs shall not be planted on the dam structure;
   ii. Wet ponds should incorporate a minimum of three diverse species of herbaceous vegetation on the vegetated shelf;
   iii. A minimum of 50 plants per 200 square feet of shelf area shall be planted;
   iv. Turf grass shall be provided on the tops of berms and on the exterior slopes of containment berms; and
   v. Weeping love grass shall not be used on the vegetated side slopes because it does not provide long-term slope stabilization.

MDC FOR STORMWATER WETLANDS:

(1) TEMPORARY PONDING DEPTH AND SURFACE AREA. The ponding depth for the design volume shall be 15 inches above the permanent pool. The surface area of the wetland is based on the surface area at the designed temporary pool elevation. The surface area shall be sized sufficiently to limit the ponding depth to 15 inches.

(2) PEAK ATTENUATION DEPTH. The wetland may be designed to temporarily pond peak attenuation volume at a depth exceeding 15 inches.

(3) SOIL AMENDMENTS. The pH, compaction and other attributes of the first 12 inches depth of the soil shall be adjusted if necessary to promote plant establishment and growth.

(4) LOCATION OF INLET AND OUTLET STRUCTURES. The inlet and outlet structures shall be located in a manner that avoids short circuiting.

(5) FOREBAY. A forebay shall be provided at the inlet to the stormwater wetland. The forebay shall comprise approximately 10 to 15 percent of the wetland surface area as measured at the temporary pool elevation. The forebay shall be 24 to 40 inches in depth with respect to the permanent pool. The forebay entrance shall be deeper than the exit.

(6) NON-FOREBAY DEEP POOLS. Deep pools shall be provided throughout the wetland. A deep pool shall be located adjacent to the outlet structure to prevent clogging. The non-forebay deep pools shall comprise 5 to 15 percent of the wetland surface area and shall be designed to retain water between storm events. The minimum depth of a deep pool at its deepest point is 18 inches below the top of the permanent pool.

(7) SHALLOW WATER ZONE. The shallow water zone shall be zero to nine inches deep with respect to the permanent pool and shall comprise approximately 40 percent of the wetland surface area. It is recommended to only plant the six to nine inch depth range if there is an adjustable outlet structure to keep the permanent pool at a lower depth during the first year.

(8) TEMPORARY INUNDATION ZONE. The temporary inundation zone shall be between 0 and 15 inches above the permanent pool elevation. The temporary inundation zones shall comprise approximately 30 to 45 percent of the surface area of the stormwater wetland.

(9) DRAWDOWN TIME. The design volume shall draw down to the permanent pool level between two and five days.

(10) DISCHARGE RATE. The wetland shall discharge the storage volume at a rate equal to or less than the predevelopment discharge rate for the one-year, 24-hour storm. (Note: The MDC Team is still studying this item.)

(11) LANDSCAPING PLAN. A landscape plan prepared by a qualified design professional licensed in North Carolina shall be provided. The landscaping plan shall include the following:

i. Delineation of planting zones;
ii. Plant layout with species names and locations; and
iii. Total number and sizes of all plant species.

(12) SHALLOW WATER PLANTINGS. The shallow water zone shall be planted at a minimum density of 50 herbaceous plants per 200 square feet (equivalent to 2 foot on center

spacing). A biodegradable mat is recommended to hold the plantings in place. (Note: The MDC Team is still studying this item.)

(13) TEMPORARY INUNDATION ZONE PLANTINGS. The temporary inundation zone shall be planted according to one of the following options (Note: The MDC Team is still studying this item.):
   i. 50 herbaceous plants per 200 square feet (equivalent to 2 foot on center spacing);
   ii. 8 shrubs per 200 square feet (equivalent to 5 foot on center spacing); or
   iii. One tree and 40 grass-like herbaceous plants per 100 square feet.

(14) VEGETATION. The following requirements apply to vegetation:
   i. Trees and woody shrubs shall not be planted on the dam structure;
   ii. Cattails shall not be planted;
   iii. Turf grass shall be provided on the tops of berms and on the exterior slopes of dams; and
   iv. Weeping love grass shall not be planted on vegetated side slopes.

(15) TRASH RACK. A trash rack or other device to trap debris shall be provided on piped outlet structures.

MDC FOR LEVEL SPREADER-FILTER STRIPS

(1) LEVEL SPREADER LENGTH. The level spreader shall be ten feet in length per cubic feet per second of stormwater flow that is directed to it. A level spreader that receives flow directly from the drainage area shall be sized based on the flow rate during the 0.75 inch per hour storm, with a flow bypass system for larger storm events. A level spreader that receives flow from an SCM shall be sized based on the draw down rate of the design volume, with a flow bypass for larger storm events. A flow bypass system is not needed if the level spreader is sized to handle the flow during 10-year storm event.

(2) BLIND SWALE. Immediately upslope of the level spreader, there shall be a blind swale or other method of ponding water. The blind swale shall be designed to provide for uniform overtopping of the level spreader.

(3) LEVEL SPREADER SPECIFICATIONS. The lip of the level spreader shall be at a uniform elevation with a construction tolerance of plus or minus ¼" at any point along its length. The level spreader shall be constructed of concrete or other stable material.

(4) LEVEL SPREADER SHAPE. The level spreader shall be straight or convex.

(5) TRANSITION ZONE. Immediately downslope of the level spreader, there shall be a one to three inch drop followed by an area that is protected against erosion via aggregate or high performance turf reinforcement matting. The minimum width of this protected area is 12 inches.

(6) MINIMUM WIDTH OF THE FILTER STRIP. The minimum width measured perpendicular to the level spreader lip of the filter strip shall be 30 feet.

(7) NO DRAWS OR CHANNELS IN THE FILTER STRIP. The filter strip shall not contain draws or channels.

(8) FILTER STRIP SPECIFICATIONS. Filter strips shall be graded with a uniform transverse slope of eight percent or less. The pH, compaction and other attributes of the first 12 inches of the soil shall be adjusted if necessary to promote plant establishment and growth. The filter strip and side slopes shall be planted with non-clumping, deep-rooted grass sod.

MDC FOR PERMEABLE PAVEMENT

(1) SHWT REQUIREMENTS FOR INFILTRATING PAVEMENT SYSTEMS. The soil subgrade surface for permeable pavement designed for infiltration shall be a minimum of two feet above the SHWT. However, the separation can be relaxed to one foot when the applicant can prove that the water table will subside to its pre-storm elevation in five days or less.

(2) SHWT REQUIREMENTS FOR DETENTION PAVEMENT SYSTEMS. The soil subgrade surface for permeable pavement designed for detention shall be a minimum of one foot above the SHWT.

(3) SOIL SUBGRADE SURFACE. The soil subgrade surface shall have a slope of less than or equal to two percent (level).

(4) STONE BASE. Washed aggregate base materials shall be used.

(5) PAVEMENT SURFACE. The proposed pavement surface shall have a demonstrated infiltration rate of at least 50 inches per hour using a head less than or equal to 4 inches.

(6) RUNOFF FROM ADJACENT BUA. Permeable pavement may be designed to receive runoff from other BUA at a ratio of 1:1 of additional BUA to permeable pavement area. Screened rooftop runoff shall not be subject to the 1:1 loading limitation.

(7) RUNOFF FROM ADJACENT PERVIOUS AREAS. Runoff from adjacent pervious areas shall be prevented from reaching the permeable pavement except for incidental, unavoidable runoff from stable vegetated areas.

(8) INSPECTIONS AND CERTIFICATION. After installation, permeable pavement shall be protected from sediment deposition until the site is completed and stabilized. An in-situ infiltration permeability test shall be conducted on the pavement after site stabilization.

(9) DRAW DOWN TIME AND SOIL INVESTIGATION FOR INFILTRATING PAVEMENT SYSTEMS. Infiltrating pavement systems shall be designed to completely dewater the design volume to the bottom of the infiltration device within 72 hours. A site-specific subsoil investigation shall be performed prior to placement of the stone base to establish the hydraulic properties and characteristics of the subsoil. The pavement surface shall not be overtopped during the design storm.

(10) PLACEMENT OF INFILTRATION MEDIA. In-situ soils may be removed and replaced with infiltration media or infiltration media may be placed on top of in-situ soils if the applicant can demonstrate that the modified soil profile allows for drainage of the design volume within 72 hours.

(11) OBSERVATION WELL. Permeable pavement shall be equipped with a minimum of one observation well at the low point in the system. If the subgrade is terraced, then there shall be one observation well for each terrace. Observation wells shall be capped.

(12) DETENTION SYSTEMS. Pavement systems may be designed to detain stormwater in the aggregate for a period of two to five days.
(13) EDGE RESTRAINTS. Edge restraints shall be provided around the perimeter of permeable interlocking concrete pavers (PICP) and grid pavers as well as anywhere permeable pavement (of any type) is adjacent to conventional asphalt.
(14) RECOMMENDATION: CONTRACTORS. The use of certified and qualified contractors in accordance with industry standard documents shall be required and noted on both project plans and specifications.
(15) RECOMMENDATION: GRADING WHEN DRY. The soil subgrade for infiltrating permeable pavement systems shall be graded when there is no precipitation. The aggregate base and permeable surface course should be completed as quickly as possible to reduce risk of soil subgrade compaction.
(16) RECOMMENDATION: SITING. Permeable pavement should not be installed in those areas where toxic pollutants are stored or handled.
(17) RECOMMENDATION: EDUCATE THE OWNER. The owner should be educated about the ongoing maintenance needs associated with permeable pavement systems; for example, not placing particulate matter on the pavement, allowable pavement loading rates, etc.
(18) RECOMMENDATION: PERMEABLE CONCRETE AND ASPHALT SPECIFICATION. For permeable concrete, the mix design should be in accordance with the latest version of ACI 522.1 *Specification for Pervious Concrete*. For permeable asphalt, the mix design should be in accordance with NAPA's *Porous Asphalt Pavements for Stormwater Management* and CAPA's *Porous Asphalt Guide Specification*.
(19) RECOMMENDATION: DOWNSPOUT OUTLETS. Downspout outlets or ground level impervious surfaces should not drain more than 1,000 square feet to a single point onto the permeable pavement.

MDC FOR SAND FILTERS

(1) SHWT SEPARATION. The SHWT shall be at least two feet below the bottom of the sand filter for open-bottom designs and one foot below the bottom of the sand filter for closed-bottom designs. Exceptions to the one foot SHWT separation may be made if the sand filter does not drain the water table and it does not float.
(2) PEAK ATTENTUATION. Sand filters may store peak attenuation volume above the design volume depth.
(3) TWO CHAMBER SYSTEM. The sand filter shall include a sediment chamber and a sand chamber. It is recommended to provide equivalent storage volume in each chamber.
(4) SEDIMENT/SAND CHAMBER SIZING. The volume of water that can be stored in the sediment chamber and the sand chamber above the sand surface combined shall be 0.75 times the design volume. The elevation of bypass devices shall be set above the ponding depth associated with this volume.
(5) MAXIMUM PONDING DEPTH. The maximum ponding depth from the top of the sand to the outlet elevation shall be six feet.
(6) FLOW DISTRIBUTION. Incoming stormwater shall be evenly distributed over the surface of the sand chamber.

(7) SAND MEDIA SPECIFICATION. Sand media shall meet ASTM C33.
(8) MEDIA DEPTH. The filter bed shall have a minimum depth of 18 inches, with a minimum depth of sand above the underdrain pipe of 12 inches.
(9) MAINTENANCE OF MEDIA. The sand filter shall be maintained in a manner that results in a drawdown of at least two inches per hour at the sand surface.
(10) CLEAN-OUT PIPES. At least one clean-out pipe shall be provided on each underdrain line. Clean out pipes shall be capped.
(11) RECOMMENDATION: INTERNAL WATER STORAGE. An underdrain with internal water storage may be installed if the in-situ soil infiltration rate is two inches per hour or greater immediately prior to the initial placement of the media.

MDC FOR POLLUTANT REMOVAL SWALES

(1) DESIGN STORM INTENSITY. The design storm intensity shall be 0.75 inch per hour.
(2) HYDRAULIC RESIDENCE TIME. Minimum Hydraulic Residence Time shall be four minutes.
(3) FLOW DEPTH. Flow depth for the design storm intensity may not exceed six inches.
(4) CROSS-SECTIONAL SIDE SLOPES. Cross-sectional side slopes stabilized with vegetative cover shall be no steeper than 3:1 (horizontal to vertical). Steeper vegetated slopes may be considered on a case-by-case basis provided that it is demonstrated that the soils and vegetation will remain stable in perpetuity.
(5) SHAPE. Swales shall be trapezoidal with a maximum bottom width of six feet.
(6) SWALE LENGTH. Swale length shall be determined based on a minimum hydraulic retention time of four minutes.
(7) SEASONAL HIGH WATER TABLE. Swales shall not be excavated below the SHWT.
(8) GRASS SPECIFICATION. The grass species in the swale shall be non-clumping, deep-rooted and rigid.
(9) GRASS HEIGHT. Grass height shall be managed at an average of six inches. The grass shall not be cut lower than four inches.
(10) CONVEYANCE OF LARGER STORMS. Swales shall non-erosively pass the ten-year storm.
(11) SWALES DESIGNED AS OTHER SCMS. Any swale may be designed in accordance with the MDC for bioretention cells, infiltration systems or stormwater wetlands, and the design volume may be credited in accordance with the appropriate device.
(12) RECOMMENDATION: FREEBOARD. Swales shall provide a minimum freeboard of six inches for the ten-year storm.

MDC FOR RAINWATER HARVESTING SYSTEMS

(1) MAJOR COMPONENTS OF A RAINWATER HARVESTING SYSTEM. Rainwater harvesting systems shall include the following components:
   a. A collection system;
   b. A pre-treatment device to minimize gross and coarse solids collection in the tank;
   c. A cistern or other storage device;
   d. An overflow; and
   e. A distribution system.

(2) FATE OF CAPTURED WATER. Use or discharge of the captured water by either the use of the stormwater to meet a water demand or the discharge of the stormwater via a passive drawdown device to a vegetated infiltration area or another SCM.

(3) SIZING. If the system is sized for 86 percent of the total annual runoff volume as demonstrated through water balance calculations, then the system shall receive full design volume credit. Smaller systems may be used in conjunction with other SCMs to reduce the design volume of the downstream device.

(4) WATER DEMAND. The usage, type, volume, frequency and seasonality of water demand shall be established and justified.

(5) WATER BALANCE CALCULATIONS. The water balance shall be calculated using the North Carolina State University Rainwater Harvester model or another continuous-simulation hydrologic model that calculates the water balance on a daily or more frequent time-step using a minimum of five representative years of actual rainfall records. The model shall account for withdrawals from the cistern for usage and for the active or passive drawdown as well as additions to the cistern by rainfall and runoff and by a make-up water source (if applicable).

(6) MAKE-UP WATER SUPPLY. If a make-up water supply discharges into the cistern, this water volume shall be accounted for in the design.

(7) DISTRIBUTION SYSTEM. The distribution system shall be tested for functionality prior to the completion of the RWH system. The design shall include a protocol for testing the functionality of the distribution system upon completion of the initial system and upon additions to the existing system.

(8) SIGNAGE REQUIREMENTS. All harvested rainwater outlets (e.g. spigots, hose bibs), and appurtenances shall be labeled as “Non-Potable Water” to warn the public and others that the water is not intended for drinking. Passive drawdown devices, when employed, shall be marked with identifying signage or labels that are visible to owners and maintenance personnel.

(9) RECOMMENDATION: AVOID ALGAE GROWTH. Cisterns should be constructed to prevent algae growth from entering the cistern.

(10) RECOMMENDATION: WATER LEVEL INDICATOR. An indicator of water level should be visible to users and maintenance personnel.

(11) RECOMMENDATION: SECURE APPURTENANCES. For commercial or institutional uses, all spigots, hose bibs or other outlets for the harvested rainwater should be of a type, or secured in a manner, that permits operation only by authorized personnel.

(12) RECOMMENDATION: COLOR CODE EXTERIOR PIPING. For commercial or institutional uses, exterior distribution piping for the harvested rainwater should be color-coded, taped, or otherwise marked to identify the source of the water as non-potable.

MDC FOR GREEN ROOFS

(1) MEDIA SPECIFICATION. The maximum organic fraction of the media shall be ten percent by volume.

(2) DESIGN VOLUME. The design volume for a green roof shall equal the media depth times the plant available water (PAW). The maximum rainfall depth that can be treated by a green roof is 1.5 inches.

(3) MINIMUM MEDIA DEPTH. The minimum media depth shall be four inches if the roof will not be irrigated or three inches if the roof will be irrigated.

(4) VEGETATION SPECIFICATION. The planting plan shall be designed to achieve a 75 percent vegetative cover within two years.

(5) SLOPE. The green roof shall have a slope (or pitch) of no greater than eight percent unless a container system designed for a greater slope is used.

(6) RECOMMENDATION: PROTECTION OF ROOF DRAINAGE. The green roof system shall include elements that protect roof drainage features such as inlets, gutters, pipes from intrusion by vegetation roots and growing media.

(7) RECOMMENDATION: CONSTRUCTION PHASING. Green roofs should be the final portion of the roof system installed to prevent excessive trampling of vegetation and compaction of media.

(8) RECOMMENDATION: ACCESS. Consider construction and maintenance access when locating green roofs.

MDC FOR DISCONNECTED IMPERVIOUS SURFACES

(1) DRAINAGE AREA FOR DISCONNECTED ROOFS. A maximum of 300 square feet of roof shall drain to each disconnected downspout unless a device is provided to spread the flow evenly across the entire width of the vegetated receiving area, in which case, the drainage area may be increased to 500 square feet. The receiving vegetated area shall be a rectangle of either 6 by 12 feet or 12 by 24 feet (width of vegetated area by length of run in direction of flow). The entire rectangle shall not include any impervious surface to ensure that water released from the roof does not run onto another impervious surface.

(2) DRAINAGE AREA FOR DISCONNECTED PAVEMENT. For disconnected pavement, the receiving vegetated area shall be either 10 or 15 feet long. The maximum width of pavement run that may discharge to the vegetated area is 100 feet and the maximum slope of the pavement shall be 7 percent.

(3) SLOPE OF THE VEGETATED RECEIVING AREA. The vegetated area shall have a maximum slope of 7 percent with land graded to promote sheet flow, except in Hydrologic Soil

Group A soils where the maximum slope is 15 percent. The vegetated area shall be graded to avoid concentrated flow.

(4) TILLING. New sites shall be tilled to six inches prior to vegetation establishment. Existing sites with healthy vegetation are not required to till the vegetated receiving area.

(5) BUA WITHIN VEGETATED RECEIVING AREAS. Vegetated receiving areas shall not contain any impervious surface except for incidental BUA along disconnected pavement.

(6) VEGETATION SPECIFICATION. The vegetated cover shall be a non-clumping, deep-rooted grass species. Soils shall be stabilized with temporary means such as straw or matting until the permanent vegetative cover has taken root or the runoff shall be directed elsewhere until vegetation has established.

(7) RECOMMENDATION: SEEDING. Seeding is preferred but sod may also be used.

(8) RECOMMENDATION: AVOID WOODED RECEIVING AREAS. It is preferable not to use wooded areas as vegetated receiving areas because uneven micro-topography often causes channelization, which reduces surface area exposed to stormwater.