pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION
Bureau of Clean Water

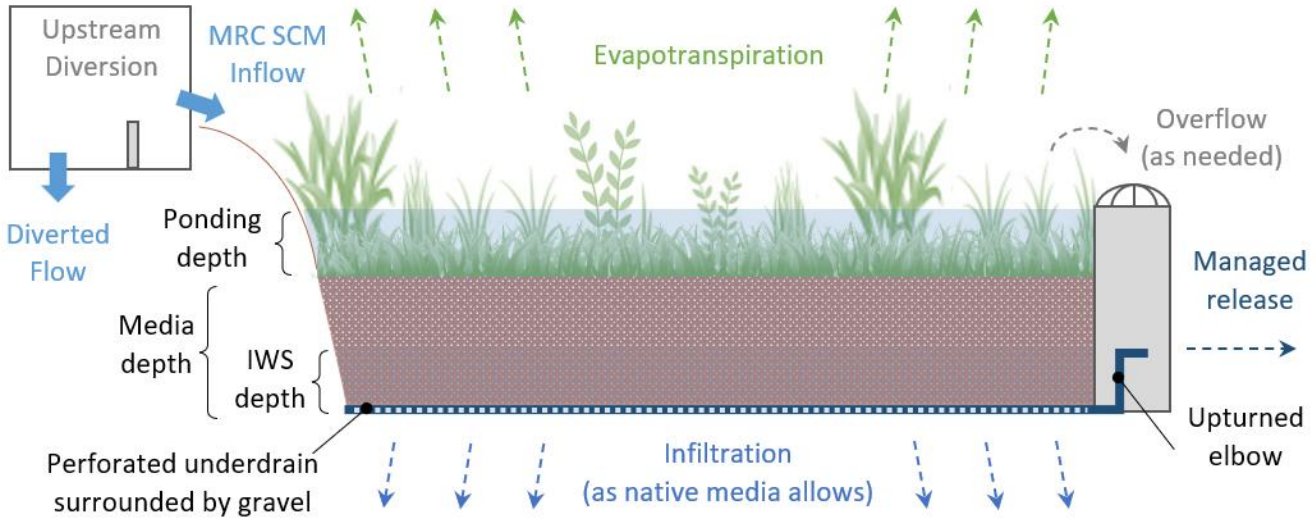
Managed Release Concept

Revised, August 15, 2025
Version 1.5

Description

Managed Release Concept (MRC) is a post-construction stormwater management (PCSM) strategy that consists of the collection, management, and filtration of captured runoff from the contributing drainage area through a stormwater control measure (SCM) that is preferably vegetated and includes the controlled release of the runoff through an underdrain within the SCM. MRC is intended to be used for project areas or subareas where infiltration is considered infeasible to meet regulatory requirements under § 102.8(g)(2) or otherwise undesirable. **Figure 1** illustrates the components of a typical MRC Bioretention SCM.

Figure 1: MRC Bioretention SCM with Internal Water Storage (IWS) and Upturned Elbow



MRC requires that runoff from the 1.2-inch/2-hour storm[1] is temporarily impounded, preferably for uptake by vegetation, is filtered through a soil media or another acceptable pretreatment device, is infiltrated through on-site undisturbed soils to the highest degree feasible (when applicable), and is released through an underdrain or control structure at a rate similar to the lateral unsaturated flow movement to the receiving waters from undeveloped areas. Flow out of the MRC SCM during the 1.2-inch/2-hour storm event must be limited to the controlled release rate (i.e., flow through the underdrain only, no overflow).

Runoff above the 1.2-inch/2-hour storm and up to the 2-year/24-hour storm is managed back to the 1-year/24-hour peak rate in one or more SCMs to protect and improve geomorphologic processes downstream of earth disturbances. An internal water storage (IWS) zone is included in the design for water quality treatment and evapotranspiration (ET) benefits. When an MRC SCM is designed according to the design standards herein, it may be used to help satisfy the PCSM requirements at 25 Pa. Code §§ 102.8(g)(2) and (3).

In accordance with 25 Pa. Code § 102.8(e), the person preparing the PCSM Plan must be trained and experienced in PCSM design methods and techniques applicable to the size and scope of the project being designed. Due to the complexity of the design of an MRC SCM and the associated analyses, the Department of Environmental

[1]1.2 inches of rainfall is equivalent to 1.0 inch of runoff from impervious surfaces using the NRCS curve number method. The 2-hour distribution is a common practice used to develop a short duration rainfall pattern for analysis.

Protection (DEP) requires that a licensed professional engineer complete the design and analyses identified in this document.

Definitions

Controlled Release Rate means a flow rate not exceeding 0.02 cfs / acre of equivalent impervious surface from the underdrain of an MRC SCM during the 1.2-inch/2-hour storm event.

Diversion means directing a portion of stormwater flows from the drainage area of an MRC SCM around the MRC SCM to a downstream SCM (typically a rate control SCM).

Equivalent Impervious means the area (in acres) that is determined by dividing the total volume of runoff (in cubic feet or CF) directed to an MRC SCM during the 1.2-inch/2-hour storm by a factor of 3,630 (1 ft/12 inches x 43,560 SF/acre).

Geomorphologic Protection means the management of the 2-year/24-hour storm for volume and water quality (tributary to the MRC SCM) by detaining the full volume of the post-construction 2-year/24-hour storm and releasing it at a rate less than or equal to the peak rate expected for the pre-construction 1-year/24-hour storm.

Managed Release means the combination of discharge at the controlled release rate and geomorphologic protection.

Applicability

MRC SCMs may be authorized for PCSM where certain criteria are met, as follows:

1. A professional engineer, licensed in the Commonwealth of Pennsylvania, must perform the analyses, calculations, and evaluations associated with MRC SCMs.

2. The applicant has completed a thorough pre-development site characterization and assessment of soil and geology of the project site (not just the proposed location of the SCM), and the applicant's licensed professional engineer has determined that it is not feasible to manage the required volume through infiltration and ET alone due to soil and/or geologic conditions or other environmental constraints on the project site. DEP intends for the use of MRC to be limited to sites where infiltration is extremely limited (i.e., very slow infiltration rate), not feasible (i.e., groundwater and/or regularly occurring seasonally high-water tables within one foot of the bottom of the SCM's soil media), or undesirable (e.g., sinkhole-prone areas or contaminated soils).

3. The installation and implementation of structural and non-structural SCMs on the project site, to the extent practicable, is not sufficient to manage the required volume.

4. SCMs providing infiltration and ET are maximized on the overall project site to the extent practicable.

5. The licensed professional engineer has investigated downstream conditions and has determined that the flow path to the confluence with the receiving surface water, if applicable, will not experience accelerated erosion through an Erosion Potential (EP) Analysis.

Where all of these criteria are met, and assuming use of MRC does not conflict with local ordinances or the provisions of an approved Act 167 plan, DEP or a delegated conservation district (CCD) may authorize the use of MRC for SCMs proposed on a project site.

The use of MRC does not preclude the applicant from minimizing any increase in stormwater runoff volume to the extent practicable, per 25 Pa. Code § 102.8(b)(3), and, when applicable, does not alleviate the requirement to demonstrate that non-discharge alternatives do not exist for the project, per 25 Pa. Code § 102.8(h)(1). Infiltration and ET must be maximized on a project site before MRC can be applied.

MRC Crediting Methods

There are two options for demonstrating volume management credit by MRC SCMs:

- **Option 1** – Adhere to the MRC Simplified Design Standards and complete the MRC Simplified Design Spreadsheet. ***MRC Simplified Design Standards only apply to MRC Bioretention SCMs*** (i.e., vegetated surface SCMs). Complete one spreadsheet for each SCM meeting MRC Simplified Design Standards. Submit the electronic file(s) or a printout(s) of the MRC Simplified Design Spreadsheet with PCSM Module 2. Enter the total volume routed to the MRC SCM up to the 2-year/24-hour storm into DEP's PCSM Spreadsheet, Volume Worksheet as managed release credit for the point of analysis (POA) or surface water that is analyzed.

- **Option 2** – If the MRC Simplified Design Standards cannot be met, use the MRC Spreadsheet to calculate volume management credit, as described in the MRC Spreadsheet Instructions. *MRC SCMs adhering to the MRC Simplified Design Standards do not need to be documented using the MRC Spreadsheet, but instead the MRC Simplified Design Spreadsheet.* Complete one spreadsheet for each SCM that does not meet the MRC Simplified Design Standards. Submit the electronic file(s) or a printout(s) of the MRC Spreadsheet with PCSM Module 2. Enter the volume management credit reported by the MRC Spreadsheet into DEP's PCSM Spreadsheet, Volume Worksheet as managed release credit for the POA or surface water that is analyzed.

MRC Design Standards

The following describes the MRC Design Standards, which are applicable to the MRC Spreadsheet.

1. **MRC SCM Selection** – There are two general types of MRC SCMs:

   a. **MRC Bioretention** – Vegetation must be provided for a minimum of 75% of the surface of the MRC SCM and satisfy the vegetation recommendations contained in DEP's PCSM Spreadsheet Instructions for ET crediting (e.g., plug plantings). Native vegetation should be selected by the licensed professional engineer in consultation with a professional that is knowledgeable in native plant ecology. Vegetation should be selected based on the plants' ability to grow within the anticipated conditions considering the SCM drainage area and depth and duration of stormwater stored in the SCM.

   b. **MRC Storage Systems –** MRC Storage Systems are underground storage units with an IWS. The outlet orifice or weir structure must be accessible for maintenance. Runoff flowing into MRC Storage Systems must be pretreated; the pretreatment options are identified in MRC Standard #3.

2. **Runoff Capture** – The runoff from the 1.2-inch/2-hour storm from the drainage area that the MRC SCM is intended to treat must be captured and managed by the MRC SCM, without overflow. Off-site stormwater should be diverted from flowing to an MRC SCM wherever possible. The runoff is filtered through vegetated media or treated and filtered to the extent practicable through the on-site undisturbed soils or other acceptable treatment systems and released through the underdrain as indicated in MRC Standard #4.

   Runoff exceeding the 1.2-inch/2-hour storm may be routed to the SCM. Volume and WQ management credit may be claimed up to the 2-year/24-hour storm. If flows exceeding the 2-year/24-hour storm are routed to the SCM, additional measures are necessary to protect the SCM.

3. **Pretreatment** – Adequate pretreatment is required for all MRC SCMs to maintain SCM function over time. Pretreatment standards are based on the flow that will be routed to the SCM, as follows:

SCM Type	Flow Routed to SCM	Pretreatment Standards
MRC Bioretention	2-Year/24-Hour Storm (or less)	The vegetated surface of the SCM may be considered adequate pretreatment unless elevated sediment loads are anticipated, in which case a forebay or other pretreatment measure should be proposed.
	> 2-Year/24-Hour Storm	A forebay should be installed meeting the following specifications: • Minimum Forebay Storage Volume (CF) – 0.25 inch of runoff per equivalent impervious area. • Minimum Forebay Length:Width Ratio – 2:1. • Minimum Forebay Depth: 1.5 ft. • Maximum Forebay Dewatering Time: 72 hrs. • Maximum Forebay Flow Through Velocity – 2 fps (up to 100-Year/24-Hour Storm if routed). An O&M Plan must identify a sufficient solids removal frequency to prevent resuspension of sediment.
MRC Storage Systems	2-Year/24-Hour Storm (or less)	**Option #1**: An upstream vegetated component (Bioretention SCM with or without an IWS) that will treat the 1.2-Inch/2-Hour Storm and meet the following standards: • Maximum Ponding Depth @ 1.2-Inch/2-Hour Storm – 0.5 ft. • Minimum Soil Media Depth – 1.5 ft. • Divert flows exceeding the 1.2-Inch/2-Hour Storm directly to the MRC Storage System.
		Option #2: Permeable pavement with a storage bed. A vacuum street sweeping maintenance program must be specified that is adequate for the drainage area. The vacuum street sweeping equipment must provide adequate suction capacity to remove particles on the pavement's surface to maintain flow pathways. The minimum street sweeping frequency is 1/quarter, which may be increased at the judgment of the designer to 1/month or more frequent depending on the anticipated load of sediment and debris and the presence of tree canopy.

SCM Type	Flow Routed to SCM	Pretreatment Standards
MRC Storage Systems	2-Year/24-Hour Storm (or less)	**Option #3**: Pretreatment of volume up to the 2-year/24-hour storm using a proprietary manufactured treatment device (MTD) or a non-proprietary sand filter. If a proprietary MTD is selected, the following standards apply: • The MTD should have current certification from either the New Jersey Department of Environmental Protection (NJDEP) or the Washington State Technology Assessment Protocol – Ecology (TAPE) at the General Use Level Designation for a minimum Total Suspended Solids (TSS) removal of 50% at the flow rate associated with the 2-year/24-hour storm of a specific site. • As an alternative to NJDEP/TAPE certification for proprietary devices, current performance verification through the National Center for Stormwater Testing and Evaluation for Products and Practices (STEPP) for 50% TSS removal using "Sediment A" in ASTM Standard E317-22 (expected to be available in the future) is considered equivalent. • The MTD must treat flows up to and including the 2-year/24-hour storm and therefore must be sized to treat the 2-year/24-hour flow for the specific site where its use is proposed. • Flow routed to the MTD may not exceed the flow that is certified by NJDEP or TAPE or verified through STEPP. Flows in excess of the verified/certified flow must be diverted (which could include diversion within the MTD). • Inspection frequency – 1/quarter and following the 2-year/24-hour storm event to inspect for sediment buildup. Non-proprietary sand filters designed using American Society of Civil Engineers (ASCE) Standards of Practice or American Society for Testing and Materials (ASTM) standards do not require certification.
	> 2-Year/24-Hour Storm	Select Option #1, #2, or #3 above AND provide a forebay or settling chamber with the following specifications: • All flow exceeding the 2-Year/24-Hour Storm must be directed to the forebay. Pretreated flow from an Upstream Vegetated Component, MTD Pretreatment, or Permeable Pavement may bypass the forebay, if desired. • Access must be provided in the design for sediment removal. • Minimum Forebay Storage Volume (CF) – 0.25 inch of runoff per equivalent impervious area. • Minimum Forebay Length:Width Ratio – 2:1. • Minimum Forebay Depth: 1.5 ft. • Maximum Forebay Flow Through Velocity – 2 fps (up to 100-Year/24-Hour Storm if routed). An O&M Plan must identify a sufficient solids removal frequency to prevent resuspension of sediment.

4. **Controlled Release Rate for the 1.2-inch/2-hour Storm** – The stormwater release rate from the MRC SCM for the 1.2-inch/2-hour storm may not exceed 0.02 cubic feet per second (cfs) from the equivalent impervious area within the MRC SCM's drainage area (within the project site). To determine the equivalent impervious area being managed by an MRC SCM, determine the total volume (in CF) of runoff generated during the 1.2-inch/2-hour event from pervious and impervious areas contributing to the MRC (from the MRC SCM's drainage area within the project site) and divide by a factor of 3,630. This release rate is rounded to the nearest hundredth of a cfs. Routing is necessary to demonstrate compliance with the standard for release rate. Runoff from off-site areas that is not diverted around a project site must be managed by the person proposing an earth disturbance activity, and the design of SCMs must include consideration of the receipt of any off-site stormwater.

   NOTE 1 – This release rate (0.02 cfs / equivalent impervious acre) is approximately the expected rate of interflow (lateral movement of stormwater to a stream) after a 2-year/24-hour storm event for a Pennsylvania non-karst watershed based on the NRCS curvilinear unit hydrograph. Releasing at this rate will produce a condition where baseflow contributions will be similar to that of an undeveloped area during and after storm events. As the level of outflow would be similar to what would be expected during and after the storm, it would not be expected to impact the storm event's effects on flooding and erosion. This rate should also be used for karst watersheds unless it can be demonstrated that interflow on a particular project site differs from this standard (such a demonstration would be considered an alternative to the MRC Design Standard).

5. **Internal Water Storage (IWS)** – A volume for IWS should be provided that is at least one foot deep below the lowest structural outlet (i.e., the outlet for the underdrain) in the MRC SCM to encourage ET, infiltration (when applicable), and denitrification.

   a. **MRC Bioretention** – To encourage ET, the overall soil media depth of a facility including the IWS should be no deeper than four (4) feet, and up to 50% of the IWS void volume can be included. For soil media, a void space of 30% can be used to describe the soil volume storage and recovery. If a void space of 30% is to be used, the void space in the soil media in the IWS should be modeled at 15% (0.5 x 0.3 void space = 0.15 or 15%). If an alternate void space is used for soil media, specific data demonstrating the void space should be submitted.

   b. **MRC Storage Systems** – For MRC Storage Systems, the IWS must be above the underdrain, but below the outlet (i.e., upturned elbow), to promote a change of the stormwater stored during rain events.

6. **Use of Liners and Infiltration** – The MRC SCM should not have an impervious liner installed unless environmental or geological conditions necessitate use of a liner, or if an existing structure would be damaged as a result of not lining the facility. Although MRC SCMs are for areas with infiltration limitations, whatever infiltration that can be achieved is encouraged. Measured saturated hydraulic conductivity rates are encouraged to be used in design and modeling.

   NOTE 2 – The presence of a project site in an area of known karst conditions does not, in itself, serve as evidence of the applicability of MRC to a project site or to the use of a liner to avoid infiltration. A detailed subsurface investigation is generally needed to evaluate the likelihood of sinkhole formation as a result of post-construction stormwater management.

7. **Geomorphologic Peak Flow Management for the 2-year/24-hour Event** – Within the MRC SCM's drainage area, the peak discharge rate from the post-construction 2-year/24-hour storm must be managed back to the pre-construction 1-year/24-hour storm peak rate, unless the pre-construction peak rate is less than 0.15 cfs, in which case the post-construction peak rate should not exceed 0.15 cfs. In the event the MRC drainage area is part of a larger overall site with non-MRC SCMs, only the MRC drainage peak flows should be managed back to the 1-year/24-hour level and overflows can be combined with flows from the non-MRC SCMs.

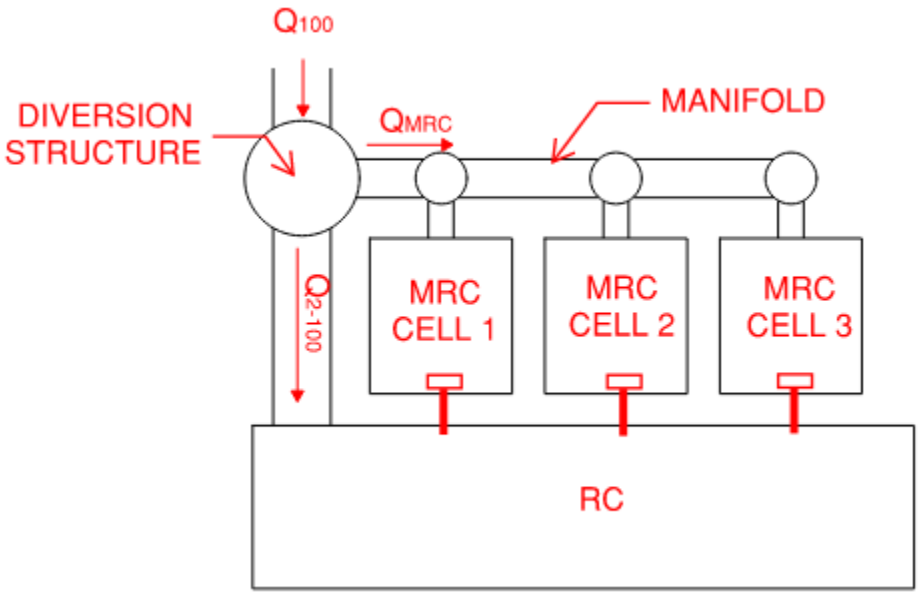
   In situations where the pre-construction drainage area to the MRC SCM varies significantly compared to the post-construction drainage area, the post-construction drainage area boundary to the MRC SCM (using existing land uses) can be used to calculate the target pre-construction 1-year/24-hour rate, as long as all areas in question are in close proximity to the MRC SCM and drain to the same surface water. In cases where the SCM is managing additional volume to offset adjacent areas that could not be captured in the MRC SCM, the targeted

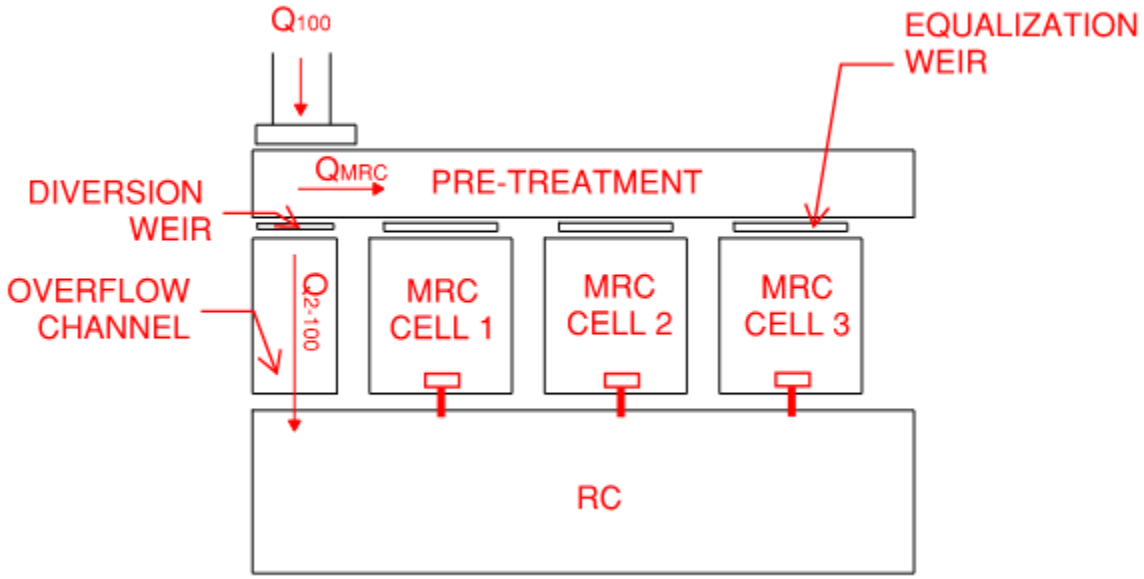
pre-construction 1-year/24-hour release rate should be calculated based on the combined flow rates from the SCM drainage area and adjacent area.

NOTE 3 – This standard is used to ensure that MRC does not contribute to channel-eroding flows in receiving surface waters.

8. **Flows Greater Than 2-Year/24-Hour Storm** – The recommended design for MRC SCMs is to divert storm events larger than the 2-year/24-hour storm to a rate control SCM; however, when it is demonstrated by the licensed professional engineer that larger storm events cannot reasonably be diverted, the MRC SCM surface component should be designed to manage the post-construction 10-, 50- and 100-year/24-hour storm event peak flows to their corresponding pre-construction rates and the MRC SCM should have an increased (i.e., more frequent) inspection and maintenance schedule that includes inspection and repair after extreme events (10-, 50- and 100-year/24-hour storm events). Given the potential for SCM failure when flows exceeding the 2-year/24-hour storm are routed to MRC SCMs, additional pretreatment in the form of a forebay or settling chamber is necessary (see Design Standard #3).

   The schematics below represent potential alternatives for diverting larger storm events around MRC SCMs to a rate control (RC) SCM. Flows may or may not be split amongst multiple independent MRC "cells". The benefits of splitting flows to multiple cells include 1) resiliency (i.e., if one cell fails or requires maintenance other cells may remain in use), and 2) larger equivalent impervious drainage areas can be treated to satisfy Design Standard #10. The diversion structure can be designed with two outflow pipes separated by a weir where the lower pipe conveys stormwater to the MRC SCM (i.e.., manifold or pretreatment conveying flow to MRC cells denoted Q_{MRC}) and the upper pipe diverts water to the RC SCM (i.e., $Q_{2\text{-}100}$). A hydraulic allowance not exceeding 6 inches is provided for as additional (temporary) ponding depth in the MRC SCM while diversions occur.





9. **Pre-Development Site Characterization and Assessment of Soil and Geology** – Adequate and appropriate soils and geologic testing and evaluation must be performed to demonstrate the infiltration capacity of the entire project site to the satisfaction of DEP. At a minimum, one infiltration test for every 40,000 square feet of disturbed area should be performed with a minimum of four tests, equally distributed across a site. The infiltration tests must be done in the most accommodating soil horizon for infiltration as demonstrated by a deep hole test within 100 feet of the infiltration test. All other sections of Appendix C Protocol 1, Site Evaluation and Soil Infiltration Testing and Appendix C Protocol 2, Infiltration Systems Guidelines per the Stormwater BMP Manual (as revised) should be followed to clearly demonstrate the infiltration capability of on-site undisturbed soils at applicable elevations and for a variety of locations. Soil probes and infiltration test locations should be identified on the PCSM Plan drawing(s). Soil borings may be substituted for test pits only when there are no opportunities on-site to complete test pits. The use of DEP's Pre-Development Site Characterization (PDSC) Spreadsheet (see *Implementation Tools* section) is required.

   NOTE 4 – The above recommended number of infiltration tests per disturbed area is to be based upon the disturbed area that is not considered a restoration activity or road maintenance activity. For example, a large sewer main installation project disturbs 30 acres in total, with 29 acres of disturbance for the sewer line installation (that will be covered by a restoration plan) and 1 acre of disturbance for a pumping station that requires a PCSM plan. The recommended number of infiltration tests would be based on the 1 acre, not 30 acres.

   NOTE 5 – The minimum number of tests can be reduced if it can be demonstrated that subsurface conditions are uniform.

   NOTE 6 – Infiltration tests resulting in saturated hydraulic conductivities (as identified in the field) of less than or equal to 0.25 inch per hour (following application of a 10% factor of safety) classify as limited. This is a saturated hydraulic conductivity representative of the lower part of the range of HSG C soils and HSG D soils.

   NOTE 7 – Research has shown that limited infiltration rates (i.e., less than or equal to 0.25 inch per hour) over time with an IWS can result in measurable losses from an SCM. Therefore, a designer can use results from the infiltration testing to describe infiltration losses for unlined MRC SCMs or utilize an infiltration rate of 0. Testing for infiltration rates should be performed as per Protocol 1 of Appendix C of the Stormwater BMP Manual (as revised). The recommendation in Protocol 2 of Appendix C that "soils underlying infiltration devices should have infiltration rates between 0.1 and 10 inches per hour" does not apply to MRC SCMs.

10. **MRC SCM Drainage Areas** – The drainage area limitations for MRC SCMs are listed in the table below. The drainage areas are limited in terms of equivalent impervious area and are based on the maximum storm event routed to the SCM. As explained in Design Standard #8, flow splitting to multiple MRC cells may be an effective strategy to achieve the drainage area standards.

    An incentive is provided in terms of an increased drainage area when at least 10% of sitewide stormwater runoff is managed through PCSM Objective A SCMs (Protected Natural Stormwater Features, Preserved Natural Open Spaces, Disconnection of Impervious Surface with Filter Strip, Riparian Buffer Establishment and Enhancement, Floodplain Restoration, Revegetation and Soil Restoration, Retentive Grading, and Vegetated Conveyance). Documentation supporting the management of 10% of sitewide runoff through these SCMs must be submitted to justify the increase in drainage area.

Maximum Storm Event Routed to SCM	Maximum Equivalent Impervious Drainage Area (acres)
1.2-Inch/2-Hour Storm (or less), **with** 10% PCSM Objective A	6
1.2-Inch/2-Hour Storm (or less), **without** 10% PCSM Objective A	5
2-Year/24-Hour Storm (or less but greater than 1.2-Inch/2-Hour Storm), **with** 10% PCSM Objective A	2.5
2-Year/24-Hour Storm (or less but greater than 1.2-Inch/2-Hour Storm), **without** 10% PCSM Objective A	2
> 2-Year/24-Hour Storm, **with** 10% PCSM Objective A	1.5
> 2-Year/24-Hour Storm, **without** 10% PCSM Objective A	1

11. **Separation Distance** – At least one foot of separation distance should be maintained between groundwater or the seasonally high-water table and the bottom footprint of the MRC SCM's soil media; however, a two-foot separation is preferred. There is no minimum separation required between bedrock or hardpan and the MRC SCM's soil media.

12. **Ponding/Drawdown Time and Ponding Depth** – The maximum ponding time (i.e., the time after the end of the storm event for stored surface water to lower to soil surface) for MRC Bioretention SCMs should not exceed 72 hours for all storm events. A maximum ponding depth (i.e., storage depth above SCM surface) of one foot for the 1.2-inch/2-hour storm and two feet for the 2-year/24-hour storm event and above should not be exceeded for MRC Bioretention.

    In addition, the lowest overflow orifice should have a minimum depth of 6 inches above the soil media to allow for infiltration into the soil media to occur long-term (unless a soil physics model is used to demonstrate that a lower minimum ponding depth is sufficient).

    A multi-stage detention facility with the upper portions of the facility providing flow attenuation for storm events greater than a 2-year/24-hour storm may be used to meet 25 Pa. Code § 102.8(g)(3). An engineered overflow structure or reinforced spillway / berm should be installed to provide safe conveyance for storm events greater than a 2-year/24-hour storm.

    For MRC Storage Systems, drawdown to the IWS storage level should not exceed 7 days (168 hours). It is noted that drawdown to the top of the underdrain orifice is acceptable for MRC Storage Systems when calculating drawdown time. The vertical interval for analysis should not exceed 0.1 foot (1.2 inches).

13. **Soil Media** – The selection of soil media should be done by considering anticipated pollutants to be treated and the vegetation that will be used. On-site soils should be evaluated for desired characteristics and infiltration capabilities as listed below. The depth of the soil media above the IWS should be a minimum of 12 inches to provide pollutant removal. If on-site undisturbed soils are unsuitable for the purpose of providing IWS, an additional one to two feet of suitable soil media should be provided below the underdrain.

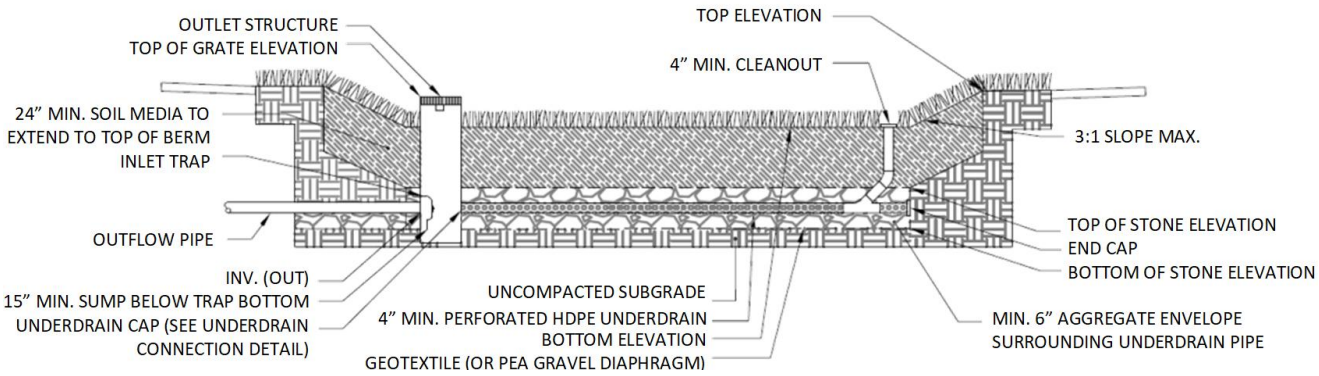
    Soil Media Drainage – The designer will need to exercise caution when selecting a soil media, as there is a delicate balance between infiltration rate and residence time. To maximize water quality treatment, the residence time within the soil media used in MRC SCMs should be selected to be close to the parameters

established for infiltration into native soils. **The designer will need to select soil media that provide the proper infiltration rate and ponding time to achieve water quality for the anticipated life cycle of the SCM**. Recommendations for soil media characteristics are presented in **Attachment A**.

14. **Underdrain Design** – The licensed professional engineer can refer to PennDOT Publication 408, Section 610 for specifications of underdrains. However, underdrains should have a minimum flow rate of 10 gallons (1.34 cubic feet) per minute per linear foot of pipe not considering the flow control orifice or upturned elbow. For non-vegetated MRC SCMs, the underdrain should be located at the bottom of the IWS to promote movement of water from previous storms. There may need to be multiple underdrains, or longer underdrains, to provide adequate design capacity for drainage. Section 6.4.7 (Constructed Filter) of the Stormwater BMP Manual (as revised) has recommended design standards for lateral spacing of multiple underdrains.

    IWS Outflow with Capped / Orifice Underdrain – It is highly recommended that an upturned elbow or an elevated weir be designed at the outlet of the underdrain (see **Figure 1**). The upturned elbow or elevated weir will create the IWS. The upturned elbow or elevated weir can also help if site conditions present daylighting issues for the underdrain's discharge elevation. Underdrains should be capped within an outlet structure when used to allow access for maintenance. The cap should be drilled to provide an appropriately sized orifice. **Figure 2** below provides an example of an underdrain detail. Note that all cleanouts and angles within the underdrain should not exceed 45 degrees. For lined, non-vegetated MRCs the underdrain leading to the upturned elbow should be located at the bottom of the IWS.

Figure 2: Example Underdrain Detail (adapted from Philadelphia Water Department's *Stormwater Management Guidance Design Manual*)



Underdrain Aggregate Envelope – A 6-inch stone envelope of AASHTO #57 should be placed around the underdrain. A geotextile (or pea gravel diaphragm) is needed around the aggregate envelope. Note that the stone should not be placed throughout the bottom of the SCM, but just in the envelope of the underdrain.

Cleanout for Underdrain – The underdrain(s) should be equipped with a clean-out for maintenance. The design of any clean-out should ensure that surface water does not enter the underdrain system through the top of the cleanout. Consideration must be given for cleaning and inspecting underdrains and access to the upturned elbow or elevated weir.

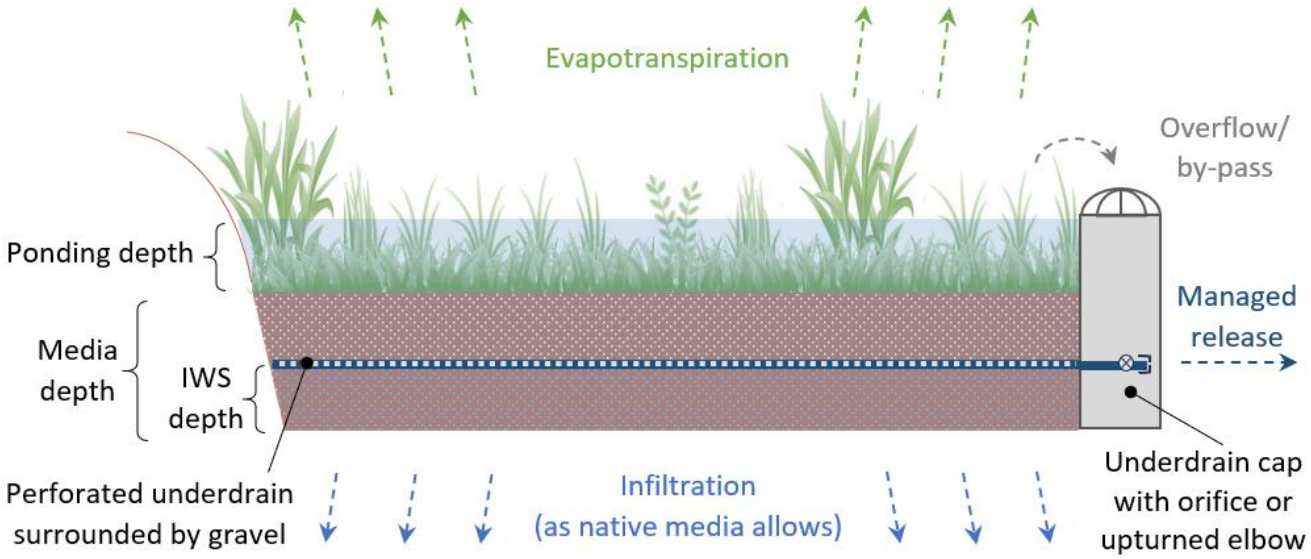
Orifices – An appropriately sized orifice is necessary on the outlet of the underdrain to achieve the Controlled Release Rate (see **Figure 3**). The orifice should be clean, smooth and sanded so that no burs or irregularities are present. The orifice should be on a plate or permanent/semi-permanent cap (e.g., glued or screw cap) of sufficient thickness, and the edges of the orifice should be ground so that flow through the orifice is smooth. Orifices should be vertical (horizontal orifices may be acceptable if appropriately protected from debris covering the orifice such as a downturned orientation or covered with permanent/semi-permanent cap with vertical openings). The orifice plate and other connections should be water-tight and accessible for maintenance. Control valves cannot be substituted for an orifice. Orifices must be accessible for routine maintenance.

15. **Discharge Flow Path** – Flow from an MRC SCM may be directed to a rate control SCM, storm sewer, or surface water through a vegetated or otherwise stable flow path in a manner that prevents accelerated erosion. Use of a level spreader may be necessary unless a licensed professional engineer demonstrates that it is unnecessary.

    The designer should consider directing the underdrain discharge of an MRC SCM away from the discharge flow path of other SCMs wherever practicable.

16. **Antidegradation Requirements** – Where the stormwater from the project site discharges to a special protection surface water, an MRC SCM can be used to satisfy the Antidegradation Best Available Combination of Technologies (ABACT) regulatory requirements in Chapters 93 and 102 (assuming that non-discharge alternatives do not exist).

Figure 3: Managed Release Concept with Capped / Orifice Underdrain with Maintenance Access for a Vegetated SCM



MRC Simplified Design Standards

Applicants proposing MRC SCMs are not required to use the MRC Spreadsheet when the MRC Simplified Design Standards will be met. Volume management credit may be claimed for the volume routed up to the 2-year/24-hour storm event for any SCM that will be designed to meet the following standards:

Design Parameter	Standard
MRC SCM Type	MRC Bioretention
Maximum Drainage Area	1 acre
Maximum Equivalent Impervious in Drainage Area	0.5 acre
Maximum Flow (Storm Event) Routed to SCM	2-year/24-hour storm (higher flows are diverted or bypassed)
Maximum Ponding Time	72 hours
Minimum Soil Media Depth (includes a minimum of 1 foot IWS)	2 feet
Maximum Ponding Depth @ 2-Year/24-Hour Storm	1.5 feet (or 6 inches above the Ponding Depth @ 1.2-Inch/2-Hour Storm)
Maximum Ponding Depth @ 1.2-Inch/2-Hour Storm	1 foot (no overflow)
Controlled Release Rate for 1.2-Inch/2-Hour Storm	0.02 cfs/acre equivalent impervious
Underdrain Outflow Rate for 1.2-Inch/2-Hour Storm	≤ Controlled Release Rate

Design Parameter	Standard
Post-Construction 2-Year/24-Hour Peak Rate	Managed Back to Pre-Construction 1-Year/24-Hour Peak Rate in a Separate SCM as necessary
Separation Distance to Groundwater or SHWT, minimum (ft)	1 foot (2 feet recommended)

Completion of the MRC Simplified Design Spreadsheet is required for each MRC SCM designed to meet these standards.

Offsetting

MRC SCMs may be designed for offsetting when contributing non-regulated earth disturbance (either impervious area or compacted pervious areas) is present in the contributing drainage area. Uncompacted pervious surfaces outside the disturbed area should be bypassed to the maximum extent practical.

When similar non-regulated impervious areas within the project site (existing impervious area not included in the proposed earth disturbance) drain to an MRC SCM, the volume managed can be increased to offset volume from adjacent earth disturbance not captured by the MRC that drains to the same surface water in close proximity to the MRC (only if infiltration is not feasible in the adjacent drainage area being routed to the MRC SCM). In these instances, the MRC design should be adjusted to account for equivalent capture, release rate, and peak flow attenuation from the combined areas.

NOTE 8 – Runoff from existing similar impervious and compacted pervious areas can be used to offset undetained areas. The runoff volume for the 1.2 inch/2-hour storm from the two areas must be equivalent (See **Figure 4**). In addition, the pollutant contribution as determined through land use of the two areas should be similar.

NOTE 9 – A composite Curve Number is not adequate for the modeling of the 1.2 inch/2-hour storm due to the large error associated with averaging of initial abstractions for storms less than or equal to the 2-year/24-hour storm event. Curve numbers for impervious and non-compacted pervious areas must be separate for this analysis.

Construction Sequence

A licensed professional engineer should provide appropriate construction sequencing for the MRC SCM. Construction sequencing should be project-specific, but at a minimum should include the following:

1. Install the MRC SCM during final phases of site construction, following permanent stabilization of the SCM's drainage area, to prevent sedimentation and/or damage from construction activity. After installation, prevent sediment-laden water from entering the facility.

2. Install and maintain proper E&S BMPs during construction.

3. Unless a liner will be installed, the MRC SCM bottom / subgrade should be uncompacted and free from rocks and debris. If the SCM served as a temporary E&S BMP, remove all deposited sediments and debris

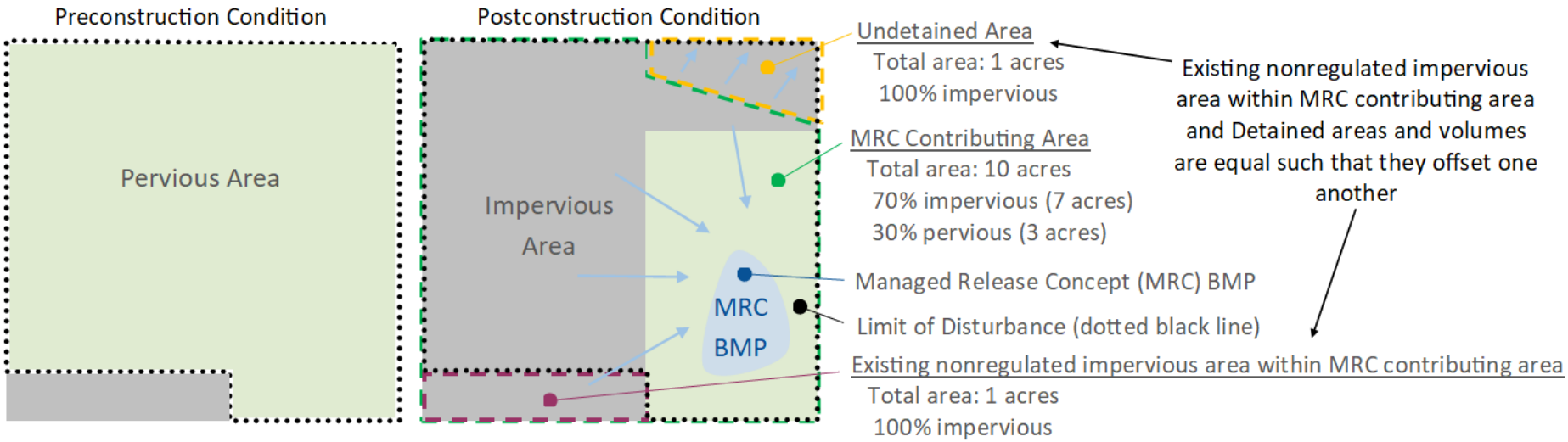
4. Install inlet and outlet structures, reinforced spillway, pipe bedding, underdrain piping with aggregate envelope, cleanouts, orifice/weir, etc.

5. Place soil media gently. Do not compact soil media or the basin bottom. The placement of soil media should be done from outside the SCM footprint to avoid compaction by construction equipment. Equipment should never drive over placed soil media.

6. Vegetate the SCM with native plantings and seed mixes, as applicable.

7. Maintain inlet protection and other E&S controls until the site is fully stabilized.

Figure 4: Offsetting and Equivalent Impervious Area Calculation Example



Calculation of Equivalent Impervious Area due to pervious surface within MRC contributing area:

$$\frac{\text{Total Volume of 1.2-in/2-hr Storm Inflow (cubic feet)}}{\text{0.0833 feet * 43560 square feet/acre}} = \text{Equivalent Impervious Area}$$

$$\frac{\text{26499 cubic feet}}{\text{0.0833 feet * 43560 square feet/acre}} = \text{7.3 acres}$$

Operation and Maintenance Schedule

A licensed professional engineer should provide an appropriate long-term operation and maintenance (O&M) schedule for the MRC SCM. The long-term operation and maintenance schedule should be project specific. At a minimum, the long-term O&M schedule must meet 25 Pa. Code § 102.8(f)(10) and include the following:

1. Upgradient catch basins and inlets should be inspected and cleaned annually, or more often if historical maintenance records suggest a more frequent cleaning.

2. Inspect and clean, as necessary, managed release orifices to prevent blockages, on a routine basis (monthly or quarterly based on operating experience).

3. The vegetation (for the MRC SCM and contributing drainage area) should be maintained in good condition, and any bare spots revegetated.

4. Care should be taken to avoid excessive compaction by mowers. Mow only as appropriate for vegetative species.

5. Inspect at least two times per year after runoff events greater than 1 inch and make sure that runoff drains down within the design parameters (a licensed professional engineer should clearly identify what these parameters are).

6. At least two times per year, or more if historical maintenance indicate it is necessary, inspect for accumulation of sediment, damage to outlet control structures, erosion, signs of water contamination/spills, and instability. Leaf litter needs to be removed annually.

7. As needed, remove accumulated sediment as required to maintain infiltration through the MRC soil media and to maintain water quality functionality. Restore original cross section. Properly dispose of sediment.

8. If porous pavement is included in the design, vacuum at least twice per year. Vacuum should have sufficient suction power and be designed for use with porous pavements.

9. All MRC SCM components should be maintained as indicated in the Stormwater BMP Manual.

10. As noted above, if the MRC SCM will manage peak flows in excess of the 2-year/24-hour storm event, an increased inspection and maintenance frequency will be necessary.

ATTACHMENT A
RECOMMENDED MEDIA SPECIFICATIONS

Soil Media

On-site soils may serve as adequate media for a vegetated SCM if it meets the following design recommendations. Otherwise, on-site soils may be modified or soils may be imported. Mixing of soils for the purpose of meeting stormwater objectives is considered a critical stage of SCM construction that must be observed by a licensed professional or their designee.

Parameter	Specification
Saturated Hydraulic Conductivity	• Saturated hydraulic conductivity of media placed in the field should be between 0.5 and 10 inches/hour and typically should not be more limiting than the underlying soil unless the underlying soil exceeds 10 inches/hour. A licensed professional should consider the effects of water quality treatment and plant survivability for media placed with a saturated hydraulic conductivity between five to 10 inches/hour. • Saturated hydraulic conductivity tests should be performed at field placed or anticipated field placed density.
Gradation and plasticity	• Soils should be classified by the USCS (ASTM D2487-17) to consider behavior of the fine fraction (i.e., plasticity): ○ A 50-85% total sand content (includes fine, medium and coarse sand) defined by particle sizes between 4.75 to 0.075 mm with a maximum fine sand content of 15% (as defined by particle sizes between 0.425 and 0.075 mm) or a well graded-soil. ○ A maximum gravel content of 15% defined by particle sizes between 4.75 mm and 75 mm. ○ A maximum non-plastic fine content (silt and clay) of 30% defined by particle sizes less than 0.075 mm or a maximum fine content of 20% with a plasticity index of less than 10.
Organic content	• Soil media should have up to 5% organic material as determined by loss on ignition (ASTM D2974). Soil media with less than 2% organic matter may be difficult to support some plant life. After establishment, plants will provide their own organic material through decomposing roots and foliage.
pH	• Media should have a pH between 6.0 and 8.5.
Other	• The recommended phosphorus content of the soil media is between 7 – 23 mg/kg. • Soil media (including imported media) should not contain pollutant concentrations that exceed 10% of the residential or non-residential Medium Specific Concentrations (MSCs) in 25 Pa. Code Chapter 250 for residential and non-residential sites, respectively, to reduce concerns related to pollutant leaching, unless higher concentrations are a result of natural background conditions.

Compost

To adjust organic content, planting soil may be amended, prior to placing and final grading, with the addition of organic compost. Organic compost amendments are preferred, but manure or mushroom compost may be used. Lawn waste compost is not recommended.

Parameter	Specification
Organic Amendments	• Organic compost amendments should meet the following criteria: o Compost should be derived from plant material and meet the general criteria set forth by the U.S. Composting Seal of Testing Assurance (STA) program. o The material should be well composted, free of viable weed seeds, and stable with regard to oxygen consumption and carbon dioxide generation. o The compost should have a moisture content that has no visible free water or dust produced when handling the material.
Manure	• Manure should be aged and meet the following criteria: o 98% passing through a 0.5-inch screen. o pH between 6.0 and 8.0 S.U. o Manufactured inert material (e.g., plastic, concrete, ceramics, metal, etc.) of less than 1.0% by weight. o Organic matter between 30 and 65% by weight. o Soluble salt content less than 5.0 millimhos per centimeter. o Carbon to nitrogen (C:N) ratio less than 25:1. o EPA 40 CFR Part 503 levels for heavy metals. o Optimum dry bulk density ranging from 40 – 50 lbs/ft^3; however, certain fully mature coarse textured composts may be lower.
Mushroom Compost	• Mushroom compost should be aged and meet the following criteria: o A pH between 6.0 and 7.0 S.U. o Sodium adsorption ratio (SAR) of the produce or material should be less than 15 as calculated below: $$SAR = \frac{[Na^2]}{\sqrt{\frac{([Ca^{2+}] + [Mg^{2+}])}{2}}}$$ Where: [Na^+] is the concentration of sodium in milliequivalents per liter (Meq/L) [Ca^{2+}] is the concentration of calcium in Meq/L [Mg^{2+}] is the concentration of magnesium in Meq/L o Moisture content of 35 to 55% (wet weight) for solids and 45 to 65% (wet weight) for moisture. o C:N ratio should be within the range of 10:1 to 15:1. o Nitrogen content between 1 to 3%.

Version History

Date	Version	Revision Reason
8/15/2025	1.5	1) Updated MRC Design Standard #1 by clarifying for MRC Bioretention that vegetation should meet the recommendations for ET crediting per DEP's PCSM Spreadsheet Instructions. 2) Added a new MRC Design Standard (#3) for pretreatment. 3) Removed the minimum controlled release rate of 0.01 cfs from MRC Design Standard #4. 4) Added schematics for diversion alternatives to MRC Design Standard #8 and identified the benefits of splitting flow amongst multiple MRC cells. 5) Modified MRC Design Standard #12 to indicate a) for MRC Bioretention the lowest overflow orifice should have a minimum depth of 6 inches above the soil media and b) drawdown time for MRC Storage Systems can be calculated by drawdown to the top of the orifice. 6) Updated MRC Design Standard #14 to modify Figure 2 and explain that horizontal orifices may be acceptable if appropriately protected from debris. 7) Clarified MRC Design Standard #15 to indicate designers should consider directing underdrain discharges from MRC SCMs away from the flow path of other SCMs.
4/3/2025	1.4	1) Added Attachment A, Recommendations for Media Specifications. 2) Added clarification to MRC Design Standard #2 that off-site stormwater should be diverted around MRC SCMs wherever possible. 3) Clarified MRC Design Standard #3 that the equivalent impervious area used to determine the controlled release rate is within the MRC SCM's drainage area that is within the project site.
11/18/2024	1.3	Updated to address two new MRC crediting tools – the MRC Simplified Design Spreadsheet and the MRC Spreadsheet – and revised design standards.
8/25/2020	1.2	Renamed the "Completing the NOI/Application and Worksheets Where an MRC BMP Is Proposed" section to "Completing Module 2 and DEP PCSM Spreadsheet," and revised the section for PCSM Module 2 and the DEP PCSM Spreadsheet. Updated MRC Design Summary sheet, MRC FAQ and MRC Design Examples. Provided Figures 3 – 6 for clarity on MRC Design Standards #8 & #10. Removed section on Water Quality as the information has been incorporated in other sections.
5/15/2019	1.1	Updated MRC Design Summary sheet; developed a separate document for Frequently Asked Questions and MRC Design Examples; changed trigger for technical review by DEP to a total drainage area of 3 acres (1.5 acres of impervious); modified runoff capture requirement to the 1.2-inch/2-hour storm event; clarified offsetting allowances for impervious areas; revised release rate to 0.01 cfs for equivalent impervious area at the 1.2-inch/2-hour storm event; and provided clarifications throughout.
12/13/2018	1.0	Original