

## **Managed Release Concept for Post-Construction Stormwater Management**

### **Frequently Asked Questions (FAQ) Revised, December 21, 2020 Version 1.3**

#### **Background**

Managed Release Concept (MRC) is a post-construction stormwater management (PCSM) protocol which, when designed according to standards established by the Department of Environmental Protection (DEP), ensures the protection of surface waters and satisfies regulatory requirements under 25 Pa. Code § 102.8. MRC can be applied to any stormwater best management practice (BMP) by a licensed professional engineer. The use of MRC within a BMP is considered an approved alternative BMP under the Chapter 102 regulations.

This FAQ document was developed to clarify information contained in DEP's [MRC concept paper document](#). Nothing in this document affects regulatory requirements. The interpretations herein are not an adjudication or a regulation. There is no intent on the part of DEP to give the interpretations in this document that weight or deference. This document provides a framework within which DEP and delegated county conservation districts (CCDs) will exercise administrative discretion in the future. DEP reserves the discretion to deviate from the interpretations in this document if circumstances warrant. Questions related to the interpretations in this document should be directed to the appropriate DEP Regional Waterways & Wetlands Program, who then may consult with DEP's Bureau of Clean Water.

#### **FAQ #1: If field testing shows an infiltration rate less than 0.1 in/hr, is there an assumed minimum infiltration rate for the MRC BMPs (e.g., 0.05 in/hr)?**

No, there is no assumed minimal infiltration rate for the underlying soils of an MRC BMP. While MRC BMPs are designed for areas where infiltration is limited, research has shown that measurable infiltration will occur even at negligible infiltration rates. When modeling, the design infiltration rate of an MRC BMP should be based upon the field testing with an appropriate safety factor applied (as recommended in Appendix C of the Stormwater BMP Manual (as revised)) and may be used at the discretion of the designer (i.e., designers can assume no infiltration).

When field testing identifies that there is zero infiltration for the underlying soils, then infiltration cannot be a function of the MRC BMP. When this is the case, ET can still be utilized for a vegetated MRC BMP.

**FAQ #2: In the example computations, the infiltration rate is 0.1 in/hr even though this BMP appears to be for SWMs with limited or no infiltration. The infiltration volume constitutes 56% of the total credit in the example.**

For the design examples, when infiltration is included, it is assumed that proper testing was performed, and the design infiltration is based upon the observed field infiltration rate with a proper safety factor applied. This shows the value of the MRC in limited infiltration regions. By limiting the release rate and extending the period of infiltration from the media to include the Internal Water Storage, even a small rate of infiltration can substantially reduce runoff volume.

**FAQ #3: If there is no assumed infiltration rate, is the target for the site still net change in runoff volume calculated by Worksheet 4 or is it CG-2 (i.e., 1 inch over the proposed impervious area)?**

The regulatory standard for volume is found in 25 Pa. Code § 102.8(g)(2), which aligns with Worksheet 4 of the PA Stormwater BMP Manual. CG-2 is no longer utilized. A properly constructed MRC BMP manages up to the 1.2-inch/2-hour storm without overflow (i.e., flow only through underdrain), regardless of the infiltration rate. That coupled with the internal water storage and peak flow reduction of the 2- to 1-year/24-hour storm is considered to satisfy the requirements of § 102.8(g)(2) for all storms up to and including the 2-year/24-hour storm.

**NOTE** – The 1.2-inch/2-hour storm is equivalent to 1 inch of runoff from impervious surfaces.

**FAQ #4: How is the 72 hr max surface dewatering computed – is it based on release rate of the orifice (0.01 cfs/impervious acre) or 2-6 in/hr rate of the soil media?**

Because the flow rate from the 0.01 cfs/equivalent impervious acre will be more restrictive than the flow rate from the soil media, the drawdown calculations should utilize the flow rate from the 0.01 cfs/equivalent impervious area and any applicable infiltration flow rate. The flow rate through the soil media will have no bearing on the functionality of the MRC BMP and does not need to be included in any hydrologic routing calculations. The designer needs to route the 1.2-inch/2-hr storm and show that the volume detained drains down to the surface of the soil media in less than 72 hours. It is anticipated that the orifice release rate will control in the routing calculations.

**FAQ #5: If the target is the Worksheet 4 volume (for sites with infiltration rates of 0 in/hr), does the entire Worksheet 4 volume need to be statically held in the soil media (0.2 void ratio for storage + 0.1 void ratio for ET)?**

No, static storage is not required to be calculated. The designer can route the design storms using generally accepted hydrologic software.

**FAQ #6: It is understood that vegetated MRCs (and porous pavement MRCs with adequate street sweeping) provide adequate water quality management for TSS, TP, and N. However, how can adequate water quality management be demonstrated for underground MRCs?**

Managing the net change in water quality should be demonstrated through the use of DEP's PCSM Spreadsheet, Quality Worksheet, for all projects. Underground MRC BMPs may or may not provide adequate water quality management, depending on factors such as the volume routed to the BMPs. Use of pretreatment prior to underground BMPs (MRC or otherwise) is highly recommended.

**FAQ #7: For vegetated MRCs with an IWS, it appears that Worksheet No. 10 may not be required to be provided to demonstrate an adequate water quality compliance. Is this correct?**

For any MRC BMP, the water quality demonstration is assumed to be met if designed in accordance with the Managed Release Concept requirements. DEP's PCSM Spreadsheet, Quality Worksheet, rather than Worksheet 10, must be used.

**FAQ #8: Why is a 2-hour distribution used for the 1.2-inch rainfall event?**

A shorter duration of rainfall distribution is used for the 1.2-inch event instead of the typically used 24-hour distribution since it better mimics naturally occurring rainfall patterns in a smaller event size, such as 1.2-inches, compared to the larger storms defined by a return period (i.e. 1-, 2-...100-year). A 2-hour duration was adapted as it has been established as the NJ DEP water quality storm and has "intermediate rainfall intensities that have the same probability or recurrence interval as the storm's total rainfall and duration" (NJDEP, 2004). The 1.2-inch/2-hour event used for the MRC designs can be evenly distributed over the 2 hours (i.e., 0.6 in/hr intensity). The NJ DEP 2-hour rising and falling distribution may be used but is not necessary and a uniform distribution of 0.6 in/hr is acceptable for this application.

**FAQ #9: Why is a NOAA Type C distribution used in the design examples for the 24-hour rainfall events?**

NOAA rainfall values are used with a NOAA Type C distribution for the 24-hour rainfall events. NRCS Type II distribution has been used previously; however, the developer of the Type II distribution no longer recommends this distribution where NOAA distributions have been established:

"To use a Type II or other legacy rainfall distribution with the updated NOAA Atlas 14 data could introduce errors by application of inaccurate rainfall intensities during the storm...Very little documentation is available that describes the development of the Type II and other legacy rainfall distributions. Study of what is available leads to the conclusion that their use be discontinued in areas covered by NOAA Atlas 14 data...There is no doubt that when these legacy rainfall distributions were developed, they were developed using the best available data, technology, and engineering judgment available at the time. With current data of improved quantity and quality, geographic information systems, and computer capabilities, a higher standard may be set with respect to developing and using updated rainfall distributions" (USDA-NRCS, 2015).

In addition, other refereed journals have also recommended against the use of "Type" distributions in lieu of other, newer distributions (Chin, 2018, Chin and Ross, 2018). The Type C curve was

specifically used as the example project is situated in Philadelphia. Type A, B, C and D curves have been developed for Pennsylvania and the surrounding area and should be used in conjunction with NOAA rainfall values depending on site location (Merkel et al., 2015). See:

Chin, David A. (2018). "Effect of Return Period on Normalized Rainfall Distributions in the United States." *Journal of Hydrologic Engineering*, 23(11), 04018046.

Chin, David A., and Ross, Eboné A. (2018). "Canonical Rainfall Distributions in the United States." *Journal of Irrigation and Drainage Engineering*, 144(11), 04018031.

Merkel, William H., Moody, Helen Fox, Quan, Quan D. (2015). "Design Rainfall Distributions based on NOAA Atlas 14 Rainfall Depths and Durations USDA-NRCS, Beltsville, MD.

United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS). (2015). "Chapter 4: Storm Rainfall Depth and Distribution- DRAFT" Part 630 Hydrology, National Engineering Handbook.

**FAQ #10: Design Standard 10 identifies, "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." If in-situ soils are unfavorable for infiltration, what is the design intent of doing additional suitable soil?**

The design intent is to create an IWS (internal water storage). Runoff needs to enter the IWS during the storm event. If the undisturbed soil can't infiltrate, then they are not suitable for the IWS. The IWS provides a volume for denitrification, added water for plants to evapotranspire, as well as temperature mitigation. An IWS will also maximize any potential infiltration.

**FAQ #11: Why are we are reducing the 2-yr/24-hr storm peak flows down to the 1-yr/24-hr storm level? Will the receiving stream not be protected by just meeting the 2-yr/24-hr pre-development rate?**

Pennsylvania's current 2-year/24-hour storm volume control is based on recharge, water quality, and geomorphologic protection. As the MRC design is targeting a smaller rainfall, additional protection is needed. Note that in many designs it is expected that the 1.2-inch capture will meet this requirement with minimal additional storage, especially as the larger storms still require peak controls.

**FAQ #12: Regarding the up-turned elbow, how will it be protected from cracking each year due to freezing conditions?**

The upturned elbow should be at the bottom of the storage media, so several feet below the surface, and the frost line. Minnesota (which typically has harsher winter conditions than Pennsylvania) recommends that outfalls not be connected to a shallow structure (like a road) that could be affected by frost heave.

**FAQ #13: What about having an IWS for an underground BMP and lined BMPs. Will this not create a dead zone which will hold water constantly? For non-vegetated, underground MRC BMPs, what can we use for nitrate removal efficiency?**

The “dead zone” is intended to reduce nitrogen which requires anerobic conditions. For non-vegetated systems, the underdrain is required to be at the bottom, so a new storm will push out the collected runoff from the previous storm. Vegetated systems have the advantage of ET reducing the IWS storage.

**FAQ #14: How do we calculate the soil moisture recovery from the media above the IWS?**

Research shows it should be removed within 7 days (there is no need to model).

**FAQ #15: When you say you need 75% vegetative coverage, what area do you mean?**

This refers to the surface infiltration footprint. Note, it is a good idea to have vegetative coverage (or another form of permanent stabilization) on the side banks to prevent accelerated erosion.

**FAQ #16: Do you need to have the orifice flow rate restricted to the manage release rate?**

No, the overall system outflow peak has to be less than or equal to the managed release rate for the 1.2-inch rainfall event without overtopping. This requires a restricted orifice, but that does not mean you can't have larger outflows during larger events.

**FAQ #17: Design Standard No. 4 identifies that the peak flow attenuation for the 2-year/24-hour storm event must be to the pre-development 1-year/24-hour storm or per an approved and current Act 167 Plan. If the municipality grants a waiver under their Act 167 ordinance to the 2-year/24-hour storm event's attenuation, will the design standard still be met?**

No. If the municipality grants a waiver to their Act 167 ordinance requirements, then this would be viewed as an MRC alternative design standard.

For example, the municipality's Act 167 ordinance requires the post-construction 2-year/24-hour storm event peak flow rate to be equal to or less than the pre-development 1-year/24-hour storm event. However, during the municipal review process a waiver is granted such that the post-construction 2-year/24-hour peak rate can be equal to or less than the pre-development 2-year/24-hour storm event. The design would not be consistent with the Act 167 Plan that was approved DEP; therefore, the design would be viewed as an alternative design standard and would generally require additional review by DEP.

**FAQ #18: The local municipal ordinance does not allow for the use of Managed Release Concept; however, the municipality has granted a waiver to allow MRC to be used. Can MRC be used?**

Yes, in this case MRC can be used.

**FAQ #19: What is the ponding time for storm events larger than the 2-yr/24-hr storm?**

In accordance with Design Standard No. 9, the drawdown time for any storm event is 72 hours. This is from when the storm event ends.

**FAQ #20: If we have an MRC BMP can we rely upon the Common Law Easement for an offsite discharge analysis?**

To answer this question, you should engage your or your client's legal counsel.

**FAQ #21: If there is a "hot spot" and the municipality won't allow infiltration, will DEP/CCD waive the 7-day dewatering time for the IWS and the testing?**

Generally not. DEP will not automatically accept that infiltration is not appropriate or feasible just because the municipality will not allow it. You will have to provide a demonstration that infiltration is not appropriate or feasible. Additionally, the drawdown time standard would still need to be met in accordance with Design Standard No. 9, or otherwise DEP would need to consider the proposed alternative.

**FAQ #22: Is a liner a deviation from the design standards; meaning an individual permit?**

The use of a liner in and of itself will not trigger the potential for an individual permit. However, if a liner is proposed, an adequate justification on the necessity of a liner will be required. You may not, for example, assume a liner must be used just because the project is in a karst area.

**FAQ #23: If there is a liner, then the IWS is not required; correct?**

Incorrect. If a liner is proposed, then the IWS still must be provided. If you do not provide an IWS, the deviation from MRC Design Standards may trigger the need for an individual permit.

**FAQ #24: What is more important, the 72-hr draw down time or the 0.01 cfs/impervious acre; as designed our MRC BMP cannot meet both?**

Both are equally important. If your design is having trouble meeting the drawdown time and the discharge rate, then a larger BMP or more BMPs are needed. If you exceed either of these criteria, then you may trigger the need for an individual permit.

**FAQ #25: Do I use the loading ratio from the Pennsylvania Stormwater BMP Manual?**

No, follow the MRC Design Standards.

**FAQ #26: How should pre to post volume increases in any bypass areas be managed?**

Increases in volume within “bypass areas” or undetained areas must be accounted for in any pre-versus post-construction calculations for rate, volume and quality. MRC BMPs may not be able to compensate for increases in rate, volume or water quality within undetained areas.

**FAQ #27: How should calculations for MRC BMPs in series be handled?**

MRC BMPs should be for small drainage areas and generally not be in a series (unless there are areas of infiltration below the MRC). If BMPs are in a series, the last BMP should generally be the one that is designed to MRC. A designer may use a detention facility downstream of an MRC BMP to meet the 2-year/24-hour storm event post-construction peak flow reduction to the 1-year/24-hour pre-construction peak flow rate if desired. The MRC BMP would still be used to satisfy water quality requirements.

**FAQ #28: How/why was 1.0 inch of runoff from impervious selected?**

This was what was used in CG-2 from the BMP Manual and is similar to what is used in many states for the water quality storm to address the first flush. In addition, capturing the 1.2-inch/2-hour storm event treats the majority of the annual runoff.

**FAQ #29: How can the 1.2-inch/2-hour runoff volume be calculated?**

The runoff volume from the 1.2-in/2-hr storm event can be calculated either by modeling software or by using DEP’s PCSM Spreadsheet, Volume Worksheet (enter 1.2 inches for rainfall in lieu of the 2-year/24-hour storm rainfall depth).

**FAQ #30: Figure 4 on page 5 of the MRC document is oversimplified. It should be explained in more detail how to offset bypass areas with areas detained by an MRC BMP in scenarios where the bypass area isn’t exactly the same (in both size and ground cover type) as the detained area.**

MRC BMPs may not be able to offset undetained areas unless the volume reduced by infiltration and ET in the BMP are greater than or equal to the increases in undetained areas.

**FAQ #31: MRC Design Standard No. 10 requires an additional “one to two” feet of suitable soil media. Should this be changed to specify either “one” or “two” feet?**

No. If on-site undisturbed soils are unsuitable for the purpose of providing internal water storage (IWS), an additional one (minimum) to two (maximum) feet of suitable soil media should be

provided below the underdrain (i.e., 1.5 feet is acceptable).

**FAQ #32: FAQ No. 1 states that there is no minimum infiltration rate, while the MRC document (on page 8) follows the BMP Manual recommendation of allowing a minimum infiltration rate of 0.1 in/hr. Which is the overriding design standard?**

The concept of MRC is to manage stormwater where infiltration rates are low, but still to encourage infiltration to occur where appropriate. The standards identified in the MRC Concept Document are the recommended design standards for an MRC BMP. The MRC Design Standards may differ from the recommendations in the PA Stormwater BMP Manual. There is no requirement to include infiltration in your modeling or calculations.

**FAQ #33: Where can the NOAA Type C distribution be found?**

Supporting information on the NOAA type curves can be found at:

[https://www.wcc.nrcs.usda.gov/ftpref/wntsc/H&H/rainDist/FIHMC\\_2015\\_Rainfall\\_Distribution\\_NOAA\\_14\\_Merkel.pdf](https://www.wcc.nrcs.usda.gov/ftpref/wntsc/H&H/rainDist/FIHMC_2015_Rainfall_Distribution_NOAA_14_Merkel.pdf)

The free WinTR55 software (and others) also has these tabulated:

[https://www.wcc.nrcs.usda.gov/ftpref/wntsc/H&H/rainDist/Documentation\\_NOAA\\_14\\_rainfall\\_dist\\_Ohio\\_Valley.pdf](https://www.wcc.nrcs.usda.gov/ftpref/wntsc/H&H/rainDist/Documentation_NOAA_14_rainfall_dist_Ohio_Valley.pdf)

Note that NOAA Type distributions are for the 2- through 100-year storms, not the 1.2” rainfall.

**FAQ #34: It is complicated when there are different standards and requirements that must be used for each BMP. The hydrographs with different rainfalls does not work for that POI.**

When a site has both MRC and non-MRC BMPs, for simplicity, it can be assumed that the post-construction drainage area to the MRC BMPs as well as the MRC BMPs themselves can be modeled as pre-construction to determine volume and water quality for use in non-MRC BMPs. However, peak rate for storms greater than the 2-year/24-hour storm still need to be managed for the MRC BMPs and the drainage area and MRC BMP drainage area and cannot be modeled as pre-construction conditions.

To elaborate:

- 1) Make sure the MRC BMP meets the criteria for the 1.2 inch/2-hour storm event volume capture and mitigate the 2-year/24-hour peak flow to be equal to or less than the 1-year/24-hour pre-construction peak for the MRC drainage area.
- 2) When running the 2-year/24-hour storm event the outflow from the MRC BMP should be considered as pre-construction conditions requiring no further treatment for volume or water quality.
- 3) Peak flows are not waived for the 10-, 50-, and 100-year/24-hour storms, so it SHOULD



NOT be considered as pre-construction for those analysis.

**FAQ #35: Can I use weighted Curve Numbers?**

For an MRC BMP, smaller rainfalls events are being used to design the system. Weighted or composite Curve Numbers (i.e., weighting impervious and meadow for an extreme examples) provide large volumetric errors for the 1.2-inch rainfall event. As such, all Curve Numbers for volume calculations should be separate for an MRC BMP.

**FAQ #36: How do I calculate peak outflow for the 2-year/24-hour storm event if I have both MRC BMPs and infiltration-based BMPs going into a downstream detention facility?**

The designer can use a weighted average of pre-construction 2-year/24-hour storm volumes to determine a weighted maximum post-construction peak rate for the 2-year/24-hour storm using the following equation:

$$\frac{(V_{infiltration} * Q_{infiltration} + V_{MRC} * Q_{MRC})}{(V_{infiltration} + V_{MRC})} = Q_{weighted}$$

Where:

$V_{infiltration}$  is the pre-construction 2-year/24-hour volume (in cubic feet (cf)) that is managed by infiltration BMPs (or other volume/water quality BMPs) going to the combined detention facility or as designated by applicable Act 167 Plan.

$Q_{infiltration}$  is the pre-construction 2-year/24-hour peak flow (in cfs; or as designated by applicable Act 167 Plan) associated with the portion of the site managed by infiltration BMPs (or other volume/water quality BMPs).

$V_{MRC}$  is the pre-construction 2-year/24-hour volume (in cf) that is intended to be managed by MRC BMPs going to the combined detention facility.

$Q_{MRC}$  is the preconstruction 1-year/24-hour peak flow (in cf) associated with the portion of the site managed by MRC BMPs.

$Q_{weighted}$  is the weighted maximum post-construction outflow peak rate (in cfs) for the 2-year/24-hour storm.

It is important to note that conceptually, areas treated by MRC BMPs and infiltration (non-MRC) BMPs will have to be separated for the pre-construction conditions in order to determine these values in the equation above. The designer can always use a more conservative approach if desired, such as limit post-construction 2-year/24-hour storm peak rate to the lowest rate applicable for the entire site.

**FAQ #37: Will DEP accept an MRC BMP design that extends below the year-round or seasonal high water table? If yes, what design considerations are there?**

Yes. Where all efforts to consider and implement alternatives have been explored and exhausted, DEP may accept a design where MRC BMPs extend below the water table. The designer should select an MRC BMP suitable for the application that protects the groundwater. This guidance recommends the following MRC configurations be considered, listed here in order of suitability:

1. MRC stormwater treatment wetlands.
2. Surface vegetated component with IWS upstream of a lined MRC storage system.
3. A lined MRC storage system that includes either porous pavement or filtration (80% or more of the suspended solids including fine sand and silt-sized particles that would enter the BMP at design conditions) of all inflows prior to the storage component. If an IWS is not practical, rigorous pretreatment is expected for underground MRC BMPs. Generally, a manufactured filtration device that removes 85% TSS and 50% TP and TN or more of the pollutants that would enter the BMP at design conditions is necessary.

Further design considerations for each alternative are included below.

MRC stormwater treatment wetlands

- May be designed to intercept groundwater to augment the permanent pool of water.
- Must be designed so that the permanent pool is sized for the runoff volume from the 1.2-inch/2-hour storm event (this volume is considered managed).
- Must be designed to manage the peak rate from the post-construction 2-year/24-hour storm event back to the pre-construction 1-year/24-hour storm peak rate (this volume is also considered managed for water quality and volume).
- Cannot be substituted with a conventional wet basin (instead of a stormwater treatment wetland).

Surface vegetated component with IWS upstream of a lined MRC storage system

- Are intended to separate the water quality function of the IWS from the storage function.
- Must have a minimum 2-foot media depth within the vegetated component.
- Must have a vegetated storage component that holds the first 0.5-inch of runoff.
- Must provide an IWS depth of 1 foot below the lowest outlet within the vegetated surface component.
- Must have a maximum ponding depth within the vegetated surface component of 6 inches (bypass systems should be designed to not exceed 6 inches of ponding in the vegetated components during the storm event).
- It is highly recommended that the designer provide a positive overflow at the inlet, or provide a bypass structure, for events greater than 1.0 inch of runoff to the vegetated surface component. When a bypass is not provided, the safe outflow and conveyance for storms up to and including the 10-year/24-hour storm is required.
- Must account for all flows out of the vegetated component and all flows out of the storage component in all hydrologic and hydraulic calculations, including controlled low flow release of the 1.2-inch/2-hour storm.

- The lined MRC storage system must be isolated from the water table to the maximum extent practicable utilizing a liner that meets the specifications of NRCS Standard 521a, or within an impermeable structure (e.g., concrete vault with sealed joints, etc.).
- The lined MRC storage system must be designed with measures taken to counteract buoyancy pressures. DEP expects that a professional engineer will provide buoyancy calculations to demonstrate the integrity of the liner and/or BMP.

#### Lined MRC storage systems

- Should be designed for inflows to enter through a permeable pavement system or filtered pretreatment device that removes 80% or more of the suspended solids including fine sand and silt-sized particles that would enter the BMP at design conditions.
- Should be designed to remain as isolated as possible from groundwater to protect the integrity of the BMP's volume and water quality management functions, using either a concrete vault or other storage system.
- Must be isolated from the water table to the maximum extent practicable utilizing a liner that meets the specifications of NRCS Standard 521a, or within an impermeable structure (e.g., concrete vault with sealed joints, etc.).
- Must be designed with measures taken to counteract buoyancy pressures. DEP expects that a professional engineer will provide buoyancy calculations to demonstrate the integrity of the liner and/or BMP.

### Version History

<b>Date</b>	<b>Version</b>	<b>Revision Reason</b>
12/21/2020	1.3	Added FAQ #37.
8/25/2020	1.2	Added FAQs #26 - #34. Updated FAQs #5 - #7 for the most current version of the MRC concept paper.
6/27/2019	1.1	Added FAQs #14 - #25
5/15/2019	1.0	Original