Post-Construction Storm Water Questions and Answers
Water Quality Volume

What is the water quality volume (WQv) and how did Ohio EPA determine how to calculate it?

The term water quality volume is generally used to define the amount of storm water runoff from any given storm that should be captured and treated in order to remove a majority of storm water pollutants on an average annual basis. Analysis of long-term, historic Ohio rainfall data indicates that designing post-construction best management practices (BMPs) to store storm water runoff from a rainfall of 0.90 inches or less results in an estimated 80 percent reduction in total suspended solids (TSS) on an average annual basis (Dorsey and Winston, 2018). Ohio EPA felt that this was a sufficient precipitation depth to control pollutants in runoff and minimize channel and stream bank erosion due to runoff from developed areas.

Are there any alternatives to using the WQv formula, runoff coefficient formula or drawdown times listed in the NPDES permit?

No. The formulas detailed in the NPDES construction general permit (CGP) for calculating the WQv or, in the case of flow-through BMPs such as grass swales, the water quality flow (WQf) must be used. Drawdown times provided in the CGP cannot be altered. These times are required to allow the practice enough time to settle pollutants out of runoff. Decreasing the drawdown times will make the practice less effective.

What surfaces should be considered impervious in determining a runoff coefficient?

The fraction of impervious surface used to determine the volumetric runoff coefficient (Rv) should be the fraction of drainage area that will be unvegetated (WEF/ASCE, 1998) such as rooftops, paved or gravel roads and parking lots, sidewalks detention basins and open water.

Is treatment of the WQv required for areas of the development that will not drain into the permanent drainage system of the site?

Yes. Treatment of the WQv is required for all portions of the site being developed. Thus, runoff from the entire site should be routed through a structural BMP before being discharged. Ohio EPA understands there may be situations where it will not be possible to establish a standard post-construction BMP for perimeter areas or for small, isolated drainage areas of the site.

The runoff reduction practices listed in the CGP can be used in place of structural BMPs to address runoff along perimeter areas or for small, isolated drainage areas that cannot be routed to storm sewers. Rear-yard lawns may be designed as vegetated filter strips so as to capture and treat the WQv. However, easements and deed restrictions may be necessary to ensure access when maintenance must be performed and to ensure that homeowners do not install structures which could impede the function of the filter strip.

Stream setbacks or riparian protection areas may also be used for perimeter areas. However, the size of stream setbacks or riparian protection areas should be justified based on the size of the stream and must meet local riparian setback requirements at a minimum. The SWP3 must include documentation that setbacks will remain in perpetuity.

Where runoff reduction practices, stream setbacks or riparian areas are not feasible, please consult with Ohio EPA for further guidance. Ohio EPA will require you to demonstrate that a site design to provide the required BMPs for these perimeter or small, isolated areas cannot be achieved.

Can areas not draining to a structural BMP be compensated for by overtreating other areas?

No. Untreated areas cannot be compensated for by overdesigning or oversizing BMPs treating the remainder of the site. When shown to be necessary, compensation could occur by constructing a BMP using the offsite mitigation procedures established in the CGP.

Am I required to include runoff generated from off-site areas or undeveloped portions of the site when determining the WQv?

Yes. The area used in calculating the WQv is the total contributing drainage area to the BMP. Ohio EPA does not require off-site areas and undeveloped portions of the site to be routed through structural post-construction BMPs and, where no adverse upstream or downstream impact would occur, Ohio EPA encourages diverting such areas away from the BMP(s). However, local government may have other requirements or may ask the developer to provide detention of off-site areas or undeveloped portions of the site for flood control reasons. If this occurs, whenever possible, structural post-construction BMPs for water quality should be located at the point just prior to where runoff from developed portions co-mingles with these other sources of runoff. This will allow the post-construction BMP to be sized only for developed portions of the site. Where this is not possible or where these areas must be routed through the post-construction practice, the SWP3 designer must account for off-site acreage and/or the acreage of undeveloped areas when calculating the WQv.

If the local government requires a detention or retention basin to manage the flood control volume and the peak rate of storm water discharge from the site, can the requirements for post-construction control for water quality be incorporated into the basin?

Yes. In fact, this appears to be the method of choice for meeting the post-construction BMP requirement. If the basin will serve the multiple functions of water quality and water quantity management, a staged outlet structure with multiple orifices or weirs will be needed. Ohio EPA does not require the WQv and any quantity control volumes be stacked within the basin, but please consult the local storm water regulations for their preference regarding this matter.

References

Dorsey, J. and R. Winston. 2018. WQv Analysis. Technical Memorandum prepared for Ohio EPA.

WEF/ASCE. 1998. Urban Runoff Quality Management. WEF Manual of Practice No. 23 and ASCE Manual and Report on Engineering Practice No. 87. Alexandria, VA and Reston, VA: WEF and ASCE.

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Ohio Environmental Protection Agency

Division of Surface Water
October 2018

NPDES Construction General Permit
#OHC000005

Post-Construction Storm Water Questions and Answers
Previously Developed Areas

The NPDES construction general permit (CGP) requires a post-construction storm water best management practice (BMP) on all disturbed areas one acre or larger. To encourage redevelopment, the CGP reduces the water quality volume (WQv) requirement for post-construction BMPs on previously developed areas.

What is a previously developed area?

Ohio EPA considers previously developed areas to be construction projects occurring on land where the area to be disturbed has measurable impervious surface and where the new project will remove or replace some or all of that impervious surface. In many cases, the entire site is considered a previously developed area, including the graded pervious area (landscaping or lawns) associated with the existing impervious surfaces.

What are the post-construction requirements on previously developed areas?

Post-construction BMPs are required on projects that qualify as previously developed areas unless the impervious area on the site is reduced such that there is a 20 percent or greater reduction in the volumetric runoff coefficient [Rv(proposed) ≤ 0.8*Rv(existing)]. Otherwise, treatment must be provided for the WQv as calculated by Equation 3 in the CGP.

Is the post-construction BMP still designed for its entire drainage area?

Yes. A BMP must be sized for the full WQv of the area that drains to it. On previously developed areas, it may be possible to locate a BMP such that only the portion of the site producing the required WQv drains to it. The minimum sub-drainage area producing the required WQv may be back-calculated by re-arranging Equation 1 in the CGP.

$$\text{Sub-drainage area (acres)} \geq \frac{\text{WQv(required)} \times 12}{\text{Rv} \times \text{P}}$$

where:

WQv (required) = result of CGP Equation 3 for the entire project (acre-feet)
Rv = volumetric runoff coefficient of the sub-drainage area
P = 0.9 inches.

The sub-drainage area should be the area likely to generate the highest pollutant loads. In most cases this area will be parking lots, roadways or other impervious surface with a Rv value of 0.95.

What if a portion of my project area is previously developed and a portion is not?

Situations may occur when adjacent open land is purchased and added to a previously developed area, or vice-versa, creating a larger common plan of development or sale that is a combination of new development and redevelopment. In these cases, calculate the WQv of the adjacent open land as new development with CGP Equation1 and the WQv of the previously developed land with CGP Equation 3 and total them to determine the WQv required for the entire common plan of development.

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Post-Construction Storm Water Q&A: Previously Developed Areas

Example Calculations

Example A:

A 5-acre shopping center (fully impervious) will be redeveloped into condominiums featuring an expansive courtyard. The proposed project will total 3.75 acres of impervious surface and 1.25 acres of greenspace.

$$Rv1 = 0.05 + 0.9\left(\frac{5\text{ acres}}{5\text{ acres}}\right) = 0.950 \qquad Rv2 = 0.05 + 0.9\left(\frac{3.75\text{ acres}}{5\text{ acres}}\right) = 0.725$$

The proposed development will reduce the Rv by 23.7%, therefore no additional post-construction BMPs are required for the site.

Example B:

An 8-acre property with vacant warehouses will be redeveloped into a retail complex. The existing warehouse and parking total 7.2 acres of impervious area. Plans for the new development specify 6.5 acres of impervious surface with a 0.5-acre storm water pond and 1.0 acre of greenspace.

$$Rv1 = 0.05 + 0.9\left(\frac{7.2\text{ acres}}{8\text{ acres}}\right) = 0.860 \qquad Rv2 = 0.05 + 0.9\left(\frac{6.5\text{ acres} + 0.5\text{ acres}}{8\text{ acres}}\right) = 0.838$$

The proposed development will reduce Rv by 2.6%. Therefore, an additional post-construction BMP is required to treat:

$$0.9\text{ (in)} \times 8\text{ (ac)} \times [\,(0.860 \times 0.2) + (0.838 - 0.860)] \div 12 = 0.09\text{ ac-ft}$$

The WQv required can be achieved using a BMP with an impervious sub-drainage area of:

$$\text{Sub-drainage area (acres)} = \frac{0.09\text{(ac-ft)} \times 12}{0.95 \times 0.90\text{(in)}} = 1.26\text{ acres}$$

Example C:

A 10-acre parking facility (Rv =0.95) will be removed and replaced with a larger 15-acre development by buying or transferring ownership of an adjacent 5-acre undeveloped (Rv = 0.05) parcel to expand the site.

$$0.9\text{(in)} \times 1\text{ (ac)} \times [\,0.95 \times 0.2) + (0.95 - 0.95)] \div 12 = 0.143\text{ ac-ft}$$
$$0.9\text{(in)} \times 0.95 \times 5\text{(ac)} \times \div 12 = \underline{0.356\text{ ac-ft}}$$
$$WQv = 0.499\text{ ac-ft}$$

The WQv required can be achieved using a BMP with an impervious sub-drainage area of:

$$\text{Sub–drainage area (acres)} = \frac{0.499\text{(ac-ft)} \times 12}{0.95 \times 0.90\text{(in)}} = 7.0\text{ acres}$$

Ohio Environmental Protection Agency

Division of Surface Water
October 2018

NPDES Construction General Permit
#OHC000005

Post-Construction Storm Water Questions and Answers
Small Construction Activities (< 2 acres)

The NPDES construction general permit (CGP) requires a post-construction storm water best management practice (BMP) on all disturbed areas one acre or larger. Recognizing the challenges of limited space, more flexibility in BMP implementation is afforded to activities authorized under the CGP where the common plan of development or sale will result in less than two acres of earth disturbance. These less than 2-acre activities are referred to as small construction activities.

Are the standard Table 4a and 4b post-construction BMPs required on small construction activities?

Post-construction BMPs must ensure compliance with Ohio's Water Quality Standards contained in Ohio Administrative Code (OAC) 3745-1. Ohio EPA believes these requirements will be met with Table 4a and 4b post-construction BMPs designed to treat the water quality volume (WQv) by detaining it for 24- to 48-hours (depending on the BMP selected). As such, these criteria should generally be applied to all development sites, regardless of size.

Although it may be impractical to locate surface detention facilities on small sites, standard BMPs including permeable pavement, sand or media filters, underground detention/infiltration, bioretention cells and infiltration trenches are well suited for small drainage areas. If space constraints or other factors (soil permeability, underground utility conflicts) preclude the use of these practices, a non-standard BMP may be selected to treat storm water runoff for pollutants and to reduce the adverse impacts on receiving waters.

What non-standard BMPs may be used?

The post-construction BMPs that will be installed must address the anticipated impacts on the channel and floodplain morphology, hydrology and water quality. BMPs should be selected to treat the pollutants and storm water concerns associated with the proposed land use.

In some instances, water quality goals may be achieved on small construction activities using a combination of soil amending, vegetative filter strips, conservation areas, grass swales, rain barrels, storm water planters, rain gardens and roof gardens, or using a subset of these practices in conjunction with standard practices. Proprietary practices may be options where they can be shown to provide the treatment needed. All practices should be designed to discharge at a non-erosive velocity.

Are non-standard BMPs required to treat the WQv?

Ohio EPA does not explicitly require that BMPs selected for small construction activities be designed to treat the WQv and drain it down over a prescribed time period. However, the BMPs listed in Table 4a or 4b, the runoff reduction practices and many proprietary BMPs must be designed per the WQv or the water quality flow (WQf) criteria to ensure compliance with Ohio's Water Quality Standards.

How is the need for a non-standard BMP documented?

As outlined in the CGP, every Storm Water Pollution Prevention Plan (SWP3) must contain a written rationale for the selection of the post-construction BMP(s). The rationale must justify the use of a non-standard BMP by explaining the factors limiting the use of a standard practice and how treatment goals will be met. Additionally, an operation and maintenance plan must be provided to the future owners or operators for all BMPs, standard or non-standard.

Does Ohio EPA review non-standard BMPs?

Non-standard practices on small construction activities do not require a review by Ohio EPA but will require approval from the local community. Note that local storm water regulations may be more restrictive in the types of BMPs permissible and should be consulted during the BMP selection process.

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Division of Surface Water
October 2018

NPDES Construction General Permit
#OHC000005

Ohio Environmental Protection Agency

Post-Construction Storm Water Questions and Answers

Water Quality Volume Drawdown

The NPDES construction general permit (CGP) requires a post-construction storm water best management practice (BMP) on all disturbed areas one acre or larger. The post-construction BMP must be designed to meet a required minimum drain time at a measured release rate over the full drawdown curve to optimize water quality treatment.

What are the discharge requirements for extended detention BMPs?

For dry extended detention basins, the water quality volume (WQv) is detained and released over 48 hours. For wet extended detention basins and wetland basins, the WQv is detained and released over 24 hours. The release period (24 or 48 hours) is the drawdown time from a brimful WQv; that is, with discharge beginning from storage of the full WQv until the entire WQv drains out of the basin.

The water quality outlet must be sized such that no more than one-half of the WQv is released in the first one-third of the required drawdown time (the first 16 hours for dry basins, the first 8 hours for wet basins and wetland basins). A greater release rate will reduce the pollutant removal efficiency and increase the hydraulic impacts to receiving streams.

How do you determine the water quality outlet (orifice) size to meet the WQv drawdown requirements?

A shortcut method is presented here for sizing the water quality outlet based on the drawdown requirements and the average hydraulic head associated with the storage volume. This simplified method will provide a starting point from which to design a vertical, circular orifice, but may be adapted for other water quality outlet configurations.

Step1. Determine the WQv for the drainage area to the BMP (see Equation 1; p21, CGP)

Step 2. Determine the average release rate for the WQv:

$$Q_{avg} = WQv/t_d$$

where:

t_d = minimum drain time (hr)

t_d = 48 hr for dry extended detention basin

t_d = 24 hr for wet extended detention basin or wetland basin

Step 3. Using average hydraulic head (Havg) equal to one-half the maximum hydraulic head (Hmax), estimate the required outlet orifice area by rearranging and solving the orifice equation:

$$A_{orifice} = Q_{avg}/[C^*(2^*g^*H_{avg})^{0.5}]$$

where:

$A_{orifice}$ = area [ft^2]

Q_{avg} = average discharge rate (ft^3/s)

C = coefficient of discharge (0.6 for sharp-edge orifice)

g = acceleration of gravity (32.2 ft/s^2)

$H_{avg} = H_{max}/2$ = average hydraulic head (ft)

H_{max} = brimful WQv elevation – water quality outlet elevation or tailwater elevation

Step 4. Based on orifice area, determine the dimensions for the orifice. For a circular orifice:

$$A_{orifice} = \pi^* d_{orifice}{}^2/4$$

$$d_{orifice} = [(4^*A_{orifice})/\pi]^{0.5}$$

where:

d is orifice diameter

Step 5. Verify the drawdown rate and adjust the orifice size as necessary.

Post-Construction Storm Water Q&A: Water Quality Volume Drawdown

How is the drawdown rate verified?

Though orifices larger than that calculated by the above method may meet the target drawdown period for the WQv basin, they may not meet the CGP requirement to discharge no more than the first half of the WQv in less than one-third of the drawdown time. To verify drawdown is acceptable, you must either (A) use a spreadsheet [see Figure 1] or (B) route the WQv (pull the plug from a full WQv) through the basin outlet to ensure the actual drawdown curve meets requirements.

To account for discharge occurring during the drawdown period, can I route the WQv through the BMP?

No. Ohio EPA understands that basin discharge will begin before the basin fills the full WQv. Routing of storm water runoff through post-construction BMPs was accounted for in the selection of the PWQv, reducing the water quality event depth from 1.10 inches to 0.90 inches.

How is compliance with the required drawdown documented?

To demonstrate compliance with the post-construction sizing requirements when designing extended detention basins, calculations to determine orifice size must be clearly indicated in the Storm Water Pollution Prevention Plan (SWP3). Ohio EPA recommends including stage-storage data or elevation-area-capacity tables indicating the elevation at which the WQv is achieved. This data must match the elevations indicated on the profile view of the outlet structure. Ohio EPA recommends including a graph (see Figure 1) that shows the post-construction BMP achieves the desired WQv release rate.

Example Calculation

A wet extended detention basin was selected as the post-construction WQv practice for a 16.5-acre residential development with 6.8 acres of impervious area. A circular orifice will be used as the outlet, and the proposed WQv depth (H_{max}) is 1.5 ft.

Step 1. Determine the WQv

Area draining to BMP, A_{total} = 16.5 ac
Impervious area draining to BMP, A_{imp} = 6.8 ac
Impervious fraction, $i = A_{imp}/A_{total}$ = (6.8 ac)/(16.5 ac) = 0.41 [41% impervious]
Volumetric runoff coefficient, Rv = 0.05 + 0.9*i = 0.05 + 0.9*(0.41) = 0.42
Water quality volume, WQv = Rv*P*A/12 = 0.42*(0.90 in)*(16.5 ac)/(12 in/ft) = 0.52 ac-ft = 22,640 ft^3

Step 2. Determine the average release rate for the WQv

$Q_{avg} = WQv/t_d$ = 22,640 ft3/ (24 hr) (3600 s/hr) = 0.262 ft^3/s

Step 3. Using average hydraulic head (H_{avg}) equal to one-half the maximum hydraulic head (H_{max}), estimate the required outlet orifice area by rearranging and solving the orifice equation

$A_{orifice} = Q_{avg}/[C*(2*g*H_{avg})^{0.5}]$ = (0.262 ft^3/s)/[0.6*(2*32.2 ft/s^2*0.75 ft)$^{0.5}$] = 0.0628 ft^2

where:

C = coefficient of discharge (0.6 for sharp-edge orifice)
g = acceleration of gravity (32.2 ft/s^2)
$H_{avg} = H_{max}/2$ = (1.5 ft)/2 = 0.75 ft (average hydraulic head)

Step 4. Based on orifice area, determine the dimensions for the orifice. For a circular orifice:

$D_{orifice} = [(4*A_{orifice})/\pi]^{0.5} = [(4*0.0628\ ft^2)/\pi]^{0.5}$ = 0.282 ft = 3.40 in

Step 5. Verify the drawdown rate and adjust the orifice size as necessary.

Volume @ $T_{8\ hours}$ = 13,173 (≥22,640/2, OK)
Volume @ $T_{24\ hours}$ =2,540 (≥ 0, OK)

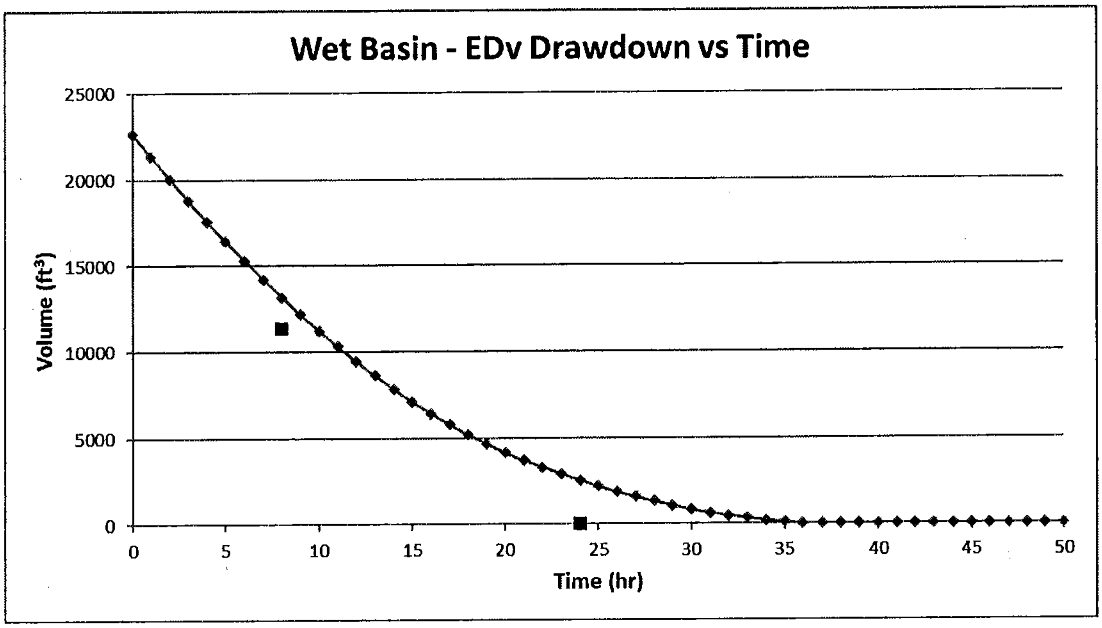

Figure 1 - Spreadsheet designed to show drawdown from brimful WQv in the above example.

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Ohio Environmental Protection Agency

Guidance on Manufactured Treatment Devices as Pretreatment for Underground Storm Water Management Systems

NPDES Construction General Permit #OHC00005 (CGP) lists an underground storm water management system (USWMS) in both of the following configurations as a standard post-construction best management practice (BMP) approved for general use:

- a USWMS providing extended detention coupled with a pretreatment practice 50 percent effective at capturing total suspended solids (TSS); and
- a USWMS providing infiltration coupled with a pretreatment practice 80 percent effective at capturing TSS.

The pretreatment TSS removal efficacy of either 50 or 80 percent must be verified through laboratory or field testing as detailed in the Alternative Post-Construction BMP Testing Protocol section of the CGP. Ohio EPA anticipates that a manufactured treatment device (MTD) will often be proposed as pretreatment for a USWMS and that designers, as well as regulated communities, will rely on the MTD certification programs referenced in the CGP to verify compliance with the CGP.

Extended Detention Versus Infiltration

If a USWMS is designed to detain the entire water quality volume (WQv) below the outlet of the system and infiltrate it into the soil, or to receive runoff reduction credit or Darby watershed ground water recharge credit, a pretreatment practice with an 80 percent TSS removal rate is required to protect the infiltrating surface from clogging.

If the USWMS captures the WQv, provides the required sediment storage and includes an outlet sized to provide extended detention, a pretreatment practice with a 50 percent TSS removal rate is required. USWMS designed for extended detention may utilize a pretreatment practice verified at 50 percent TSS removal rate and still provide the opportunity to infiltrate a portion of the WQv.

Verifying Acceptable Pretreatment

Ohio EPA recommends using the State of New Jersey Department of Environmental Protection (NJDEP) certification program to confirm that a pretreatment MTD meets the CGP requirements. The NJDEP's test protocol is comparable to the laboratory testing protocol in the CGP. MTDs with test results certified by NJDEP for 50 percent TSS removal efficacy are acceptable to Ohio EPA for pretreatment of USMS providing extended detention. An MTD certified by NJDEP for 80 percent TSS removal efficacy is acceptable to Ohio EPA for pretreatment of USMS providing infiltration or extended detention.

The NJDEP certification letter should be reviewed to assure applicable design conditions, excluding those specific to the State of New Jersey, are met. For example, the maximum treatment flow rate (MTFR) for the selected MTD should equal or exceed the Ohio's water quality flow (WQF) for the MTD's drainage area. Only MTD models or sizes included in the certification letter should be considered approved unless the certification letter specifically approves a method to scale additional models or sizes.

The CGP further indicates Ohio EPA will accept field test results certified under the State of Washington, Technology Assessment Protocol - Ecology program (TAPE). It should be noted that not all MTDs listed as certified by TAPE have undergone field testing comparable to the CGP requirements. Only an MTD certified by TAPE with ***General Use Level Designation for Basic Treatment*** is acceptable to Ohio EPA for pretreatment at 80 percent TSS efficacy. MTFR, hydraulic loading, drainage area and other relevant design criteria associated with the TAPE certification should be followed.

NJDEP- and TAPE-certified MTDs as of June 2018 are listed in Table 1 and Table 2. The most current lists can be found at: ***nj.gov/dep/stormwater/treatment.html*** and ***ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies.***

General Permit OHC000005: Guidance on Manufactured Treatment Devices as Pretreatment for Underground Storm Water Management Systems

Hydraulic Sizing

Most MTDs treat storm water as it is received with little or no detention and as such, must be able to achieve the required TSS removal when subject to the WQF. The WQF must be determined in accordance with the CGP for the contributing drainage area and calculated time of concentration (tc) to the pretreatment MTD. The MTD model or size, or number of filter units, must have a treatment flow rate equal to or exceeding the WQF.

If there are multiple inlets to the USMS, each inlet must include pretreatment sized accordingly. Flow may be divided equally among multiple pretreatment practices installed in parallel at any inlet.

Sizing Example

A USWMS is designed to provide extended detention of the WQv. One inlet to the system drains 0.50 acres of pavement with a calculated tc of five minutes and will be pretreated using a MTD that NJDEP has certified for 50 percent TSS removal. The NJDEP certification letter approves the MTD sizes to the following criteria:

MTD Size	NJDEP 50% TSS MTFR (cfs)
#2	0.35
#4	1.15
#6	3.75
#8	5.85

The required WQF for this inlet is calculated as: WQF = CIA = 0.95 * 2.37(in/hr) * 0.50 (ac) = 1.13 (cfs). The #4 unit with a MTFR of 1.15 cfs exceeds the WQF and is acceptable for pretreatment on this inlet.

A second inlet drains 1.00 acres with a tc of eight minutes, with a WQF calculated as: WQF = CIA = 0.95 * 2.04(in/hr) * 1.00 (ac) = 1.94 (cfs). A #6 unit meets the MTFR.

Additional Considerations

In addition to a verified TSS removal efficacy, a properly designed pretreatment practice will minimize the quantity of sediment, floatables, oils and grease that reach the underground storage system where they will become difficult to remove and subject to resuspension, as well as minimize clogging of any infiltration surface. The ***Rainwater and Land Development Manual*** specification on pretreatment should be consulted for additional design considerations.

Designers must consider the long-term performance of a BMP. Pretreatment MTDs typically have limited storage capacity for accumulated material, therefore a viable **Operation and Maintenance Plan** with a specific inspection and cleaning schedule is vital to long-term performance.

Please note a regulated MS4 may have additional or more stringent requirements and should be consulted prior to selection of a pretreatment practice.

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General Permit OHC000005: Guidance on Manufactured Treatment Devices as Pretreatment for Underground Storm Water Management Systems

TABLE 1: Manufactured Treatment Devices Certified by NJDEP and TAPE for <u>80 percent TSS Removal</u> for Pretreatment of USWMS Providing Infiltration. (as of 6/2018)

NJDEP	TAPE (General Use, Basic Treatment)
Aqua-Filter Stormwater Filtration System by AquaShield, Inc.	BayFilter w/ BFC Media by BaySaver Technologies, Inc.
BayFilter™ Enhanced Media Cartridge by BaySaver Technologies, LLC	BayFilter w/EMC Media
Biopod™ Biofilter with StormMix Media by OldCastle Precast Inc.	MWS-Linear Modular Wetland by BioClean Environmental Services, Inc.
Filterra Bioretention System by Contech Engineered Solutions	StormFilter using PhosphoSorb Media at 1.67 gpm/sq ft by CONTECH Engineered Solutions, LLC.
Kraken Stormwater Filtration System by BioClean Environmental Service, Inc.	Stormfilter using ZPG Media by CONTECH Engineered Solutions, LLC.
PerkFilter™ Media Filtration System by Oldcastle Precast, Inc.	Filterra System by CONTECH Engineered Solutions, LLC.
Stormwater Management StormFilter by CONTECH Stormwater Solutions, Inc.	Filterra Bioscape by CONTECH Engineered Solutions, LLC.
Up-Flo Filter by Hydro International	Media Filtration System by CONTECH Engineered Solutions, LLC.
	FloGard Perk Filter by Oldcastle Precast, Inc.
	BioPod Biofilter with Curb Inlet by Oldcastle Precast, Inc.
	ecoStorm plus by Watertectonics, Inc.

TABLE 2: Manufactured Treatment Devices Certified by NJDEP for <u>50 percent TSS Removal</u> for Pretreatment of USWMS Providing Extended Detention. (as of 6/2018)

NJDEP
Aqua-Swirl By AquaShield, Inc.
BaySaver Barracuda by BaySaver Technologies, LLC
Continuous Deflective Separator (CDS) Unit by CONTECH Stormwater Solutions, Inc.
Downstream Defender by Hydro International, Inc.
Dual Vortex Separator by Oldcastle Stormwater Solutions
First Defense HC (FDHC) Stormwater Treatment Device by Hydro International, Inc.
HydroStorm Hydrodynamic Separator by Hydroworks LLC.
Nutrient Separating Baffle Box® (NSBB) with Hydro-Variant Technology Stormwater Treatment Device by Suntree Technologies, Inc.
SiteSaver Stormwater Treatment Device by Fresh Creek Technologies, Inc.
StormPro Stormwater Treatment Device by Environment 21, LLC
StormTrap SiteSaver®-4 (STSS-4) by FreshCreek Technologies, Inc
Terre Kleen™ Hydrodynamic Separator by Terre Hill Stormwater Systems
SciClone™ Hydrodynamic Separator by BioClean Environmental Services, Inc.