Appendix C – BMP Performance Curves and Static Storage Volume Calculation Methods

Sources of EPA Region 1 Stormwater BMP Performance Curves

The BMP Performance Curves are included in a variety of MS4 Stormwater General Permits and tools developed by EPA Region 1 and/or state agencies in New England.

- New England Stormwater Retrofit Manual
- EPA MS4 General Permit for Massachusetts (Appendix F, Attachment 3)
- EPA MS4 General Permit for New Hampshire (Appendix F, Attachment 3)
- EPA Best Management Practice Accounting and Tracking Tool (BATT)
- Rhode Island Department of Transportation (RIDOT) Stormwater Control Plan Calculator
- University of New Hampshire Stormwater Center BMP Performance Fact Sheets
- EPA BMP Performance Curves for Fecal Indicator Bacteria
- EPA Technical Information for Use and Application of Performance Curves for Indicator Bacteria

BMP Performance Curve Category[1]	Stormwater BMP Type Connecticut Stormwater Quality Manual	Static Storage Volume Equation[2]
Infiltration Trench	**Infiltration Trench** Static Storage Volume = ponding water storage volume and void space volume of stone	$V = (A * D_{ponding}) + (L * W * D_{stone} * n_{stone})$ V = static storage volume (cubic feet) A = average area between maximum ponding depth and the trench surface (square feet) $D_{ponding}$ = maximum ponding depth (feet) L = length (feet) W = width (feet) D_{stone} = depth of stone (feet) n_{stone} = porosity of stone (use default value of 0.4). Other porosity values may be used as determined from testing of the proposed materials.
	Dry Well **Infiltrating Catch Basin** **Underground Infiltration System (Chambers)** Static Storage Volume = water storage volume of storage structures and void space volume of stone underlying and surrounding the storage structures	• Static storage volume equations vary based on type of system. • Refer to manufacturer's design guidance for calculating static storage volume for manufactured infiltration chambers and similar subsurface storage units. • When calculating the stone storage capacity, subtract the storage volume of the chambers from the calculated storage volume of the stone layer before multiplying by stone porosity.
	Permeable Pavement (no underdrain) Static Storage Volume = void space volume of choker course (stone), filter course (sand), and stone reservoir	$V = L * W * (D_{stone} * n_{stone} + D_{sand} * n_{sand})$ V = static storage volume (cubic feet) L = length (feet) W = width (feet) D_{stone} = depth of stone courses (feet) D_{sand} = depth of sand filter course (feet) n_{stone} = porosity of stone courses (use default value of 0.4) n_{sand} = porosity of sand filter course (use default value of 0.3)

BMP Performance Curve Category[1]	Stormwater BMP Type Connecticut Stormwater Quality Manual	Static Storage Volume Equation[2]
Infiltration Trench (continued)	**Tree Filter (no underdrain)** Static Storage Volume = ponding water storage volume and void space volume of soil filter media and gravel/stone layers (pea gravel and stone reservoir) if stone reservoir is used. If stone reservoir is not included, exclude pea gravel and stone from the static storage volume calculation.	The following equation for bioretention systems may be used. Refer to manufacturer's design guidance for manufactured tree filters for additional guidance. $V = (L * W * D_{ponding}) + (L * W * D_{soil} * n_{soil}) + (L * W * D_{stone} * n_{stone})$ V = static storage volume (cubic feet) L = length of bioretention system (feet) W = average width of bioretention system between maximum ponding depth and the bottom of the system (feet) $D_{ponding}$ = maximum ponding depth (feet) D_{soil} = depth of bioretention soil layer (feet) D_{stone} = depth of underdrain gravel and/or stone reservoir layer(s) between bottom of the bioretention soil layer and native soil (feet) n_{soil} = porosity of bioretention soil (use default value of 0.3) n_{stone} = porosity of gravel/stone (use default value of 0.4)
Infiltration Basin	**Infiltration Basin** Static Storage Volume = ponding water storage volume	$V = A * D_{ponding}$ V = static storage volume (cubic feet) A = average area between maximum ponding depth and the basin bottom (square feet) $D_{ponding}$ = maximum ponding depth (feet)

BMP Performance Curve Category[1]	Stormwater BMP Type Connecticut Stormwater Quality Manual	Static Storage Volume Equation[2]
Infiltration Basin (continued)	**Dry Water Quality Swale (no underdrain)** Static Storage Volume = water storage volume of swale and void space volume of soil filter media and gravel/stone layers (pea gravel and stone reservoir) if stone reservoir is used. If stone reservoir is not included, exclude pea gravel and stone from the static storage volume calculation.	$V = (L * W * D_{ponding}) + (L * W * D_{soil} * n_{soil}) + (L * W * D_{stone} * n_{stone})$ V = static storage volume (cubic feet) L = length of swale (feet) W = average width of swale between maximum ponding depth and the bottom of the swale (feet) $D_{ponding}$ = maximum ponding depth (feet) D_{soil} = depth of bioretention soil layer (feet) D_{stone} = depth of underdrain stone/gravel layer (feet) n_{soil} = porosity of bioretention soil (use default value of 0.3) n_{stone} = porosity of gravel/stone (use default value of 0.4)
	Bioretention (no underdrain) Static Storage Volume = ponding water storage volume and void space volume of soil filter media and gravel/stone layers (pea gravel and stone reservoir) if stone reservoir is used. If stone reservoir is not included, exclude pea gravel and stone from the static storage volume calculation.	$V = (L * W * D_{ponding}) + (L * W * D_{soil} * n_{soil}) + (L * W * D_{stone} * n_{stone})$ V = static storage volume (cubic feet) L = length of bioretention system (feet) W = average width of bioretention system between maximum ponding depth and the bottom of the system (feet) $D_{ponding}$ = maximum ponding depth (feet) D_{soil} = depth of bioretention soil layer (feet) D_{stone} = depth of underdrain gravel and/or stone reservoir layer(s) between bottom of the bioretention soil layer and native soil (feet) n_{soil} = porosity of bioretention soil (use default value of 0.3) n_{stone} = porosity of gravel/stone (use default value of 0.4)

BMP Performance Curve Category[1]	Stormwater BMP Type Connecticut Stormwater Quality Manual	Static Storage Volume Equation[2]
Biofiltration	**Bioretention (with underdrain)** **Tree Filter (with underdrain)** Static Storage Volume = Ponding water storage volume and void space volume of soil filter media and stone/gravel layers (pea gravel and stone reservoir)	$V = (L * W * D_{ponding}) + (L * W * D_{soil} * n_{soil}) + (L * W * D_{stone} * n_{stone})$ V = static storage volume (cubic feet) L = length of bioretention system (feet) W = average width of bioretention system between maximum ponding depth and the bottom of the system (feet) $D_{ponding}$ = maximum ponding depth (feet) D_{soil} = depth of bioretention soil layer (feet) D_{stone} = depth of underdrain gravel and/or stone reservoir layer(s) between bottom of the bioretention soil layer and native soil (feet) n_{soil} = porosity of bioretention soil (use default value of 0.3) n_{stone} = porosity of gravel/stone (use default value of 0.4) The above equation for bioretention systems may be used for tree filters. Refer to manufacturer's design guidance for manufactured tree filters for additional guidance.
	Surface Sand Filter (with underdrain) Static Storage Volume = ponding volume and void space volume of sand and gravel/stone layers	$V = (A * D_{ponding}) + (A_{bed} * D_{sand} * n_{sand}) + (A_{bed} * D_{stone} * n_{stone})$ V = static storage volume (cubic feet) A = average area between maximum ponding depth and the filter bed surface (square feet) A_{bed} = surface area of filter bed (square feet) $D_{ponding}$ = maximum ponding depth above filter bed (feet) D_{sand} = depth of sand layer (feet) D_{stone} = depth of underdrain stone layer (feet) n_{sand} = porosity of sand (use default value of 0.3) n_{stone} = porosity of stone (use default value of 0.4)

BMP Performance Curve Category[1]	Stormwater BMP Type Connecticut Stormwater Quality Manual	Static Storage Volume Equation[2]
Biofiltration (continued)	**Dry Water Quality Swale (with underdrain)** Static Storage Volume = Water storage volume of swale and void space volume of soil filter media and gravel/stone layers (pea gravel and stone reservoir)	$V = (L * W * D_{ponding}) + (L * W * D_{soil} * n_{soil}) + (L * W * D_{stone} * n_{stone})$ V = static storage volume (cubic feet) L = length of swale (feet) W = average width of swale between maximum ponding depth and the bottom of the swale (feet) $D_{ponding}$ = maximum ponding depth (feet) D_{soil} = depth of bioretention soil layer (feet) D_{stone} = depth of underdrain stone/gravel layer (feet) n_{soil} = porosity of bioretention soil (use default value of 0.3) n_{stone} = porosity of gravel/stone (use default value of 0.4)
Gravel Wetland	**Subsurface Gravel Wetland** **Shallow Wetland** Static Storage Volume = pretreatment volume plus volume of ponding and volume of void space in subsurface gravel/stone bed	$V = (A_{pretreatment} * D_{pretreatment}) + (A_{wetland} * D_{ponding}) + (A_{ISR} * D_{stone} * n_{stone})$ V = static storage volume (cubic feet) $A_{pretreatment}$ = pretreatment surface area (square feet) $A_{wetland}$ = surface area of wetland (square feet) $A_{Internal\ Storage\ Reservoir}$ = surface area of internal storage reservoir (square feet) $D_{pretreatment}$ = maximum ponding depth in pretreatment area (feet) $D_{ponding}$ = maximum ponding depth above wetland floor (feet) D_{stone} = depth of gravel/stone bed (feet) n_{stone} = porosity of gravel/stone (use default value of 0.4)

BMP Performance Curve Category[1]	Stormwater BMP Type Connecticut Stormwater Quality Manual	Static Storage Volume Equation[2]
Porous Pavement	**Permeable Pavement (with underdrain)** Static Storage Volume = void space volume of choker course (stone), filter course (sand), and stone reservoir	$V = L * W * (D_{stone} * n_{stone} + D_{sand} * n_{sand})$ V = static storage volume (cubic feet) L = length (feet) W = width (feet) D_{stone} = depth of stone courses (feet) D_{sand} = depth of sand filter course (feet) n_{stone} = porosity of stone courses (use default value of 0.4) n_{sand} = porosity of sand filter course (use default value of 0.3)
Wet Pond	**Wet Pond** **Micropool Extended Detention Pond** **Wet Extended Detention Pond** **Multiple Pond System** **Wet Water Quality Swale** Static Storage Volume = permanent pool volume prior to high flow bypass (excludes pretreatment volume)	$V = A_{pond} * D_{pond}$ V = static storage volume (cubic feet) A = average area between maximum ponding depth and bottom of pond (square feet) $D_{ponding}$ = maximum ponding depth (feet) Static storage volume can also be calculated based on microtopography (proposed contours) and the elevation of the high flow bypass or overflow.
Dry Pond	**Dry Extended Detention Basin** **Extended Detention Shallow Wetland Pond/Wetland System** Static Storage Volume = ponding volume prior to high flow bypass (excludes pretreatment volume)	$V = A_{pond} * D_{pond}$ V = static storage volume (cubic feet) A = average area between maximum ponding depth and bottom of pond (square feet) $D_{ponding}$ = maximum ponding depth (feet) Static storage volume can also be calculated based on microtopography (proposed contours) and the elevation of the high flow bypass or overflow.

BMP Performance Curve Category[1]	Stormwater BMP Type Connecticut Stormwater Quality Manual	Static Storage Volume Equation[2]
Impervious Cover Disconnection	**Impervious Area Disconnection** **Vegetated Filter Strip** **Vegetated Buffer** **Qualifying Pervious Area (QPA)**	Use of BMP performance curves is based on the ratio of impervious area to pervious area instead of static storage volume.

[1] BMP categories and nomenclature used with EPA Region 1 BMP Performance Curves and EPA Region 1 MS4 Stormwater General Permits.

[2] Static Storage Volume is also commonly referred to as "Design Storage Volume (DSV)" in the context of the EPA Region 1 BMP Performance Curves and EPA Region 1 MS4 Stormwater General Permits. Other porosity values may be used for subsurface aggregate layers (bioretention soil, sand, pea gravel, stone, etc.) in lieu of those recommended in the table above as determined from testing of the proposed materials.