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TITLE 250 - DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

CHAPTER 150 – WATER RESOURCES

SUBCHAPTER 10 – WASTEWATER & STORM WATER

PART 8 – Stormwater Management, Design and Installation Rules

8.1 Purpose

Provide standards for planning, designing and installing effective stormwater best management practices (BMPs) to effectively manage the impacts of stormwater and prevent adverse impacts to water quality, habitat and flood storage capacity,

8.2 Authority

These rules are promulgated pursuant to requirements and provisions of R.I. Gen. Laws Chapter 45-61.2, The Smart Development for a Cleaner Bay Act of 2007; Chapter 46-12, Water Pollution; Chapter 46-13.1, Groundwater Protection; Chapter 42-17.1, Environmental Management; and in accordance with Chapter 42-35, Administrative Procedures.

8.3 Applicability

A. Stormwater management required pursuant to state and local programs that reference the "Rhode Island Stormwater Design and Installation Standards Manual" shall be in accordance with the standards and performance criteria in this Part;

B. The stormwater management standards and performance criteria in this Part do not apply to single-family lots of record. See the "State of Rhode Island Stormwater Management Guidance for Individual Single-Family Residential Lot Development" for recommended procedures to comply with requirements for stormwater management for development of single family residential lots of record.

C. In reviewing stormwater retrofit designs to improve water quality, as compared to existing conditions, the approving agencies may approve designs that do not meet the minimum standards or performance criteria herein due to existing site constraints.

8.4 Incorporated Materials

A. These regulations hereby adopt and incorporate United States Department of Agriculture Natural Resources Conservation Service Technical Release No. 55 (2015) by reference, not including any further editions or amendments thereof and only to the extent that the provisions therein are not inconsistent with these regulations.

B. These regulations hereby adopt and incorporate United States Department of Natural Resources Conservation Service Technical Release No. 20 (2015) by reference, not including any further editions or amendments thereof and only to the extent that the provisions therein are not inconsistent with these regulations.

C. These regulations hereby adopt and incorporate ASTM D5126 - 16e1 Standard Guide for Comparison of Field Methods for Determining Hydraulic Conductivity in Vadose Zone (2016) by reference, not including any further editions or amendments thereof and only to the extent that the provisions therein are not inconsistent with these regulations.

D. These regulations hereby adopt and incorporate ASTM D3385 - 18 Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer (2018) by reference, not including any further editions or amendments thereof and only to the extent that the provisions therein are not inconsistent with these regulations.

E. These regulations hereby adopt and incorporate ASTM D5093 - 15e1 Standard Test Method for Field Measurement of Infiltration Rate Using a Double-Ring Infiltrometer with Sealed-Inner Ring (2015) by reference, not including any further editions or amendments thereof and only to the extent that the provisions therein are not inconsistent with these regulations.

F. These regulations hereby adopt and incorporate ASTM D448 - 12 (2017) Standard Classification for Sizes of Aggregates for Road and Bridge Construction (2017) by reference, not including any further editions or amendments thereof and only to the extent that the provisions therein are not inconsistent with these regulations.

G. These regulations hereby adopt and incorporate ASTM C33/C33M -18 Standard Specification for Concrete Aggregates (2018) by reference, not including any further editions or amendments thereof and only to the extent that the provisions therein are not inconsistent with these regulations.

8.5 Definitions

A. As used in these rules, the following terms shall, where the context permits, be construed as follows:

1. "Approving agency" means an entity that will enforce or require compliance with the minimum standards in this Part.

2. "Aquatic bench" means a 10-15 foot wide bench which is located around the inside perimeter of a permanent pool and is normally vegetated with aquatic plants; the goal is to provide pollutant removal and enhance safety in areas using stormwater ponds.

3. "Aquifer" means a porous water-bearing formation of permeable rock, sand or gravel capable of yielding economically significant quantities of groundwater.

4. "ASTM" means American Society of Testing Materials.

5. "Baseflow" means the portion of streamflow that is not due to storm runoff but is the result of groundwater discharge or discharge from lakes or similar permanent impoundments of water.

6. "Bioretention" means a water quality practice that utilizes vegetation and soils to treat urban stormwater runoff by collecting it in shallow depressions, before filtering through an engineered bioretention planting soil media.

7. "BMP" means best management practice.

8. "Buffer" means a special type of preserved area along a watercourse or wetland where development is restricted or prohibited. Buffers protect and physically separate a resource from development. Buffers also provide stormwater control flood storage and habitat values.

9. "Catch basin" means a structure containing a sump placed below grade to conduct water from a street or other paved surface to the storm sewer.

10. "Catch basin insert" means a structure, such as a tray, basket, or bag that typically contains a pollutant removal medium (filter media) and a method for suspending the structure in the catch basin. They are placed directly inside of existing catch basins where stormwater flows into the catch basin and is treated as it passes through the structure.

11. "Channel" means a natural stream that conveys water; a man-made ditch or swale excavated for the flow of water.

12. "Channel protection" or "CPv" means a design criterion which requires 24-hour detention of the 1-year, post-developed, 24-hour Type III storm event runoff volume for the control of stream channel erosion.

13. "Channel stabilization" means erosion prevention and stabilization of velocity distribution in a channel using jetties, drops, revetments, structural linings, vegetation and other measures.

14. "Check dams" means small temporary dams constructed across a swale or drainage ditch to reduce the velocity of concentrated stormwater flows.

15. "Cistern" means a container that stores large quantities of rooftop stormwater runoff and may be located above or below ground. Also see Rain Barrel.

16. "Clay" means

    a. A mineral soil separate consisting of particles less than 0.002 millimeter in equivalent diameter.

    b. A soil texture class.

    c. (Engineering) A fine-grained soil (more than 50% passing the No. 200 sieve) that has a high plasticity index in relation to the liquid limit. (Unified Soil Classification System).

17. "Combined sewer overflows" or "CSOs" means combined sewers collect both stormwater runoff and sanitary wastewater in a single set of sewer pipes. When combined sewers do not have enough capacity to carry all the runoff and wastewater or the receiving water pollution control plant cannot accept all the combined flow, the combined wastewater overflows from the collection system into the nearest body of water, creating a CSO.

18. "Compaction" means any process by which the soil grains are rearranged to decrease void space and bring them in closer contact with one another, thereby increasing the weight of solid material per unit of volume, increasing the shear and bearing strength and reducing permeability.

19. "Contour" means

    a. An imaginary line on the surface of the earth connecting points of the same elevation.

b. A line drawn on a map connecting points of the same elevation.

20. "CRMC" means Rhode Island Coastal Resources Management Council.

21. "Crushed stone" means gravel-sized particles that pass through a 3-inch sieve and are retained on the No. 4 sieve, and are angular in shape as produced by mechanical crushing. Crushed stone must be washed in order to be used in stormwater BMPs to prevent clogging by fines.

22. "Curve number" or "CN" means a numerical representation of a given area's hydrologic soil group, plant cover, impervious cover, interception and surface storage derived in accordance with Natural Resources Conservation Service methods. This number is used to convert rainfall volume into runoff volume.

23. "Cut" means a portion of land surface or area from which earth has been removed or will be removed by excavation; the depth below original ground surface to excavated surface.

24. "Darcy's law" means an equation stating that the rate of fluid flow through a porous medium is proportional to the potential energy gradient within the fluid. The constant of proportionality is the hydraulic conductivity, which is a property of both the porous medium and the fluid moving through the porous medium. Sizing of filtering BMPs and dry swales is based on this principle.

25. "Deep sump catch basins" means storm drain inlets that typically include a grate or curb inlet and at least a four-foot sump to capture trash, debris and some sediment and oil and grease. Also known as an oil and grease catch basin.

26. "Deicers" means materials applied to reduce icing on paved surfaces. These consist of salts and other formulated materials that lower the melting point of ice, including sodium chloride, calcium chloride, calcium magnesium acetate, and blended products consisting of various combinations of sodium, calcium, magnesium, and chloride, as well as other constituents.

27. "DEM" means Rhode Island Department of Environmental Management.

28. "Design points" or "Points of analyses" means common locations at a site where pre-development and post-development conditions can be compared.

29. "Design storm" means a precipitation event for which the capacity of a best management practice is sized and designed. Design storms are expressed in terms of Type III, 24-hour events (i.e., 1-year, 10-year, and 100-year storms).

30. "Detention" means the temporary storage of storm runoff in a BMP with the goals of controlling peak discharge rates.

31. "Detention structure" means a structure constructed for the purpose of temporary storage of surface runoff and gradual release of stored water at controlled rates.

32. "Disposal site" means a structure, well, pit, pond, lagoon, impoundment, ditch, landfill or other place or area, excluding ambient air or surface water, where uncontrolled oil or hazardous material has come to be located as a result of any spilling, leaking, pouring, ponding, emitting, emptying, discharging, injecting, escaping, leaching, dumping, discarding or otherwise disposing of such oil or hazardous material. Disposal sites are designated as LUHPPLs.

33. "Disturbed area" means an area in which the natural vegetative soil cover has been removed or altered and, therefore, is susceptible to erosion.

34. "Diversion" means a channel with a supporting ridge on the lower side constructed across the slope to divert water from areas where it is in excess to sites where it can be used or disposed of safely. Diversions differ from terraces in that they are individually designed.

35. "Downstream analysis" means calculation of peak flows, velocities, and hydraulic effects at critical downstream locations to ensure that proposed projects do not increase post-development peak flows and velocities at these locations.

36. "Drainage" means the removal of excess surface water or ground water from land by means of surface or subsurface drains.

37. "Drainage area" or "watershed" means all land and water area from which runoff may run to a common (design) point.

38. "Dry extended detention pond" or "dry pond" or "detention basin" means a stormwater basin designed to capture, temporarily hold, and gradually release a volume of stormwater runoff to attenuate and delay stormwater runoff peaks. Dry extended detention ponds provide water quantity control (peak flow control and stream channel protection) as opposed to water quality control.

39. "Dry swale" means an open drainage channel explicitly designed to detain and promote the filtration of stormwater runoff through an underlying fabricated soil media.

40. "Dry well" means small excavated pits or trenches filled with aggregate that receive clean stormwater runoff primarily from building rooftops. Dry wells function as infiltration systems to reduce the quantity of runoff from a site. The use of dry wells is applicable for small drainage areas with low sediment or pollutant loadings and where soils are sufficiently permeable to allow reasonable rates of infiltration.

41. "Emergency spillway" means an open and/or closed channel designed to safely discharge stormwater flows in excess of the principal spillway capacity.

42. "Erosion" means

    a. The wearing away of the land surface by running water, wind, ice, or other geological agents, including such processes as gravitational creep.

    b. Detachment and movement of soil or rock fragments by water, wind, ice or gravity. The following terms are used to describe different types of water erosion:

        (1) Accelerated erosion - Erosion much more rapid than normal, natural or geologic erosion, primarily as a result of the influence of the activities of man or, in some cases, of other animals or natural catastrophes that expose base surfaces.

        (2) Gully erosion - The erosion process whereby water accumulates in narrow channels and, over short periods, removes the soil from this narrow area to considerable depths, ranging from 1 or 2 feet to as much as 75 to 100 feet.

        (3) Rill erosion - An erosion process in which numerous small channels only several inches deep are formed.

        (4) Sheet erosion - The spattering of small soil particles caused by the impact of raindrops on wet soils. The loosened and spattered particles may or may not subsequently be removed by surface runoff.

43. "Erosive velocities" means velocities of water that are high enough to wear away the land surface. Exposed soil will generally erode faster than stabilized soils. Erosive velocities will vary according to the soil type, slope, structural, or vegetative stabilization used to protect the soil.

44. "Exfilter" means a conventional stormwater filter without an underdrain system. The filtered volume ultimately infiltrates into the underlying soils.

45. "Extended detention" or "ED" means a stormwater design feature that provides for the gradual release of a volume of water over a 24- to 48-hour interval in order to increase settling of urban pollutants and protect downstream channels from frequent storm events.

46. "Filter strip" means a strip of permanent vegetation to treat sheet flow from adjacent impervious areas by causing deposition of transported material, thereby reducing sediment flow.

47. "Filtering practices" means practices that capture and store stormwater runoff and pass it through a filtering media such as sand, organic material, or the native soil for pollutant removal. Stormwater filters are primarily water quality control devices designed to remove particulate pollutants and, to a lesser degree, bacteria and nutrients. Filtering systems include sand filters, organic filters, bioretention, and tree filters.

48. "Floodplain" means areas adjacent to a stream or river that are subject to flooding or inundation during a storm event that occurs, on average, once every 100 years (or has a likelihood of occurrence of 1/100 in any given year).

49. "Flow splitter" means an engineered, hydraulic structure designed to divert a percentage of storm flow to a BMP located out of the primary channel, or to direct stormwater to a parallel pipe system, or to bypass a portion of baseflow around a BMP.

50. "Forebay" means a storage space located near a stormwater BMP inlet that serves to trap incoming coarse sediments before they accumulate in the main treatment area.

51. "Grade" means

    a. The slope of a road, channel or natural ground.

    b. The finished surface of a canal bed, roadbed, top of embankment, or bottom of excavation; any surface prepared for the support of construction, like paving or laying a conduit.

c. To finish the surface of a canal bed, roadbed, top of embankment or bottom of excavation.

52. "Grass channels" means traditional vegetated open channels, typically trapezoidal, triangular, or parabolic in shape, whose primary function is to provide non-erosive conveyance, typically up to the 10-year frequency design flow. They provide limited pollutant removal through filtration by grass or other vegetation, sedimentation, biological activity in the grass/soil media, as well as limited infiltration if underlying soils are pervious.

53. "Gravel" means

a. “Pea” gravel is an aggregate consisting of mixed sizes of 1/4-inch to 3/4-inch particles that normally occur in or near old streambeds and have been worn smooth by the action of water. Pea gravel is often used as a filter layer in stormwater BMPs.

b. According to the Unified Soil Classification System, gravel is a soil having particle sizes that pass through a 3-inch sieve and are retained on the No. 4 sieve; may be angular in shape as produced by mechanical crushing. Also referred to as “crushed stone.” Crushed stone can be used as a media for stormwater best management practices.

c. Type of impervious surface when used for road, driveway, or parking surfaces.

54. "Gravel WVTS" means a wet vegetated treatment system that maintains a saturated gravel bed and provides treatment by stormwater movement through the gravel bed and plant/soil treatment processes.

55. "Green roofs" means multilayered, constructed roof systems consisting of a vegetative layer, media, a geotextile layer, and a synthetic drain layer installed on building rooftops. Rainwater is either intercepted by vegetation and evaporated to the atmosphere or retained in the substrate before being returned to the atmosphere through transpiration and evaporation.

56. "Ground cover" means plants that are low growing and provide a thick growth that protects the soil as well as providing some beautification of the area occupied.

57. "Groundwater recharge" means the process by which water that seeps into the ground, eventually replenishing groundwater aquifers and surface waters such as lakes, streams, and the oceans. This process helps

maintain water flow in streams and wetlands and preserves water table levels that support drinking water supplies.

58. "Groundwater recharge volume" or "Rev" means the post-development design recharge volume (on a storm event basis) required to minimize the loss of annual pre-development groundwater recharge. The Rev is determined as a function of annual pre-development recharge for site-specific soils or surficial materials, average annual rainfall volume, and amount of impervious cover on a site.

59. "Gully" means a channel or miniature valley cut by concentrated runoff through which water commonly flows only during and immediately after heavy rains. The distinction between gully and rill is one of depth. A gully is sufficiently deep that it would not be obliterated by normal tillage operations, whereas a rill is of lesser depth and would be smoothed by ordinary farm tillage.

60. "Hazard classification" for dams means a rating for a dam that relates to the probable consequences of failure or misoperation of the dam, which is a determination made by the DEM Director based on an assessment of loss of human life, damages to properties or structures located downstream of the reservoir, or loss of use as a drinking water supply. A higher hazard dam does not imply that it is more likely to fail or be misoperated than a lower hazard dam.

61. "Head" or "Hydraulics" means

    a. The height of water above any plane of reference.

    b. The energy, either kinetic or potential, possessed by each unit weight of a liquid expressed as the vertical height through which a unit weight would have to fall to release the average energy possessed. Used in various terms such as pressure head, velocity head, and head loss.

62. "Herbaceous perennial" means a plant whose stems die back to the ground each year.

63. "Hydrodynamic separators" means a group of stormwater treatment technologies designed to remove large particle total suspended solids and large oil droplets, consisting primarily of cylindrical-shaped devices that are designed to fit in or adjacent to existing stormwater drainage systems. The most common mechanism used in these devices is vortex-enhanced sedimentation, where stormwater enters as tangential inlet flow into the side of the cylindrical structure. As the stormwater spirals through the

chamber, the swirling motion causes the sediments to settle by gravity, removing them from the stormwater.

64. "Hydrograph" means a graph showing variation in depth or discharge of a stream of water over a period of time.

65. "Hydrologic cycle" means the distribution and movement of water between the earth's atmosphere, land, and water bodies.

66. "Hydrologic soil group" or "HSG" means a Natural Resource Conservation Service classification system in which soils are categorized into four runoff potential groups. The groups range from A soils, with high permeability and little runoff production, to D soils, which have low permeability rates and produce much more runoff.

67. "Illicit discharges" means unpermitted discharges to waters of the state that do not consist entirely of stormwater or uncontaminated groundwater except certain discharges identified in the RIPDES Phase II Stormwater General Permit.

68. "Impaired waters" means those waterbodies not meeting water quality standards. Pursuant to Section 303(d) of the federal Clean Water Act, 33 U.S.C. § 1313 (2018), each state prepares a list of impaired waters (known as the 303(d) list) which is presented in the state's Integrated Water Report as Category 5 waters. Those impaired waters for which a TMDL has been approved by US EPA and is not otherwise impaired, are listed in Category 4A.

69. "Impervious cover" or "I" means those surfaces that cannot effectively infiltrate rainfall consisting of surfaces such as building rooftops, pavement, sidewalks, driveways, compacted gravel.

70. "Infill" means a development site that meets all of the following: the site is currently predominately pervious (less than 10,000 square feet of existing impervious cover); it is surrounded (on at least 3 sides) by existing development (not including roadways); the site is served by a network of existing infrastructure and does not require the extension of utility lines or new public road construction to serve the property; and the site is 1 acre or less where the existing land use is commercial, industrial, institutional, governmental, recreational, or multifamily residential.

71. "Infiltration practices" means stormwater treatment practices designed to capture stormwater runoff and infiltrate it into the ground over a period of days.

72. "Infiltration rate" means the rate at which stormwater percolates into the subsoil measured in inches per hour.

73. "Land use with higher potential pollutant load" or "LUHPPL" means area where the land use has the potential to generate highly contaminated runoff, with concentrations of pollutants in excess of those typically found in stormwater.

74. "Landfill" means a facility or part of a facility established in accordance with a valid site assignment for the disposal of solid waste into or on land. Landfills are designated as LUHPPLs.

75. "Level spreader" means a device for distributing stormwater uniformly over the ground surface as sheet flow to prevent concentrated, erosive flows and promote infiltration.

76. "Limit of disturbance" means a line delineating the boundary of the area to be disturbed during a development or redevelopment project. Area outside this boundary shall not be touched.

77. "Low impact development" or "LID" means a site planning and design strategy intended to maintain or replicate predevelopment hydrology through the use of site planning, source control, and small-scale practices integrated throughout the site to prevent, infiltrate and manage runoff as close to its source as possible.

78. "Maximum extent practicable" means to show that a proposed development has met a standard to the maximum extent practicable, the applicant must demonstrate the following:

    a. All reasonable efforts have been made to meet the standard in accordance with current local, state, and federal regulations,

    b. A complete evaluation of all possible management measures has been performed, and

    c. If full compliance cannot be achieved, the highest practicable level of management is being implemented.

79. "Mulch" means a natural or artificial protective layer of suitable materials, usually of organic matter such as wood chips, leaves, straw, or peat, placed around plants that aids in soil stabilization, soil moisture conservation, prevention of freezing, and control of weeds. In addition, mulches serve as soil amendments upon decomposition (for organic mulches).

80. "Native plants" means plants that are adapted to the local soil and rainfall conditions and that require minimal watering, fertilizer, and pesticide application.

81. "Non-structural controls" means pollution control techniques, such as management actions and behavior modification that do not involve the construction or installation of devices.

82. "Off-line" means a stormwater management system designed to manage small storm events by diverting a percentage of stormwater flow away from the storm drainage system. Flow from large storm events will bypass this stormwater management system.

83. "Oil separators" or "Particle separators" means a device consisting of 1 or more chambers designed to remove trash and debris and to promote sedimentation of coarse materials and separation of free oil (as opposed to emulsified or dissolved oil) from stormwater runoff. Oil/particle separators are typically designed as off-line systems for pretreatment of runoff from small impervious areas, and therefore provide minimal attenuation of flow. Also called oil/grit separators, water quality inlets, and oil/water separators.

84. "On-line" means a stormwater management system designed to manage stormwater in its original drainage channel or pipe network such that all stormwater flow will be directed to and through the stormwater management system.

85. "Open channels" or "Swales" or "Grass channels" means systems that are used for the conveyance, retention, infiltration and filtration of stormwater runoff.

86. "Outfall" means the point where water flows from a conduit, stream, or drain.

87. "Outlet" means the point at which water discharges from stormwater practices such as pipes or channels.

88. "Outlet control structure" means a hydraulic structure placed at the outlet of a channel, spillway, pond, etc., for the purpose of dissipating energy, providing a transition to the channel or pipe downstream, while achieving the discharge rates for specified designs.

89. "OWTS" means onsite wastewater treatment system.

90. "Peak discharge rate" means the maximum instantaneous rate of flow during a storm, usually in reference to a specific design storm event.

91. "Peak flow control" means criteria intended to address increases in the frequency and magnitude of a range of potential flood conditions resulting from development and include stream channel protection, conveyance protection, peak runoff attenuation, and emergency outlet sizing.

92. "Performance monitoring" means collection of data on the effectiveness of individual stormwater treatment practices.

93. "Permanent pool" or "Wet pool" means an area of a stormwater management practice that has a fixed water surface elevation due to a manipulation of the outlet structure.

94. "Permeability" means the rate of water movement through the soil column under saturated conditions.

95. "Permeable paving materials" means materials that are alternatives to conventional pavement surfaces and are designed to increase infiltration and reduce stormwater runoff and pollutant loads. Alternative materials include porous asphalt, pervious concrete, and various pavers and open-celled grids.

96. "Piping" means removal of soil material through subsurface flow channels or “pipes” developed by seepage water.

97. "Plugs" means pieces of vegetation, usually cut with a round tube, which can be used to propagate the plant by vegetative means.

98. "Point source" means any discernible, confined and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which pollutants are or may be discharged.

99. "Pondscaping" means plantings around stormwater ponds that emphasize native vegetative species to meet specific design intentions. Species are selected for up to six zones in the basin and its surrounding setback, based on their ability to tolerate inundation and/ or soil saturation.

100. "Pretreatment" means techniques employed in stormwater BMPs to provide storage or filtering to help trap coarse materials before they enter the system.

101. "Principal spillway" means an open and/or closed channel designed to allow a normal range of stormwater flows to discharge from an impoundment.

102. "Qualifying pervious area" or "QPA" means the generally flat, natural or landscaped vegetated areas that are fully stabilized and where discharge from impervious areas may be directed via sheet flow in order to obtain a Stormwater Credit.

103. "QA" means quality assurance.

104. "QAP" means quality assurance plan.

105. "QC" means quality control.

106. "Rational equation" means an empirical equation acceptable for estimating peak flow rates for small urbanized drainage areas with short times of concentration, but not for estimating runoff volume. The Rational Equation is Q=CiA; where Q = peak discharge, C = rational Method runoff coefficient, i = rainfall intensity (inches/hour); and A = drainage area (acres).

107. "Redevelopment" means any construction, alteration, or improvement that disturbs a total of 10,000 square feet or more of existing impervious area where the existing land use is commercial, industrial, institutional, governmental, recreational, or multifamily residential.

108. "Responsible authority" means authority responsible for long-term maintenance of stormwater BMPs.

109. "Retention" means the amount of precipitation on a drainage area that does not escape as runoff. It is the difference between total precipitation and total runoff.

110. "Right of way" or "ROW" means right of passage, as over another’s property. A route that is lawful to use. A strip of land acquired for transport or utility construction.

111. "RIPDES" means Rhode Island Pollutant Discharge Elimination System.

112. "Riser" means a type of outlet control structure that consists of a vertical pipe that extends from the bottom of a pond BMP and houses the control devices (weirs/orifices) to achieve the discharge rates for specified designs.

113. "Runoff" means the water from rain, snowmelt, or irrigation that flows over the land surface and is not absorbed into the ground, instead flowing into surface waters or land depressions.

114. "Safety bench" means a flat area above the permanent pool and surrounding a stormwater basin designed to provide a separation from the basin pool and adjacent slopes.

115. "Sand" means

a. (Agronomy) A soil particle between 0.05 and 2.0 millimeters in diameter.

b. A soil textural class.

c. (Engineering) According to the Unified Soil Classification System, a soil particle larger than the No. 200 sieve (0.074mm) and passing the No. 4 sieve (approximately 1/4 inch).

116. "SARA 312 generator" means a facility that is required by the Emergency Planning and Community Right to Know Act, 42 U.S.C § 116 also known as Title III of the Superfund Amendments and Reauthorization Act of 1989 (SARA Title III), to submit an inventory of the location of hazardous chemicals which are located at the site. SARA 312 generators are designated as LUHPPLs.

117. "Seasonal high groundwater table" or "SHGT" means the elevation of the groundwater table during that time of the year at which it is highest as determined by direct observation or by interpretation of hydromorphic features in the soil profile.

118. "Sediment" means solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water, gravity, or ice and has come to rest on the earth’s surface either above or below sea level.

119. "Sediment chamber" or "forebay" means an underground chamber or surface impoundment designed to remove sediment and/or floatables prior to a primary or other secondary stormwater treatment practice.

120. "Seepage" means

a. Water escaping through or emerging from the ground.

b. The process by which water percolates through the soil.

121. "SESC" means soil erosion and sediment control.

122. "Setbacks" means the minimum distance requirements for location of a structural BMP in relation to roads, wells, septic fields, and other structures. Also, the area immediately surrounding a best management practice that provides a separation barrier to adjacent development and acts as filter to remove pollutants and provide infiltration of stormwater prior to reaching the BMP.

123. "Shallow WVTS" means a wet vegetated treatment system that consists of aquatic vegetation within a permanent pool ranging in depth from 6” to 18” during normal conditions that is equivalent to the entire WQv and provides treatment via settling and plant/soil treatment processes.

124. "Sheet flow" means water, usually storm runoff, flowing in a thin layer over the ground surface.

125. "Side slopes" means the slope of the sides of a channel, dam or embankment. It is customary to name the horizontal distance first, as 1.5 to 1, or frequently, 1 ½: 1, meaning a horizontal distance of 1.5 feet to 1 foot vertical.

126. "Silt" means

   a. (Agronomy) A soil separate consisting of particles between 0.05 and 0.002 millimeter in equivalent diameter.

   b. A soil textural class.

   c. (Engineering) According to the Unified Soil Classification System a fine-grained soil (more than 50% passing the No. 200 sieve) that has a low plasticity index in relation to the liquid limit.

127. "Site" means 1 or more lots, tracts, or parcels of land to be developed or redeveloped for a complex of uses, units or structures, including but not limited to commercial, residential, institutional, governmental, recreational, open space, and/or mixed uses. When calculating site size, jurisdictional wetland areas defined by DEM or CRMC regulations and undeveloped lands protected by conservation easements should be subtracted from the total site area.

128. "Site planning and design strategies" means techniques of planning, engineering, and landscape design that maintain predevelopment hydrologic functions and pollutant removal mechanisms to the extent practical.

129. "Soil test" means a chemical analysis of soil to determine needs for fertilizers or amendments for species of plant being grown.

130. "Source control" means practices to limit the generation of stormwater pollutants at their source.

131. "Stabilization" means providing adequate measures, vegetative and/or structural, that will prevent erosion from occurring.

132. "Stormwater" means water consisting of precipitation runoff or snowmelt.

133. "Stormwater basin" means a land depression or impoundment created for the detention or retention of stormwater runoff.

134. "Stormwater filter" means a stormwater treatment method that utilizes an artificial media to filter out pollutants entrained in urban runoff.

135. "Stormwater management plan" means a plan describing the proposed methods and measures to prevent or minimize water quality and quantity impacts associated with a development project both during and after construction. It identifies selected LID source controls and treatment practices to address those potential impacts, the engineering design of the treatment practices, and maintenance requirements for proper performance of the selected practices.

136. "Stormwater pollution prevention plan" or "SWPPP" means a plan that identifies potential sources of pollution and outlines specific management activities designed to minimize the introduction of pollutants into stormwater.

137. "Stormwater retrofits" means modifications to existing development to incorporate source controls and structural stormwater treatment practices to remedy problems associated with and improve water quality mitigation functions of older, poorly designed, or poorly maintained stormwater management systems.

138. "Stormwater treatment train" means stormwater treatment practices, as well as site planning techniques and source controls, combined in series to enhance pollutant removal or achieve multiple stormwater objectives.

139. "Stream buffers" means zones of variable width that are located along both sides of a stream and are designed to provide a protective natural area along a stream corridor.

140. "Stream order" means the relative size of a stream based on Strahler’s (1957) method. Streams with no tributaries are first-order streams, represented as the start of a solid line on a 1:24,000 USGS Quadrangle Sheet. A second-order stream is formed at the confluence of two first-order streams. However, if a first-order stream joins a second-order stream, it remains a second-order stream; it is not until a second-order stream combines with another second-order stream that it becomes a third-order stream, and so on. Peak flow controls (CPv and Qp) are waived for discharges to fourth-order and larger streams.

141. "Street sweeper" means equipment that removes particulate debris from roadways and parking lots. Includes mechanical broom sweepers, vacuum sweepers, regenerative air sweepers, and dry vacuum sweepers.

142. "Structural BMPs" means devices that are constructed to manage stormwater runoff.

143. "Subgrade" means the soil prepared and compacted to support a structure or a pavement system.

144. "Subwatershed" means the area draining to the point of confluence between two first-order tributaries.

145. "Technical Release No. 55" or "TR-55" means a watershed hydrology model developed by the US Soil Conservation Service (now US Natural Resources Conservation Service) used to calculate runoff volumes and provide a simplified routing for storm events through ponds.

146. "Time of concentration" means time required for water to flow from the most remote point of a drainage area, in a hydraulic sense, to the point of analysis.

147. "Toe of slope" means where the slope stops or levels out. Bottom of the slope.

148. "Token spillways" or "emergency spillways" means spillways that are placed above the water elevation of the largest managed storm and are required if not already provided as part of the conveyance of the 100-year storm event.

149. "Topsoil" means fertile or desirable soil material used to top dress road banks, subsoils, parent material, etc.

150. "Total maximum daily load" or "TMDL" means a calculation of the maximum amount of a pollutant that a water body can receive and still

meet water quality standards, and an allocation of that amount to the pollutant's sources, including a margin of safety.

151. "Total nitrogen" or "TN" means the sum of total Kjeldahl nitrogen, nitrate, and nitrite. Nitrogen is typically the growth-limiting nutrient in estuarine and marine systems.

152. "Total phosphorus" or "TP" means sum of orthophosphate, metaphosphate (or polyphosphate) and organically bound phosphate. Phosphorus is typically the growth-limiting nutrient in freshwater systems.

153. "Total suspended solids" or "TSS" means the total amount of soils particulate matter that is suspended in the water column.

154. "Trash rack" means a grill, grate, or other device at the intake of a channel, pipe, drain or spillway for the purpose of preventing oversized debris from entering the structure and clogging the outlet weir/orifice.

155. "Tree filter" means a small bioretention practice that may be contained in a concrete vault with an underdrain connecting to the storm drain system, or may have an open base for infiltration into the underlying soils.

156. "Underground detention facilities" means vaults, pipes, tanks, and other subsurface structures designed to temporarily store stormwater runoff for water quantity control and to drain completely between runoff events. They are intended to control peak flows, limit downstream flooding, and provide some channel protection.

157. "Underground infiltration systems" means structures designed to capture, temporarily store, and infiltrate the water quality volume over several days, including premanufactured pipes, vaults, and modular structures. Used as alternatives to infiltration trenches and basins for space-limited sites and stormwater retrofit applications.

158. "Urban stormwater runoff" means stormwater runoff from developed areas.

159. "Velocity head" means the head due to the velocity of a moving fluid, equal to the square of the mean velocity divided by twice the acceleration due to gravity (32.16 feet per second per second).

160. "Water balance" means an equation describing the input, output, and storage of water in a watershed or other hydrologic system.

161. "Water quality flow" or "WQf" means the peak flow rate associated with the water quality design storm or WQv.

162. "Water quality swales" means vegetated open channels designed to treat and attenuate the water quality volume and convey excess stormwater runoff. Dry swales are primarily designed to receive drainage from small impervious areas and rural roads. Wet swales are primarily used for highway runoff, small parking lots, rooftops, and pervious areas.

163. "Water quality volume" or "WQv" means the storage needed to capture and treat 90% of the average annual stormwater runoff volume. In Rhode Island, this equates to 1-inch of runoff from impervious surfaces.

164. "Watershed inches" means a measurement used to compare stormwater volume requirements between sites of varying sizes. Required volumes in acre-feet can be converted to watershed inches by dividing by the total site area in acres and multiplying by 12 inches/feet.

165. "Wet swale" means an open drainage channel or depression, explicitly designed to retain water or intercept groundwater for water quality treatment.

166. "Wet vegetated treatment system" or "WVTS" means shallow, constructed pools that capture stormwater and allow for the growth of characteristic emergent vegetation. See also definition of shallow WVTS and gravel WVTS.

8.6 Stormwater Management Standards and Performance Criteria Overview

A. Applicants for all applicable new and redevelopment projects in the State of Rhode Island are required to meet the eleven minimum standards and comply with the specific performance criteria in §§ 8.6 through 8.17 of this Part. In the case of restoration or retrofitting, deviation from these standards may be appropriate at the discretion of the approving agency.

B. All applicable project proposals must include a stormwater management site plan for review by State and local government. The plan must address the minimum standards in §§ 8.6 through 8.17 of this Part.

C. When a project’s stormwater management system is designed, installed, and maintained in accordance with the requirements of this Part, its runoff impacts will be presumed to be in compliance with applicable state regulatory standards and requirements.

D. Unless otherwise noted, all storm events referred to herein are 24 hours in duration and utilize US Natural Resources Conservation Service Type III precipitation distribution. Rainfall amounts for Rhode Island for various return frequencies are provided in § 8.6(E) of this Part and shall be used for design unless otherwise specified.

E. Design Rainfall Amounts for Rhode Island: All Rhode Island County rainfall values were obtained from the Northeast Regional Climate Center (NRCC) using regional rainfall data processed by NRCC from the period of record through December 2008.

RI County	24-hour (Type III) Rainfall Amount (inches)						
	1-Year	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Providence County	2.7	3.3	4.1	4.9	6.1	7.3	8.7
Bristol County	2.8	3.3	4.1	4.9	6.1	7.3	8.6
Newport County	2.8	3.3	4.1	4.9	6.1	7.3	8.6
Kent County	2.7	3.3	4.1	4.8	6.2	7.3	8.7
Washington County	2.8	3.3	4.1	4.9	6.1	7.2	8.5

F. If the standard or criterion is not used or achieved, a written technical justification that is acceptable to the approving agency must be provided.

G. The design practices described in this Part shall be implemented by an individual with a demonstrated level of professional competence, such as a professional engineer licensed to practice in the State of Rhode Island.

8.7 Minimum Standard 1: Low Impact Development (LID) Site Planning and Design Strategies

A. LID site planning and design strategies must be used to the maximum extent practicable in order to reduce the generation of the water runoff volume for both new and redevelopment projects.

B. Applicants need to document that the full list of approved LID methods and/or procedures were explored at the site and need to supply a specific rationale in the event LID strategies are rejected as infeasible. The site planning process must be documented and include how the proposed project will meet the following measures and/or methods to:

1. Protect as much undisturbed open space as possible to maintain pre-development hydrology and allow precipitation to naturally infiltrate into the ground;

2. Maximize the protection of natural drainage areas, streams, surface waters, wetlands, and other regulated areas;

3. Minimize land disturbance, including clearing and grading, and avoid areas susceptible to erosion and sediment loss;

4. Minimize soil compaction and restore soils compacted as a result of construction activities or prior development;

5. Provide low-maintenance, native vegetation that encourages retention and minimizes the use of lawns, fertilizers, and pesticides;

6. Minimize impervious surfaces;

7. Minimize the decrease in the "time of concentration" from pre-construction to post construction, where "time of concentration" means the time it takes for runoff to travel from the hydraulically most distant point of the drainage area to the point of interest within a watershed;

8. Infiltrate precipitation as close as possible to the point it reaches the ground using vegetated conveyance and treatment systems;

9. Break up or disconnect the flow of runoff over impervious surfaces; and

10. Provide source controls to prevent or minimize the use or exposure of pollutants into stormwater runoff at the site in order to prevent or minimize the release of those pollutants into stormwater runoff.

8.8 Minimum Standard 2: Groundwater Recharge

A. Stormwater must be recharged within the same subwatershed to maintain baseflow at pre-development recharge levels to the maximum extent practicable in accordance with the requirements described in §§ 8.8(D) through (H) of this Part. Applicants may be required to provide a water budget analysis for proposed groundwater dewatering. Recharge volume is determined as a function of annual pre-development recharge for site-specific soils or surficial materials, average annual rainfall volume, and amount of impervious cover on a site. Recharge must occur in a manner that protects groundwater quality.

B. Stormwater runoff from a LUHPPL is not allowed to infiltrate into groundwater. The stormwater recharge requirement may be specifically waived if an applicant can demonstrate a physical limitation that would make implementation impracticable or where unusual geological or soil features may exist such as significant clay deposits or ledge, where recharge does not currently occur; fill soils; or areas of documented slope failure.

C. Maintaining pre-development groundwater recharge conditions may also be used to reduce the volume requirements dictated by other sizing criteria (water quality, channel protection, and overbank flood control) and the overall size and cost of stormwater treatment practices.

D. The recharge criterion (Rev) requires that the following volume of stormwater be recharged based on the amount of impervious area. The groundwater recharge requirement may be waived or reduced by applying the LID Stormwater Credit outlined in § 8.18 of this Part. Recharge requirements are based on hydrologic soil group (HSG) as follows:

Rev = (1 inch) (F) (I)/12
Where:
Rev = groundwater recharge volume (acre feet)
F = recharge factor, see table below in § 8.8(F) of this Part
I = impervious area (acres)

E. Recharge Factors Based on Hydrologic Soil Group (HSG)

HSG	Recharge Factor (F)
A	0.60
B	0.35
C	0.25
D	0.10

F. The recharge volume is considered as part of the total water quality volume that must be provided at a site and must be achieved by disconnection of impervious areas (see § 8.18 of this Part), a structural practice that infiltrates stormwater into the underlying soils or substratum, or a combination of the two.

G. Roof runoff may be infiltrated without pretreatment unless the roof is deemed to have a higher potential pollution load pursuant to § 8.14(C) of this Part. Recharged roof runoff can be subtracted from WQv but not from larger storm calculations, unless applicant verifies that the drywells are sized for the 100-year, 24-hour Type III storm event.

8.9 Minimum Standard 3: Water Quality

A. Stormwater runoff must be treated before discharge. The amount that must be treated from each rainfall event is known as the required water quality volume (WQv). The required WQv is calculated as described in §§ 8.9(E) through (J) of this Part and excludes LID credits allowed under § 8.18 of this Part.

B. The WQv must be treated by at least one of the structural BMPs listed in §§ 8.19 through 8.25 of this Part at each location where a discharge of stormwater will occur. Structural BMPs are generally required to achieve the following minimum average pollutant removal efficiencies: 85% removal of total suspended solids, 60% removal of pathogens, 30% removal of total phosphorus for discharges to freshwater systems, and 30% removal of total nitrogen for discharges to saltwater or tidal systems. Based upon results published in the scientific literature, the structural BMPs listed in §§ 8.19 through 8.25 of this Part will meet these standards when properly designed, constructed, and maintained.

Pretreatment is required for water quality treatment practices where specified in §§ 8.19 through 8.25 of this Part.

C. BMPs targeted to remove other pollutant(s) of concern and/or to achieve higher pollutant removal efficiencies may be required for impaired receiving waters, drinking water reservoirs, bathing beaches, shellfishing grounds, Outstanding National Resource Waters, Special Resource Protection Waters, tributaries thereto, and for those areas where watershed plans, including Special Area Management Plans or Total Maximum Daily Loads, have been completed. In some cases, the permitting agencies may require that an applicant prepare and submit a pollutant loading analysis developed in accordance with the provisions of §§ 8.36 through 8.38 of this Part.

D. Applicants or other interested parties may petition DEM and CRMC to add one or more BMPs to the list of acceptable structural stormwater controls described in §§ 8.19 through 8.25 of this Part by submitting monitoring results and supporting information developed in accordance with the provisions of the Technology Assessment Protocol in §§ 8.39 and 8.40 of this Part.

E. The required WQv, which results in the capture and treatment of the entire runoff volume for 90% of the average annual storm events, is equivalent to the runoff associated with the first 1.2 inches of rainfall over the impervious surface (i.e., 1 inch of runoff). The water quality volume requirement may be waived or reduced by applying the LID Stormwater Credit outlined in § 8.18 of this Part. The WQv is calculated using the following equation:

$$WQv = (1") (I) / 12$$

Where:

WQv = water quality volume (in acre-feet)

I = impervious area (acres)

F. A minimum WQv value of 0.2 watershed inches (0.2 inches over the entire disturbed area) is required, which requires the calculation of the total site disturbance. This minimum treatment volume is necessary to fully treat the runoff from pervious surfaces on sites with low impervious cover, i.e., less than 20% of the disturbed area. However, this requirement does not imply that every pervious subarea of disturbance must be treated with a structural water quality BMP.

G. For facility sizing criteria, the basis for hydrologic and hydraulic evaluation of development sites should be as follows:

1. Impervious cover is measured from the site plan and includes all impermeable surfaces; and

2. Off-site areas shall be assessed based on their “pre-development condition” for computing the water quality volume (i.e., treatment of only on-site areas is required). However, if an off-site area drains to a proposed BMP, flow from that area must be accounted for in the sizing of a specific practice.

H. Acceptable water quality treatment BMPs are described in detail in §§ 8.19 through 8.25 of this Part. Other practices may be used to meet other criteria, such as recharge or flood control, but only the practices §§ 8.19 through 8.25 of this Part may be used to meet the water quality criterion. In addition, disconnection of impervious areas (see § 8.18 of this Part) may be used to meet some or all of the WQv, including the minimum WQv.

I. Although most of the stormwater treatment practices in this Rule are sized based on WQv, flow diversion structures for off-line stormwater treatment practices must be designed to bypass flows greater than the WQf. The WQf shall be calculated using the WQv described above and a modified curve number (CN) for small storm events.

1. The following equation shall be used to calculate a modified CN. This modified CN can then be used in a traditional TR-55 model, incorporated above at § 8.4(A) of this Part, or spreadsheet in order to estimate peak discharges for small storm events. Using the water quality volume, a corresponding CN is computed utilizing the following equation:

$$CN = 1000 / [10 + 5P + 10Q - 10(Q^2 + 1.25\,QP)^{1/2}]$$

Where:

P = rainfall, in inches (use 1.2 inches for the Water Quality Storm that produces 1 inch of runoff)

Q = runoff volume, in watershed inches (equal to WQv ÷ total drainage area)

2. When using a hydraulic/hydrologic model for facility sizing and WQf determination, designers must use this adjusted CN for the drainage area to generate runoff equal to the WQv for the 1.2-inch precipitation event.

3. Designers can also use a TR-55 model, incorporated above at § 8.4(A) of this Part, spreadsheet to find the WQf. Using the computed CN from the equation above, the time of concentration (tc), and drainage area (A); the WQf for the water quality storm event can be computed with the following steps:

   a. Read initial abstraction (Ia) from TR-55, incorporated above at § 8.4(A) of this Part, Table 4.1 or calculate using Ia = 200/CN – 2

   b. Compute Ia/P (P = 1.2 inches)

   c. Approximate the unit peak discharge (qu) from TR-55, incorporated above at § 8.4(A) of this Part, Exhibit 4-III using tc and Ia/P

   d. Compute the peak discharge (WQf) using the following equation:

$$WQf = qu * A * Q$$

Where:

WQf = the peak discharge for water quality event, in cubic feet per second

qu = the unit peak discharge, in cubic feet per second/square mile/inch

A = drainage area, in square miles

Q = runoff volume, in watershed inches (equal to WQv ÷ A)

8.10 Minimum Standard 4: Conveyance and Natural Channel Protection

A. Open drainage and pipe conveyance systems must be designed to provide adequate passage for flows leading to, from, and through stormwater management facilities for at least the peak flow from the 10-year, 24-hour Type III design storm event. Protection for natural channels downstream must be supplied by providing 24-hour extended detention of the 1-year, 24-hour Type III design storm event runoff volume.

B. The channel protection volume (CPv) is the 24-hour extended detention of the post-development runoff volume from the 1-year, 24-hour Type III design storm event. If a stormwater discharge is proposed within 200 feet of streams and any contiguous natural or vegetated wetlands in watersheds draining to cold-water fisheries, surface detention practices are prohibited (underground detention or infiltration practices will be required). Consult DEM's Water Quality Regulations to determine if a project is in a watershed directly draining to a cold-water fishery. Discharges beyond 200 feet shall be designed to discharge up to the CPv through an underdrained gravel trench outlet.

C. For facility sizing criteria, the basis for hydrologic and hydraulic evaluation of development sites are as follows:

1. The models TR-55, incorporated above at § 8.4(A) of this Part, or TR-20, incorporated above at § 8.4(B) of this Part, (or approved equivalent) shall be used for determining the CPv.

2. The Rational Method may be used for sizing the conveyance system.

3. Off-site areas draining to proposed facility shall be modeled as "present condition" for the 1-year storm event.

4. The length of sheet flow used in time of concentration (tc) calculations is limited to no more than 100 feet for post-development conditions.

5. The required minimum CPv shall be computed using either §§ 8.10(C)(5)(a) or (b) of this Part below:

a. A modified version of the TR-55, incorporated above at § 8.4(A) of this Part, short-cut sizing approach.

(1) This modification (Harrington, 1987. Design Procedures for Stormwater Management Extended Detention Structures. Maryland Department of Environment, Dundalk, MD) is for applications where the peak discharge is very small compared with the uncontrolled discharge. This often occurs in the 1-year, 24-hour Type III detention sizing. Using TR-55, incorporated above at § 8.4(A) of this Part, the unit peak discharge (qu) can be determined based on the curve number and time of concentration. Knowing qu and T (extended detention time), qo/qI (peak outflow discharge/peak inflow discharge) can be estimated from Figure in § 8.10(C)(5)(a)((2)) of this Part. Figure in § 8.10(C)(5)(a)((3)) of this Part can also be used to estimate Vs/Vr. When qo/qI is <0.1 and off the graph, Vs/Vr can also be

calculated using the following equation for Type II/III rainfall distributions:

Vs/Vr = 0.682 – 1.43 (qo/qI) + 1.64 (qo/qI)2 – 0.804 (qo/qI)3

Where:

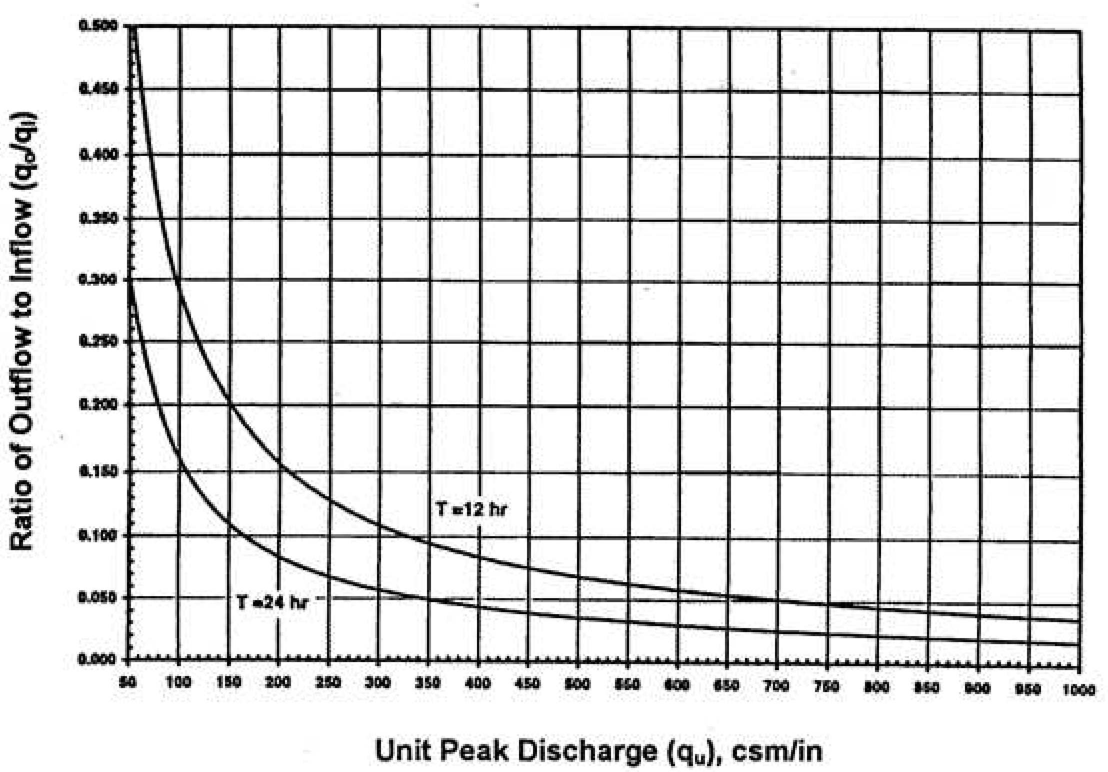
Vs = required storage volume (acre-feet)

Vr = runoff volume (acre-feet)

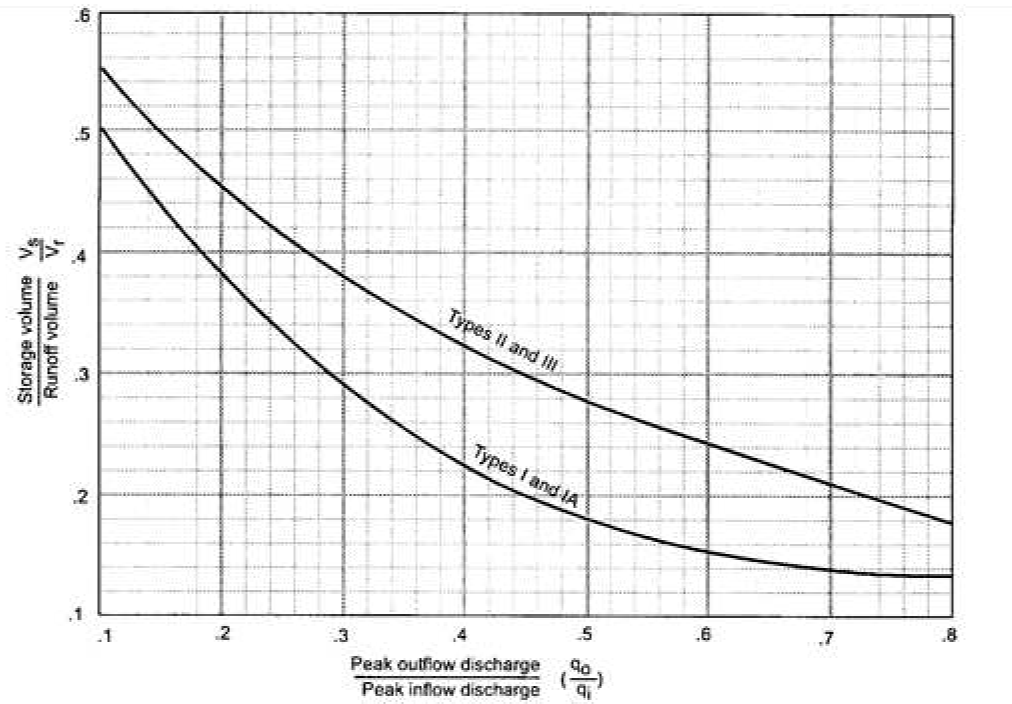
qo = peak outflow discharge (cubic feet per second)

qI = peak inflow discharge (cubic feet per second)

(2) Detention Time vs. Discharge Ratios. (Maryland Stormwater Design Manual. Maryland Department of the Environment (MDE) 2000)



(3) Approximate Detention Basin Routing For Rainfall Types I, IA, II, and III. (TR-55, incorporated above at § 8.4(A) of this Part)



b. By calculating 65% of the direct runoff volume from the post-development 1-year, 24-hour Type III storm based on one of the approved models listed above, using the following equation:

> Vs = 0.65 * Vr
>
> Where:
>
> Vs = CPv = required channel protection storage volume; and
>
> Vr = runoff volume from 1-year, 24-hour Type III storm.

6. The CPv shall be released at roughly a uniform rate over a 24-hour duration. To determine the average release rate, use the following equation:

> Average release rate = Vr / T
>
> Where:
>
> Vr = defined above; and
>
> T = extended detention time (24 hours)

D. The CPv criterion can be waived for sites that:

1. Direct discharge to a large river (4th-order stream or larger), bodies of water > 50 acres in surface area, or tidal waters.

2. Small facilities with impervious cover less than or equal to 1 acre.

3. Projects when the post-development peak discharge from the facility without attenuation is less than 2 cubic feet per second for the 1-year, 24-hour Type III design storm event.

8.11 Minimum Standard 5: Overbank Flood Protection (Qp)

A. Downstream overbank flood protection must be provided by attenuating the post-development peak discharge rate to the pre-development levels for the 10-year and 100-year, 24-hour Type III design storm events. In addition, designers must demonstrate that runoff from the site for storms up to the 100-year, 24-hour Type III design storm events actually reach proposed structural practices designed to meet this criterion.

B. Peak flow attenuation is required for the 10-year and 100-year, 24-hour Type III design storm events.

C. For facility sizing criteria, the basis for hydrologic and hydraulic evaluation of development sites are as follows:

1. The models TR-55, incorporated above at § 8.4(A) of this Part, and TR-20, incorporated above at § 8.4(B) of this Part, (or approved equivalent) will be used for determining the required storage and outlet structures for attenuating the peak flows from the 10-year and 100-year, 24-hour Type III design storms.

2. The standard for characterizing pre-development land use for on-site areas shall be woods, meadow, or rangeland. For agricultural land, use a CN representing rangeland.

3. For purposes of computing runoff, all pervious lands prior to development shall be assumed to be in good condition regardless of conditions existing at the time of computation.

4. If an off-site area drains to a facility, an applicant must also demonstrate safe passage of the 100-year event, based on actual conditions upstream.

5. The length of sheet flow used in tc calculations is limited to no more than 150 feet for pre-development conditions and 100 feet for post-development conditions.

6. An applicant must demonstrate that flows from the 100-year event will be safely conveyed to a practice designed to manage the 100-year event.

D. The Overbank Flood Protection criterion can be waived for sites that:

1. Direct discharge to a large river (4th-order stream or larger), bodies of water > 50.0 acres in surface area, or tidal waters.

2. A downstream analysis indicates that peak discharge control would not be beneficial or would exacerbate peak flows in a downstream tributary of a particular site (i.e., through coincident peaks).

E. A downstream analysis is required for projects meeting the project size and impervious cover characteristics in the table in § 8.11(E)(1) of this Part, or when deemed appropriate by the approving agency when existing conditions are already causing a problem, to determine whether peak flow impacts are fully attenuated by controlling the 10- and 100-year events. The criterion used for the limit of the downstream analysis is referred to as the "10% rule." Under the 10% rule, a hydrologic and hydraulic analysis is extended downstream to the point where the site represents 10% of the total drainage area.

1. Table 3-5. Projects for Which a Downstream Analysis Is Required

Area of Disturbance Within the Subwatershed (acres)	Impervious Cover (%) (I / disturbed area contributing to discharge locations)
>5 to10	>75
>10 to 25	>50
>25 to 50	>25
>50	all projects

2. If flow rates and velocities (for Qp) with the proposed detention facility increase by less than 5% from the pre-developed condition, and no existing structures are impacted, then no additional analysis is necessary. If the flow rates and velocities increase by more than 5%, then the

designer must redesign the detention structure, evaluate the effects of no detention structure, or propose corrective actions to the impacted downstream areas. Additional investigations may be required by the approving agency on a case-by-case basis depending on the magnitude of the project, the sensitivity of the receiving water resource, or other issues such as past drainage or flooding complaints.

3. Stormwater designers must be able to demonstrate that runoff will not cause downstream flooding within the stream reach to the location of the 10% rule. The absence of on-site detention shall not be perceived to waive or eliminate groundwater recharge (Rev), water quality control (WQv), or stream channel protection requirements (CPv).

4. A typical downstream analysis will require a hydrologic investigation of the disturbed area draining to a proposed detention facility and of the contributory watershed to the location of the 10% rule for the 10- and 100-year, 24-hour Type III storms. The approving agency may also request analysis of the 1-year, 24-hour Type III storm on a case-by-case basis. A hydraulic analysis of the stream channel below the facility to the location of the 10% rule will also be necessary. Depending on the magnitude of the impact and the specific conditions of the analysis, additional information and data may be necessary such as collecting field run topography, establishing building elevations and culvert sizes or investigating specific drainage concerns or complaints.

8.12 Minimum Standard 6: Redevelopment and Infill Projects

A. Redevelopment does not apply to projects or portions of projects when the total existing impervious area disturbed is less than 10,000 square feet. However, specific regulatory programs may impose additional requirements. Any creation of new impervious area over portions of the site that are currently pervious is required to comply fully with the requirements of this Part. In no case on a redevelopment project shall the levels of stormwater treatment and recharge be less than the levels prior to initiation of the proposed project.

1. The permitting authority may take into consideration prior projects or multi-phase projects in determining if the redevelopment threshold has been met.

2. Building demolition is included as an activity defined as redevelopment, but building renovation is not.

3. Removal of roadway materials down to the erodible soil surface is an activity defined as redevelopment, but simply resurfacing of a roadway surface is not.

4. Pavement excavation and patching that is incidental to the primary project purpose, such as replacement of a collapsed storm drain, is not classified as redevelopment.

B. Redevelopment Stormwater Requirements: In order to determine the stormwater requirements for redevelopment projects, the percentage of the site covered by existing impervious areas must be calculated.

1. For sites with less than 40% existing impervious surface coverage, the stormwater management requirements for redevelopment will be the same as for new development. The applicant, however, can meet those requirements either on-site or at an approved off-site location within the same watershed provided the applicant satisfactorily demonstrates that impervious area reduction, LID strategies, and/or structural BMPs have been implemented on-site to the maximum extent practicable. An approved off-site location must be identified, the specific management measures identified, and an implementation schedule developed in accordance with local review and with DEM/CRMC concurrence, as appropriate. The applicant must also demonstrate that there are no downstream drainage or flooding impacts as a result of not providing on-site management.

2. For redevelopment sites with 40% or more existing impervious surface coverage, only Standards 2, 3, and 7-11 (§§ 8.8, 8.9 and 8.13 through 8.17 of this Part) must be addressed. However, the approving agency may require peak flow control on a case-by-case basis within a watershed with a history of flooding problems. Recharge and stormwater quality shall be managed for in accordance with one or more of the following techniques:

a. Reduce existing impervious area by at least 50% of the redevelopment area;

b. Implement other LID techniques to the maximum extent practicable to provide recharge and water quality management for at least 50% of the redevelopment area;

c. Use on-site structural BMPs to provide recharge and water quality management for at least 50% of redevelopment area;

d. Any combination of impervious area reduction, other LID techniques, or on-site structural BMPs for at least 50% of redevelopment area; or

e. If none of the above options are practical in terms of water quality management, alternatives may be proposed that would achieve an equivalent pollutant reduction by using a combination of other types of BMPs and strategies, including treating 100% of the redevelopment area by BMPs with a lesser pollutant removal efficiency than stipulated in § 8.9 of this Part (Standard 3: Water Quality).

3. Off-site structural BMPs to provide recharge and water quality management for an area equal to or greater than 50% of redevelopment areas may be used to meet these requirements provided that the applicant satisfactorily demonstrates that impervious area reduction, LID strategies, and/or on-site structural BMPs have been implemented to the maximum extent practicable. An approved off-site location must be identified, the specific management measures identified, and an implementation schedule developed in accordance with local review and with DEM/CRMC concurrence, as appropriate. The applicant must also demonstrate that there are no downstream drainage or flooding impacts as a result of not providing on-site management for large storm events.

C. Infill Project Stormwater Management Requirements: For infill sites, the stormwater management requirements will be the same as for new development except that existing impervious area may be excluded from the stormwater management plan (unless subject to local approval or necessary for mitigation by regulation) and only Standards 2, 3, and 7-11 (§§ 8.8, 8.9 and 8.13 through 8.17 of this Part) need be applied. The applicant, however, can meet the recharge and water quality requirements either on-site or at an approved off-site location within the same watershed, provided the applicant satisfactorily demonstrates that impervious area reduction, LID strategies, and/or structural BMPs have been implemented on-site to the maximum extent practicable. An approved off-site location must be identified, the specific management measures identified, and an implementation schedule developed in accordance with local review and with DEM/CRMC concurrence, as appropriate. The applicant must also demonstrate that there are no downstream drainage or flooding impacts as a result of not providing on-site management.

8.13 Minimum Standard 7: Pollution Prevention

All development sites require the use of source control and pollution prevention measures to minimize the impact that the land use may have on stormwater runoff quality. These measures shall be outlined in a stormwater pollution prevention plan.

8.14 Minimum Standard 8: Land Uses with Higher Potential Pollutant Loads

A. Stormwater discharges from land uses with higher potential pollutant loads (LUHPPLs) require the use of specific source control and pollution prevention measures and the specific stormwater BMPs approved for such use. Allowable BMPs for LUHPPLs are included in the Table in § 8.14(D) of this Part. Many LUHPPLs require additional special permits such as a RIPDES Multi-Sector General Permit, and sector-specific required BMPs are included in Section VI of the Multi-Sector General Permit.

B. Stormwater runoff from a LUHPPL shall not be recharged to groundwater, unless it has been adequately treated for the pollutant of concern as determined by the approving agency. The recharge prohibition at LUHPPLs applies only to stormwater discharges that come into contact with the area or activity on the site that may generate the higher potential pollutant load. In addition, infiltration practices should not be used where subsurface contamination is present from prior land use due to the increased threat of pollutant migration associated with increased hydraulic loading from infiltration systems, unless the contamination is removed and the site has been remediated, or if approved by DEM.

C. The following land uses and activities are considered stormwater LUHPPLs:

1. Areas within an industrial site (as defined in § 1.4(A)(111) of this Subchapter) that are the location of activities subject to the RIPDES Multi-Sector General Permit (except where a No Exposure Certification for Exclusion from RIPDES Stormwater Permitting has been executed);

2. Auto fueling facilities;

3. Exterior vehicle service, maintenance and equipment cleaning areas;

4. Road salt storage and loading areas (if exposed to rainfall);

5. Outdoor storage and loading/unloading of hazardous substances; and

6. Disposal sites as defined in § 8.5 of this Part.

8.15 Minimum Standard 9: Illicit Discharges

All illicit discharges to stormwater management systems are prohibited, including discharges from OWTS, and sub-drains and French drains near OWTSs that do not meet the State's Rules Establishing Minimum Standards Relating to Location, Design, Construction and Maintenance of Onsite Wastewater Treatment Systems.

8.16 Minimum Standard 10: Construction Activity Soil Erosion, Runoff, Sedimentation, and Pollution Prevention Control Measure Requirements

A. Soil Erosion and sedimentation control measures must be utilized during the construction phase as well as during any land disturbing activities.

B. All soil erosion, runoff, sedimentation, and construction activity pollution prevention control measures must be designed and implemented in accordance with the SESC Plan requirements outlined in the Performance Criteria in § 8.16(D) of this Part. The Rhode Island Soil Erosion and Sediment Control Handbook provides the recommended and primary means to achieve the performance criteria. The component of the Stormwater Management Plan that addresses this standard is referred to as a SESC Plan.

C. For all land disturbance activities that require a permit from the RI DEM or the CRMC, a qualified SESC Plan preparer shall be a Rhode Island Registered Professional Engineer, a Certified Professional in Erosion and Sediment Control, a Certified Professional in Storm Water Quality, or a Rhode Island Registered Landscape Architect who certifies that the SESC Plan meets the Performance Criteria in § 8.16(D) of this Part. The Preparer shall have the specific credentials and experience needed to select the appropriate practices for the application. If the project involves significant land grading or requires an engineered site design, then the SESC Plan must be prepared by a Professional Engineer licensed in the State of RI.

D. SESC measures must be utilized during the construction phase as well as during any land disturbing activities. Owners and operators must design, install, and maintain effective soil erosion, runoff, and sediment controls. SESC plans must document how the proposed activities are consistent with the following Performance Criteria:

    1. Avoid and Protect Sensitive Areas and Natural Features: Areas of existing and remaining vegetation and areas that are to be protected during construction must be clearly marked on the plans. Throughout planning, design, and construction the Applicant must demonstrate that the activities are consistent with § 8.7 of this Part (Minimum Standard 1, Low Impact Development Site Planning and Design Strategies).

    2. Minimize Area of Disturbance:

a. Limits of Disturbance (LOD) shall be clearly marked on all SESC plans. The SESC Plan must identify how the Applicant has minimized the area of disturbance by locating sites in less sensitive areas in accordance with § 8.7 of this Part (Minimum Standard 1, Low Impact Development Site Planning and Design Strategies).

b. Construction activity shall be phased to minimize the amount of area that is being actively disturbed. Activities disturbing greater than five acres must include phasing in combination with other controls.

c. Adequate temporary controls must be installed on previous phases prior to initiating the land disturbance in subsequent phases until final site stabilization is achieved and post-construction control measures are brought on-line.

3. Minimize the Disturbance of Steep Slopes: Construction activities should be avoided on steep slopes to the Maximum Extent Practicable to comply with § 8.7 of this Part.

4. Preserve Topsoil: Site owners and operators must preserve existing topsoil on the construction site to the maximum extent feasible and as necessary to support healthy vegetation. If it is determined that preserving native topsoil is infeasible, the reasons why this was determined must be addressed in the SESC Plan.

5. Stabilize Soils: Stabilization of disturbed areas must, at a minimum, be initiated immediately whenever any clearing, grading, excavating or other earth disturbance activities have permanently ceased on any portion of the site, or temporarily ceased on any portion of the site and will not resume for a period exceeding 14 calendar days. Stabilization must be completed using vegetative stabilization measures or using alternative measures whenever vegetative measures are deemed impracticable or during periods of drought. All disturbed soils exposed prior to October 15th shall be seeded by that date. Any such areas which do not have adequate vegetative stabilization by November 15th must be stabilized through the use of non-vegetative erosion control measures. If work continues within any of these areas during the period from October 15th through April 15th, care must be taken to ensure that only the area required for that day's work is exposed, and all erodible soil must be restabilized within 5 working days. In limited circumstances, stabilization may not be required if the intended function of a specific area of the site necessitates that it remain disturbed.

6. Protect Storm Drain Inlets: If there is a stormwater discharge from the construction site to a storm drain inlet under the project's control, the site owner and operator must install inlet protection measures that remove sediment from discharge prior to entry into the storm drain inlet. The operator must clean, or remove and replace, the protection measures as sediment accumulates, the filter becomes clogged, and/or performance is compromised. Accumulated sediment adjacent to the inlet protection measures must be removed by the end of the same work day in which it is found or by the end of the following work day if removal by the same work day is not feasible.

7. Protect Storm Drain Outlets: Outfall protection must be used to prevent scour and erosion at discharge points through the protection of the soil surface, reduction of discharge velocity, and the promotion of infiltration.

8. Establish Temporary Controls for the Protection of Post-Construction Stormwater Control Measures: Temporary measures shall be installed to protect permanent or long-term stormwater control and treatment measures as they are installed and throughout the construction phase of the project so that they will function properly when they are brought online. The plan shall identify areas where infiltration measures are proposed and provide measures to restrict construction activity to prevent compaction of the area. In cases where this is not possible to avoid the area the Plan must include methods to restore the infiltration capacity of the soils.

9. Establish Sediment Barriers: Sediment control measures must be installed along the perimeter areas of the site that will receive stormwater from earth disturbing activities. The Rhode Island Soil Erosion and Sediment Control Handbook provided the recommended and primary means to achieve this performance criteria.

10. Divert or Manage Run-on from Up-gradient Areas: Structural control measures must be used to limit stormwater flow from coming onto the project area, and to divert and slow on-site stormwater flow from exposed soils to limit erosion, runoff, and the discharge of pollutants from the site.

11. Properly Design Constructed Stormwater Conveyance Channels: Temporary conveyance practices must be sized to handle the peak flow from the 10-year, 24-hour Type III design storm. Temporary conveyance measures may be required to be sized to handle the peak flow from larger design storms as determined on a case-by-case basis.

12. Retain Sediment On-Site

a. The SESC Plan shall contain a combination of practices that control erosion, control run-off, and control sediment. The combination of practices must be designed to prevent discharges of sediment. All plans shall include inlet protection, construction entrances, and containment of stockpiled materials.

b. For Disturbed Areas <1 Acre: Those areas with a common drainage location that serves an area with less than 1 acre disturbed at one time, a combination of phasing, stabilization and conveyances that provide run-off control will be sufficient.

c. For Disturbed Areas 1 to 5 Acres: Those areas with a common drainage location that serves an area between 1 and 5 acres disturbed at one time, a temporary sediment trap must be provided where attainable and where the sediment trap is only intended to be used for a period of 6 months or less. For longer term projects with a common drainage location that serves between 1 and 5 acres disturbed at one time, a temporary sediment basin must be provided where attainable. Temporary sediment trapping practices must be sized to have a total storage volume capable of storing 1 inch of runoff from the contributing area or 134 cubic yards per acre of drainage area. A minimum of 50% of the total volume shall be storage below the outlet (wet storage). The Rhode Island Soil Erosion and Sediment Control Handbook provides the recommended and primary means to achieve this performance criteria.

d. For Disturbed Areas > 5 Acres: Those areas with a common drainage location that serves an area with greater than 5 acres disturbed at one time, a temporary (or permanent) sediment basin must be provided where attainable until final stabilization of the site is complete. The Rhode Island Soil Erosion and Sediment Control Handbook provides the recommended and primary means to achieve this performance criteria. The volume of wet storage shall be at least twice the sediment storage volume and shall have a minimum depth of 2 feet. Sediment storage volume must accommodate a minimum of 1 year of predicted sediment load. See the sediment volume formula in the Rhode Island Soil Erosion and Sediment Control Handbook as the recommended and primary means to achieve this performance criteria. In addition to sediment storage volume and wet storage volume, the sediment basin shall provide adequate residence storage volume to provide a minimum 10 hours residence time for a 10 -year frequency, 24 hour duration, Type III distribution storm. To the maximum extent practicable, outlet structures must be utilized that withdraw water from the surface of temporary sedimentation basins, if required or specified by the designer, for the purpose of minimizing the discharge of pollutants. Exceptions may include periods of extended cold weather, where alternative outlets are required during frozen periods. If such a device is infeasible for portions of or the entire construction period justification must be made in the SESC Plan.

13. Control Temporary Increases in Stormwater Velocity, Volume, and Peak Flows:

a. The Plan must identify all discharge points and propose a combination of practices to ensure control of both peak flow rates and total runoff volume to minimize flooding, channel erosion, and stream bank erosion in the immediate vicinity of discharge points. The plan must identify if discharge points from the site discharge directly to a surface water or to an off-site conveyance. The designer must ensure that the proposed combination of practices are adequate to protect the receiving waters and downstream conveyances from the excessive velocities that would cause scouring or channel erosion.

b. In most cases, the combination of practices that control erosion, control run-off, and control sediment used to retain sediment on-site will be adequate to control temporary increases in volume and peak flows. However, the designer must evaluate if conditions warrant the use of additional retention/detention practices beyond those required to address § 8.16(D)(12) of this Part. The evaluation must include a description of site conditions and proposed on-site controls and conveyances for all discharge points. For those projects proposing a common drainage location that serves an area with greater than 5 acres disturbed at one time, the approving agency may require peak flow control on a case-by-case basis.

14. Construction Activity Pollution Prevention Control Measures: The SESC Plan must describe the pollution prevention measures that will be implemented to control pollutants in stormwater. The owner and operator must design, install, implement, and maintain effective pollution prevention measures to minimize the discharge of pollutants. The Rhode Island Soil Erosion and Sediment Control Handbook provides the recommended and primary means to achieve this performance criteria.

15. Control Measure Installation, Inspections, Maintenance, and Corrective Actions:

a. The installation of temporary erosion, runoff, sediment, and pollution prevention control measures must be completed by the time each phase of earth-disturbance has begun.

b. Construction sites must be inspected by or under the supervision of the owner and operator at least once every 7 calendar days and within 24 hours after any storm event which generates at least 0.25 inches of rainfall per 24 hour period and/or after a significant amount of runoff.

c. If an inspection reveals a problem, the operator must initiate work to fix the problem immediately after discovering the problem, and complete such work by the close of the next work day, if the problem does not require significant repair or replacement, or if the problem can be corrected through routine maintenance.

d. When installation of a new control or a significant repair is needed, site owners and operators must ensure that the new or modified control measure is installed and made operational by no later than 7 calendar days from the time of discovery where feasible. If it is infeasible to complete the installation or repair within 7 calendar days, the reasons why it is infeasible must be documented in the SESC Plan along with the schedule for installing the stormwater control measure(s) and making it operational as soon as practicable after the 7-day timeframe.

e. If corrective actions are required, the site owner and operator must ensure that all corrective actions are documented on the inspection report in which the problem was first discovered. Corrective actions shall be documented, signed, and dated by the site operator once all necessary repairs have been completed.

8.17 Minimum Standard 11: Stormwater Management System Operation and Maintenance

A. The stormwater management system, including all structural stormwater controls and conveyances, must have an Operation and Maintenance Plan to ensure that it continues to function as designed. The Operation and Maintenance Plan shall identify measures for implementing maintenance activities in a manner that minimizes stormwater runoff impacts.

B. The long-term Operation and Maintenance Plan shall at a minimum include:

1. Stormwater management system(s) owners;

2. The party or parties responsible for operation and maintenance, including how future property owners will be notified of the presence of the stormwater management system and the requirement for proper operation and maintenance;

3. The routine and non-routine maintenance tasks for each BMP to be undertaken after construction is complete and a schedule for implementing those tasks;

4. A plan that is drawn to scale and shows the location of all stormwater BMPs in each treatment train along with the discharge point;

5. A description and delineation of public safety features;

6. An estimated operation and maintenance budget; and

7. Funding source for operation and maintenance activities and equipment.

8.18 LID Stormwater Credit: Rooftop, Roadway, Driveway or Parking Lot Runoff Directed to Qualifying Pervious Areas (QPAs)

A. The LID Stormwater Credit using QPAs may be used to reduce the required Recharge Volume and Water Quality Volume, provided that any pervious surfaces used to treat and infiltrate stormwater runoff meet the requirements set forth herein. The application of the Credit does not relieve the design engineer or reviewer from meeting the remaining minimum standards described in §§ 8.6 through 8.17 of this Part or the standard of engineering practice associated with safe conveyance of stormwater runoff and good drainage design.

B. Stormwater Credit shall not be applied:

1. At sites where stormwater runoff is directed to non-permeable soils, such as bedrock and soils classified as Hydrologic Soil Group D;

2. At sites with urban fill, soils classified as contaminated, and soils with a seasonal high groundwater elevation within 18 inches of the land surface.

C. QPAs are natural or landscaped vegetated areas fully stabilized, with runoff characteristics at or lower than the US Natural Resources Conservation Service Curve Numbers in the table below in § 8.18(D) of this Part. All QPAs must be shown on site plans, must have a minimum of 4 inches of topsoil or organic material, and must be located outside of regulated wetland areas and regulated buffer to a waterbody or wetland. In order for lawns to be considered as QPAs, they must consist of low-maintenance grasses adapted to the New England region.

D. Maximum US Natural Resources Conservation Service Hydrologic Soil Group (HSG) Runoff Curve Numbers for QPAs

Cover Type	HSG A	HSG B	HSG C
Natural: Woods Good Condition	30	55	70
Natural: Brush Good Condition	30	48	65
Landscaped: Good Condition (grass cover > 75% or equivalent herbaceous plants)	39	61	74

E. A LID Stormwater Credit is available when rooftop, roadway, driveway, or parking lot runoff is directed to a QPA where it can either infiltrate into the soil or flow over it with sufficient time and reduced velocity to allow for adequate filtering. QPAs are generally flat locations, where the discharge is directed via sheet flow and not as a point source discharge. The credit may be obtained by grading the site to induce sheet flow over specially designed, gently sloped vegetated areas that can treat and infiltrate the runoff. This credit is available for impervious cover associated with all land uses, except for runoff from that portion of a LUHPPL that may generate runoff with a higher potential pollutant load.

F. If runoff from impervious areas is adequately directed to a QPA, the area can be deducted from total impervious area, therefore reducing the required Water Quality Volume and the size of the structural BMPs used to meet the removal requirement of § 8.9 of this Part (Standard 3). Redirected runoff can also be used to meet the recharge requirement as a non-structural practice.

G. The LID Stormwater Credit is subject to the following restrictions:

1. To prevent compaction of the soil in the QPA, construction vehicles must not be allowed to drive over the area. If it becomes compacted, the soil must be suitably amended, tilled, and re-vegetated once construction is complete to restore infiltration capacity.

2. The QPA must be designed to not cause basement seepage. To prevent basement seepage, at a minimum, runoff must be directed away from the building foundation and be infiltrated at least 10 feet away from the foundation.

3. The rooftop area contributing runoff to any one downspout and/or the non-rooftop impervious areas draining to any one discharge location cannot exceed 1,000 square feet.

4. The length of the QPA (in feet) shall be equal to or greater than the contributing rooftop area (in square feet) divided by 13.3 and the maximum contributing flow path from non-rooftop impervious areas shall be 75 feet.

5. For non-rooftop runoff, the length of the QPA must be equal to or greater than the length of the contributing impervious area.

6. For roof runoff, the width of the QPA (in feet) shall be equal to or greater than the roof length.

7. For non-roof runoff, the width of the QPA shall be no less than the width of the contributing impervious surface.

8. Although they may abut, there shall be no overlap between QPAs. They shall not be directed to the same area.

9. The lot must be greater than 6,000 square feet.

10. The slope of the QPA shall be less than or equal to 5.0%.

11. Where provided, downspouts must be at least 10 feet away from the nearest impervious surface to prevent reconnection to the stormwater management system.

12. Where provided, downspouts must have appropriate provisions to induce sheet flow.

13. Where a gutter/downspout system is not used, the rooftop runoff must be designed to sheet flow at low velocity away from the structure housing the roof.

14. A DEM-licensed Class IV Soil Evaluator or RI-registered Professional Engineer shall confirm that the depth to the seasonal high groundwater table is 18 inches or greater. The soil evaluation must identify the soil texture, HSG (from US Natural Resources Conservation Service soil maps), and depth to the seasonal high groundwater table.

15. If a QPA is located in less permeable soils (HSG “C”), the water table depth and soil texture shall be evaluated by a DEM-licensed Class IV Soil Evaluator or RI-registered Professional Engineer to determine if a level

spreading device is needed to sheet flow stormwater over vegetated surfaces.

16. Runoff from driveways, roadways, and parking lots may be directed over soft shoulders, through curb cuts, or level spreaders to QPAs. Measures must be employed at the discharge point to the QPA to prevent erosion and promote sheet flow.

17. To take credit for rooftop disconnection associated with a LUHPPL, the rooftop runoff must not commingle with runoff from any paved surfaces or activities or areas on the site that may generate higher pollutant loads.

18. The Operation and Maintenance Plan required by § 8.17 of this Part (Minimum Standard 11) must include measures to inspect the QPA at least yearly to remove any deposited sediment.

19. The QPA must be owned or controlled by the property owner.

20. In locations where there is a history of groundwater seepage and/or basement flooding, the credit shall not be utilized.

H. The impervious areas contributing runoff to the QPA can be deducted from the impervious surfaces used to calculate the WQv, and can meet the Rev requirement if enough area is disconnected in accordance with the Percent Area Method, described below.

1. The amount of impervious area that needs to be disconnected to meet the recharge requirement is referred to as the recharge area. It is equivalent to the recharge volume but can be achieved by filtration of sheet flow over a QPA. Recharge area is calculated according to the equation below:

> Recharge area = (F) (I)
>
> Where:
>
> Recharge area = Required impervious area to be directed to a QPA (acres)
>
> F = Recharge factor based on HSG (dimensionless) § 8.8(F) of this Part
>
> I = Impervious area (acres)

2. If only a portion of the recharge area can be directed to a QPA due to site constraints, a designer must use a structural BMP to recharge the difference. This amount can be determined by the following approach:

a. Calculate both the Rev and recharge area for the site;

b. The site impervious area draining to a QPA is subtracted from the recharge area calculation from Credit Step 1, above in § 8.18(H)(1) of this Part;

c. The remaining recharge area is divided by the original recharge area to calculate a pro-rated percentage that must be directed to structural infiltration BMPs; and

d. The pro-rated percentage is multiplied by the original Rev to calculate a new Rev that must be met by an approved structural practice(s).

8.19 Structural Stormwater Treatment Practices for Meeting Water Quality -- Overview

A. §§ 8.20 through 8.25 of this Part provide the requirements for acceptable structural BMPs that can be used to meet the water quality criteria in § 8.9 of this Part. Sediment volumes do not need to be calculated for sizing of the BMPs in §§ 8.20 through 8.25 of this Part.

B. Minimum Design Criteria for BMPs: If required design criteria for a particular BMP cannot be met at a site, an alternative BMP must be selected, or adequate justification must be provided to the approving agency why the particular criteria is not practicable. Design requirements are provided for the following 6 categories:

1. Feasibility: Identify site considerations that may restrict the use of a practice.

2. Conveyance: Convey runoff to the practice in a manner that is safe, minimizes erosion and disruption to natural channels, and promotes filtering and infiltration.

3. Pretreatment: Trap coarse elements before they enter the facility, thus reducing the maintenance burden and ensuring a long-lived practice.

4. Treatment/Geometry: Provide the required water quality treatment through design elements that provide the maximum pollutant removal.

5. Environmental/Vegetation: Reduce secondary environmental impacts of facilities through features that minimize disturbance of natural stream systems and comply with environmental regulations. Provide vegetation that enhances the pollutant removal and aesthetic value of the practice.

6. Maintenance: Maintain the long-term performance of the practice through regular maintenance activities, and through design elements that ease the maintenance burden.

8.20 Wet Vegetated Treatment Systems (WVTS)

A. Feasibility

1. WVTS designs shall not be located within jurisdictional waters, including wetlands; except that on already developed sites, WTVS designs may be allowed in jurisdictional upland buffers in areas already altered under existing conditions, if acceptable to the approving agency.

2. WVTS designs shall not be located within stream channels in order to prevent habitat degradation caused by these structures.

3. Assess the hazard classification of the structure and consider alternative placement and/or design refinements to reduce or eliminate the potential for the structure being subject to the RI DEM Rules and Regulations for Dam Safety, Part 130-05-1 of this Title.

4. The use of WVTS designs in watersheds draining to cold-water fisheries is restricted to prohibit discharges within 200 feet of streams and any contiguous natural or vegetated wetlands. Discharges beyond 200 feet shall be designed to discharge up to and including the CPv through an underdrained gravel trench outlet. Additional storage for Qp may be discharged through traditional outlet structures.

5. WVTS designs specified to manage LUHPPL runoff require a 3-foot separation to groundwater. All other land uses do not require groundwater separation.

6. The volume below the surface elevation of the permanent pool shall not be included in storage calculations for peak flow management (CPv/Qp).

7. Setbacks for WVTS designs from OWTSs shall be consistent with the setbacks in DEM's Rules Establishing Minimum Standards Relating to Location, Design, Construction and Maintenance of Onsite Wastewater Treatment Systems.

B. Conveyance

1. Flow paths from the inflow points to the outflow points of WVTS shall be maximized through the use of BMP geometry and features such as berms and islands.

2. The channel immediately below a WVTS outfall shall be modified to prevent erosion and conform to natural dimensions in the shortest possible distance, typically by use of appropriately sized riprap placed over filter cloth.

3. A stilling basin or outlet protection shall be used to reduce flow velocities from the principal spillway to non-erosive velocities (3.5 to 5.0 feet per second).

4. A subsurface water level must be maintained in the gravel WVTS through the design of the outlet elevation (invert just below the surface). The outlet invert location must be open or vented to prevent a siphon that would drain the WVTS.

5. For discharges beyond 200 feet from streams (and any contiguous natural or vegetated wetlands) in cold-water fisheries, the underdrained gravel trench shall be designed to meet the following requirements:

   a. Shall be sized to release the CPv over at least 12 hours and not more than 24 hours to provide adequate cooling of stormwater runoff discharging from the WVTS;

   b. Shall be 4 feet wide, located at least 2 feet from the WVTS permanent pool, and located at the furthest location opposite from the principal inflow location to the facility;

   c. The trench shall have a length of 3 feet per 1,000 cubic feet of CPv storage volume, have a depth of at least 3 feet, and maintain 2 feet of gravel cover over a 6-inch diameter perforated pipe outlet (Rigid Schedule 40 PVC or SDR35);

   d. Shall utilize geotextile fabric placed between the gravel trench and adjacent soil; and

   e. Shall utilize clean poorly-graded gravel (i.e., uniform stone size).

C. WVTS Liners: When a WVTS is located in medium to coarse sands and above the average groundwater table, a liner shall be used to sustain a permanent pool of water. If geotechnical tests confirm the need for a liner (soils with an infiltration rate of 0.05 inches/hour or greater), acceptable options include:

   1. 6 to 12 inches of clay soil (minimum 15% passing the #200 sieve and a minimum permeability of 1 x 10-5 cm/sec);

   2. A 30 mil poly-liner;

3. Bentonite; or

4. Use of chemical additives.

D. Pretreatment - Sediment Forebay

1. Each WVTS shall have a sediment forebay or equivalent upstream pretreatment. The forebay shall consist of a separate cell.

2. The forebay shall be sized to contain a minimum of 10% of the WQv, and shall be at least 3 feet deep. The forebay storage volume counts toward the total WQv requirement.

3. A forebay shall be provided at each inlet, unless the inlet provides less than 10% of the total design storm inflow to the WVTS.

4. The forebay shall be designed with non-erosive outlet conditions.

5. Direct access for appropriate maintenance equipment shall be provided to the forebay.

E. Minimum Water Quality Volume (WQv)

1. The surface area of a shallow WVTS shall be at least 1.5% of the contributing drainage area; the gravel WVTS surface area shall be at least 0.35% of contributing drainage area.

2. For a shallow WVTS: A minimum of 35% of the total surface area shall have a depth of 6 inches or less, and at least 65% of the total surface area shall be shallower than 18 inches. At least 10% of the WQv shall be provided in a sediment forebay or other pretreatment practice, and at least 25% of the WQv shall be provided in "deep water zones" with a depth equal to or greater than 4 feet. The remaining 65% of the WQv shall be provided in some combination of shallow permanent pool (depth less than 4 feet) and the ED storage volume above the permanent pool, as applicable. ED storage volume shall not exceed 50% of the WQv and shall drain over 24 hours.

3. For a gravel WVTS: At least 10% of the WQv shall be provided in a sediment forebay or other pretreatment practice. The remaining 90% of the WQv shall be provided in some combination of one or more basins or chambers filled with a minimum 24-inch gravel layer and the open, ED storage volume above the gravel, as applicable. ED storage volume shall not exceed 50% of the WQv and shall drain over 24 hours.

F. Minimum WVTS Geometry

1. Flow paths from the inflow points to the outflow points of WVTS shall be maximized through the use of BMP geometry and features such as berms and islands. The minimum length to width ratio for a shallow WVTS is 2:1.

2. For a gravel WVTS: length to width ratio of 1:1 or greater is needed for each treatment cell with a minimum flow path within the gravel substrate of 15 feet.

G. Shallow WVTS Benches: The perimeter of all deep pool areas (four feet or greater in depth) shall be surrounded by two benches as follows:

1. Except when side slopes are 4:1 (h:v) or flatter, provide a safety bench that generally extends 15 feet outward (a 10 foot minimum bench is allowable on sites with extreme space limitations at the discretion of the approving agency) from the normal water edge to the toe of the WVTS side slope. The maximum slope of the safety bench shall be 6%; and

2. Incorporate an aquatic bench that generally extends up to 15 feet inward from the normal edge of water, has an irregular configuration, and a maximum depth of 18 inches below the normal pool water surface elevation.

H. Planting Plan

1. A planting plan for a WVTS and its setback shall be prepared to indicate how aquatic and terrestrial areas will be stabilized and established with vegetation. Minimum elements of a plan include: delineation of pondscaping zones, selection of corresponding plant species, plant locations, sequence for preparing WVTS bed (including soil amendments, if needed), and sources of plant material. Donor plant material must not be from natural wetlands.

2. Donor soils for WVTS mulch shall not be removed from natural wetlands.

I. WVTS Setbacks

1. A WVTS setback shall be provided that extends 25 feet outward from the maximum design water surface elevation of the WVTS.

2. Woody vegetation shall not be planted or allowed to grow on a dam, or within 15 feet of a dam or toe of the embankment, or within 25 feet of a principal spillway outlet.

J. Maintenance

1. Maintenance responsibility for a WVTS and its setback shall be vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of plan approval.

2. General inspections shall be conducted on an annual basis and after storm events greater than or equal to the 1-year, 24-hour Type III precipitation event.

3. The principal spillway shall be equipped with a removable trash rack, and generally accessible from dry land.

4. A maintenance and operation plan must specify that sediment removal in the forebay shall occur every 5 years or after 50% of total forebay capacity has been lost, whichever occurs first.

5. An operation and maintenance plan shall specify that if a minimum vegetative coverage of 50% is not achieved in the planted areas after the second growing season, a reinforcement planting is required.

6. Sediment and organic build-up shall be removed from a gravel WVTS every 2 years, as needed.

7. In a gravel WVTS, vertical cleanouts must be constructed that are connected to the distribution and collection subdrains at each end.

8. For discharges beyond 200 feet from streams (and any contiguous natural or vegetated wetlands) in cold-water fisheries, the gravel trench outlet shall be inspected after every storm in the first 3 months of operation to ensure proper function. Thereafter, the trench shall be inspected at least once annually. Inspection shall consist of verifying that the WVTS is draining to the permanent pool elevation within the 24-hour design requirement and that potentially clogging material, such as accumulation of decaying leaves or debris, does not prevent the discharge through the gravel. When clogging occurs, at least the top 8 inches of gravel shall be replaced over with new material. Sediments shall be disposed of in an acceptable manner.

9. A maintenance right of way or easement shall extend to a WVTS from a public or private road.

10. A low-flow orifice or weir shall be provided when a WVTS is sized for the CPv. The low-flow orifice or weir shall be designed to ensure that no clogging shall occur.

11. The outlet control structure shall be located within the embankment for maintenance access, safety and aesthetics.

12. Except where local slopes prohibit this design, each WVTS shall have a drain pipe that can completely or partially drain the practice. The drain pipe shall have an elbow or protected intake within the WVTS to prevent sediment deposition, and a diameter capable of draining the permanent pool within 24 hours.

13. Access to the drain pipe shall be secured by a lockable structure to prevent vandalism and/or accidental draining of the pond, which could pose a safety hazard due to high drainage velocities.

K. Safety Features

1. Proposed graded side slopes to the WVTS shall not exceed 3:1 (h:v), and shall terminate on the safety bench.

2. The principal spillway opening shall not permit access by small children, and endwalls above pipe outfalls greater than 48 inches in diameter shall be fenced to prevent a hazard.

3. Token or emergency spillways (those placed above the water elevation of the largest managed storm) are required if not already provided as part of the conveyance of the 100-year storm event and must be a minimum 8 feet wide, 1 foot deep, with 2:1 channel side slopes.

8.21 Stormwater Infiltration Practices

A. Stormwater infiltration practices in this section capture and temporarily store the WQv before allowing it to infiltrate into the soil over a maximum period of 48 hours. The requirements for stormwater infiltration practices in this section apply to infiltration basins, infiltration trenches, subsurface chambers and dry wells. This section does not apply to those practices that infiltrate stormwater into the soil addressed in § 8.22 of this Part (Permeable Pavement), § 8.23 of this Part (Filtering Systems), and § 8.25 of this Part (Open Channel Systems).

B. Feasibility

1. Roof runoff from non-LUHPPL sites can be infiltrated directly, without pretreatment, and counted toward both Rev and WQv requirements.

2. In order to meet the water quality standard, the bottom of infiltration practices must be located in the soil profile. Where a TMDL or CRMC goal requires maximum treatment of runoff, the bottom of infiltration

practices shall be within the uppermost soil horizons (A or B) or another BMP is required.

3. To be suitable for infiltration, underlying soils shall have an in-situ infiltration rate of at least 0.5 inches per hour, as initially determined from US Natural Resources Conservation Service soil textural classification, and subsequently confirmed by field geotechnical tests in accordance with § 8.21(E)(4)(b) of this Part. The minimum geotechnical testing at the site of a proposed infiltration practice is 1 test hole per 5,000 square feet, with a minimum of 1 boring or test pit (taken within the proposed limits of the facility). However, for residential rooftop runoff, testing requirements are reduced to 1 infiltration test and 1 test pit per 5 lots assuming consistent terrain and within the same US Natural Resources Conservation Service soil series. If terrain and soil series are not consistent, then requirements increase to 1 infiltration test and 1 test hole per 1 lot.

4. Soils shall also have a clay content of less than 20% and a silt content of less than 60%.

5. The bottom of infiltration practices cannot be located in fill with the exception for strictly residential land uses, for which the bottom of practices may be located in up to 2 feet of fill consisting of material suitable for long-term infiltration after placement. Practices for non-residential sites that cannot be placed in natural soil may be designed as filtering systems. Such cases shall meet the media requirements of sand filters as described in § 8.23 of this Part.

6. To protect groundwater from possible contamination, runoff from designated LUHPPLs or activities shall not be directed to an infiltration facility.

7. The bottom of the infiltration facility shall be separated by at least 3 feet vertically from the SHGT and the bedrock layer (when treating WQv), as documented by on-site soil testing. The SHGT elevation in the area of each infiltration facility must be verified by a DEM-licensed Class IV Soil Evaluator or RI-registered Professional Engineer. The distance may be reduced to 2 feet for strictly residential land uses, excluding roadways.

8. Infiltration practices that are designed for the 10-year storm event or greater and have a separation from the bottom of the system to the seasonal high groundwater of less than four feet shall provide a groundwater mounding analysis.

a. The groundwater mounding analysis must show that the groundwater mound that forms under the infiltration system will not break out above the land or jurisdictional water.

b. Infiltration practices designed for residential rooftops ≤ 1,000 ft^2 are exempt from this requirement.

9. Infiltration practices cannot be placed in locations that cause water problems (such as seepage which may cause slope failure) to downgrade properties.

10. Infiltration facilities must meet the minimum horizontal setbacks in the table below:

	Minimum Horizontal Setbacks	
	From small-scale facilities serving residential properties (feet)	From all other infiltration facilities (feet)
Public Drinking Water Supply Well – Drilled (rock), Driven, or Dug	200	200
Public Drinking Water Supply Well – Gravel Packed, Gravel Developed	400	400
Private Drinking Water Wells	50	100
Surface Water Drinking Water Supply Impoundment with Supply Intake1	100	200
Tributaries that Discharge to the Surface Drinking Water Supply Impoundment1	50	100
Coastal Features	50	50
All Other Surface Waters	50	50

	Minimum Horizontal Setbacks	
	From small-scale facilities serving residential properties (feet)	From all other infiltration facilities (feet)
Up-gradient from Natural slopes > %15	25	50
Down-gradient from Building Structures2	10	25
Up-gradient from Building Structures2	10	50
Onsite Wastewater Treatment Systems	15	25
1 Refer to DEM Rules Establishing Minimum Standards Relating to Location, Design, Construction and Maintenance of Onsite Wastewater Treatment Systems, Figures 14-16 for maps of the surface water drinking water impoundments. 2 Setbacks from building structures applies only where basement or slab is below the ponding elevation of the infiltration facility.		

C. Conveyance

1. Adequate stormwater outfalls shall be provided for the overflow associated with the 1-year design storm event (non-erosive velocities on the down-slope).

2. The overland flow path of surface runoff exceeding the capacity of the infiltration system shall be evaluated to preclude erosive concentrated flow during the overbank events. If computed flow velocities exiting the system overbank exceed erosive velocities (3.5 to 5.0 feet/second) for the 1-year storm event, an overflow channel and/or level spreader shall be provided.

3. All infiltration systems shall be designed to fully de-water the entire WQv within 48 hours after the storm event.

4. If runoff is delivered by a storm drain pipe or along the main conveyance system, the infiltration practice must be designed as an off-line practice, except when used exclusively to manage CPv and Qp.

D. Pretreatment

1. For infiltration basins, chambers, and trenches, a minimum pretreatment volume of at least 25% of the WQv must be provided to protect the long-term integrity of the infiltration rate. This must be achieved by using one of the following options (see §§ 8.26 through 8.31 of this Part):

   a. Grass channel;

   b. Filter strip;

   c. Sediment forebay; or

   d. Deep sump catch basin and one of the following:

      (1) Upper sand layer (6 inch minimum with filter fabric at the sand/gravel interface);

      (2) Washed pea gravel (1/8 inch to 3/8 inch); or

      (3) Proprietary device.

2. Exit velocities from pretreatment chambers flowing over vegetated channels shall be non-erosive (3.5 to 5.0 feet/second) during the 1-year design storm.

E. Treatment

1. If the in-situ infiltration rate for the underlying soils is greater than 8.3 inches per hour, 100% of the WQv shall be treated by an acceptable water quality practice prior to entry into an infiltration facility.

2. Infiltration practices shall be designed to exfiltrate the entire WQv through the floor of each practice, unless the depth is greater than ½ the square root of the bottom surface area.

3. The construction sequence and specifications for each infiltration practice shall be precisely followed.

4. Design infiltration rates shall be determined by using either §§ 8.21(E)(4)(a) or (b) of this Part:

a. Design Infiltration Rates for Different Soil Textures (from Rawls, W. I., D. L. Brakensiek, and K. E. Saxton. 1982. Soil water characteristics. Trans. ASAE, 25(5):13l6-1328.)

US Department of Agriculture Soil Texture	Design Infiltration Rate (inches/hour)	Design Infiltration Rate (feet/minute)
Sand	8.27	0.0115
Loamy Sand	2.41	0.0033
Sandy Loam	1.02	0.0014
Loam	0.52	0.0007
Silt Loam	0.27	0.0004

b. In-situ rates established by one of the approved methods listed below in §§ 8.21(E)(4)(b)((1)) through ((4)) of this Part. Rates derived from standard percolation tests are not acceptable. Field test methods to assess saturated hydraulic conductivity must simulate the "field-saturated" condition and must be conducted at the depth of the bottom of the proposed infiltrating practice. Design infiltration rates shall be determined by using a factor of safety of 2 from the field-derived value. The saturated hydraulic conductivity analysis must be conducted by a DEM-licensed Class IV Soil Evaluator or RI-registered Professional Engineer.

(1) Guelph permeameter - ASTM D5126 - 16e1 Standard Guide for Comparison of Field Methods for Determining Hydraulic Conductivity in Vadose Zone, incorporated above at § 8.4(C) of this Part.

(2) Falling head permeameter – ASTM D5126 - 16e1 Standard Guide for Comparison of Field Methods for Determining Hydraulic Conductivity in Vadose Zone, incorporated above at § 8.4(C) of this Part.

(3) Double ring permeameter or infiltrometer - ASTM D3385 - 18 Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer, incorporated above at § 8.4(D) of this Part; ASTM D5093 - 15e1 Standard Test

Method for Field Measurement of Infiltration Rate Using a Double-Ring Infiltrometer with a Sealed-Inner Ring, incorporated above at § 8.4(E) of this Part; ASTM D5126 - 16e1 Standard Guide for Comparison of Field Methods for Determining Hydraulic Conductivity in Vadose Zone, incorporated above at § 8.4(C) of this Part.

(4) Amoozemeter or Amoozegar permeameter (Amoozegar, A. 1992. Compact constant head permeameter: a convenient device for measuring hydraulic conductivity. In G.C. Topp et al., Eds. Advances in Measurement of Soil Physical Properties: Bringing Theory into Practice. Soil Science Society of America Special Publication, 30. Soil Science Society of America, Madison, WI, pp. 31–42)

F. Vegetation: Upstream construction shall be completed and stabilized before connection to a downstream infiltration facility. A dense and vigorous vegetative cover shall be established over the contributing pervious drainage areas before runoff can be accepted into the facility.

G. Maintenance

1. A legally binding and enforceable maintenance agreement shall be executed between the facility owner and the responsible authority to ensure the following:

2. Infiltration practices shall never serve as a sediment control device during site construction phase. Great care must be taken to prevent the infiltration area from compaction by marking off the location before the start of construction at the site and constructing the infiltration practice last, connecting upstream drainage areas only after construction is complete, and the contributing area is stabilized. In addition, the SESC plan for the site shall clearly indicate how sediment will be prevented from entering the site of an infiltration facility.

3. An observation well shall be installed in every infiltration trench or chamber system, consisting of an anchored 4- to 6-inch diameter perforated PVC pipe with a lockable cap installed flush with the ground surface. The approving agency may require multiple observation wells for large underground chamber systems.

4. Infiltration practices shall be inspected annually and after storms equal to or greater than the 1-year, 24-hour Type III storm event.

5. If sediment or organic debris build-up has limited the infiltration capabilities (infiltration basins) to below the design rate, the top 6 inches shall be removed and the surface roto-tilled to a depth of 12 inches.

8.22 Permeable Paving

A. There are two major types of permeable paving:

1. Porous asphalt and pervious concrete. Although they appear to be the same as traditional asphalt or concrete pavement, they have 10%-25% void space and are constructed over a base course that doubles as a reservoir for the stormwater before it infiltrates into the subsoil or is directed to a downstream facility.

2. Pavers. Three alternative paver configurations will be acceptable to the approving agency as water quality BMPs. These are as follows:

   a. Permeable solid blocks or reinforced turf: This type of permeable paving surface includes permeable solid blocks (where the blocks have a minimum void ratio of 15%) and contain open-cell grids filled with either ASTM D448 - 12 Standard Classification for Sizes of Aggregates for Road and Bridge Construction, incorporated above at § 8.4(F) of this Part, No. 8 washed aggregate for (paving blocks) or sandy soil and planted with turf (for reinforced turf applications), set on a prepared base course consisting of a minimum of 1.5 inches of ASTM D448 - 12 Standard Classification for Sizes of Aggregates for Road and Bridge Construction, incorporated above at § 8.4(F) of this Part, No. 8 washed aggregate, over a minimum of 4 inches of ASTM D448 - 12 Standard Classification for Sizes of Aggregates for Road and Bridge Construction, incorporated above at § 8.4(F) of this Part, No. 57 washed stone. ASTM D448 - 12 Standard Classification for Sizes of Aggregates for Road and Bridge Construction, incorporated above at § 8.4(F) of this Part, No. 2 washed stone is used as a reservoir course as necessary to manage variable storm sizes or provide other functions.

   b. Solid blocks with open-cell joints > 15% of surface: This type of paver surface includes interlocking impermeable solid blocks or open grid cells that must contain permeable void areas (between the impermeable blocks) exceeding 15% of the surface area of the paving system. Permeable void areas are to be filled with ASTM D448 - 12 Standard Classification for Sizes of Aggregates for Road and Bridge Construction, incorporated above at § 8.4(F) of this Part, No. 8 washed aggregate and compacted with a minimum

5,000 lbf plate compactor. Pavers are set on prepared base course materials consisting of a minimum of 1.5 inches of ASTM D 448 - 12 Standard Classification for Sizes of Aggregates for Road and Bridge Construction, incorporated above at § 8.4(F) of this Part, No. 8 washed aggregate, over a minimum of 4 inches of ASTM D448 - 12 Standard Classification for Sizes of Aggregates for Road and Bridge Construction, incorporated above at § 8.4(F) of this Part, No. 57 washed stone. ASTM D448 - 12 Standard Classification for Sizes of Aggregates for Road and Bridge Construction, incorporated above at § 8.4(F) of this Part, No. 2 washed stone is used as a reservoir course as necessary to manage variable storm sizes or provide other functions.

c. Solid blocks with open-cell joints < 15% of surface: This type of paver surface includes interlocking impermeable solid blocks or open grid cells that must contain permeable void areas (between the impermeable blocks) less than 15% of the surface area of the paving system. Permeable void areas are to be filled with ASTM D448 - 12 Standard Classification for Sizes of Aggregates for Road and Bridge Construction, incorporated above at § 8.4(F) of this Part, No. 8 washed aggregate and compacted with a minimum 5,000 lbf plate compactor. In order to meet the water quality treatment requirements of § 8.9 of this Part, these types of systems must be designed to provide one inch of surface storage above the permeable pavement system. Pavers are set on prepared base course materials consisting of a minimum of 1.5 inches of ASTM D448 - 12 Standard Classification for Sizes of Aggregates for Road and Bridge Construction, incorporated above at § 8.4(F) of this Part, No. 8 washed aggregate, over a minimum of 4 inches of ASTM D448 - 12 Standard Classification for Sizes of Aggregates for Road and Bridge Construction, incorporated above at § 8.4(F) of this Part, No. 57 washed stone. ASTM D448 - 12 Standard Classification for Sizes of Aggregates for Road and Bridge Construction, incorporated above at § 8.4(F) of this Part, No. 2 washed stone is used as a reservoir course as necessary to manage variable storm sizes or provide other functions.

B. Treatment Suitability: Permeable paving practices might not be able to provide overbank flood control (Qp) storage. Combine with other practices to handle runoff from large storm events, when required. Extraordinary care shall be taken to assure that clogging does not occur through the use of performance bonds, post-construction inspection and long-term maintenance.

C. There are two categories of permeable pavement:

1. Infiltration Facility: The base stores water and drains to underlying soil. There are no perforated drain pipes at bottom of base; however, they may have overflow pipes for saturated conditions and extreme storm events; and

2. Detention Facility: This design includes an impermeable liner at the bottom of the base aggregate, which then flows to a downstream facility for additional treatment and storage. This category is useful in sites with high groundwater, bedrock, LUHPPL, and areas with fill soils. If designed as a detention system, infiltration restrictions noted in § 8.22(D) of this Part do not apply.

D. Feasibility

1. In order to meet the water quality standard, the bottom of infiltrating permeable pavement practices must be located in the soil profile. Where a TMDL or CRMC goal requires maximum treatment of runoff, the bottom shall be within the uppermost soil horizons (A or B) or another BMP is required.

2. To be suitable for infiltration, underlying soils shall have an in-situ infiltration rate of at least 0.5 inches per hour, as initially determined from US Natural Resources Conservation Service soil textural classification, and subsequently confirmed by field geotechnical tests. The minimum geotechnical testing at the site of a proposed infiltrating practice is one test hole per 5,000 square feet, with a minimum of one boring or test pit per infiltration facility (taken within the proposed limits of the facility).

3. For infiltrating permeable paving practices, underlying soils shall also have a clay content of less than 20% and a silt content of less than 60%.

4. The bottom of an infiltrating permeable pavement practice cannot be located in fill with the exception for strictly residential land uses, for which the bottom may be located in up to 2 feet of fill consisting of material suitable for long-term infiltration. Practices for non-residential sites that must be placed in fill shall meet the media requirements of sand filters as described in § 8.23 of this Part.

5. To protect groundwater from possible contamination, runoff from designated LUHPPL land uses or activities must not be directed to permeable pavement unless designed as a detention facility (with an impermeable liner).

6. To avoid excessive nitrogen loading to coastal embayments, permeable pavements are not permitted to receive runoff from other areas. They

shall only be used to manage precipitation that falls directly on the permeable pavement area.

7. The bottom of an infiltrating permeable pavement practice shall be separated by at least 3 feet vertically from the SHGT or bedrock layer (when treating WQv), as documented by on-site soil testing. The SHGT elevation in the area of an infiltrating permeable pavement facility must be verified by a DEM-licensed Class IV Soil Evaluator or RI-registered Professional Engineer. The distance may be reduced to 2 feet in strictly residential areas.

8. This practice is not appropriate for high traffic/high speed areas (≥ 1,000 vehicle trips/day) due to clogging potential.

9. To avoid frost heave, design base to drain quickly (depth > 24 inches).

10. Use permeable paving only on gentle slopes (less than 5%).

11. Infiltrating permeable pavement practices must meet the minimum horizontal setbacks in the table below:

	Minimum Horizontal Setbacks	
	From small-scale facilities serving residential properties OR non-vehicle surface applications (feet)	For all other applications (feet)
Public Drinking Water Supply Well – Drilled (rock), Driven, or Dug	200	200
Public Drinking Water Supply Well – Gravel Packed, Gravel Developed	400	400
Private Drinking Water Wells	25	100
Surface Water Drinking Water Supply Impoundment with Supply Intake1	100	200

	Minimum Horizontal Setbacks	
	From small-scale facilities serving residential properties OR non-vehicle surface applications (feet)	For all other applications (feet)
Tributaries that Discharge to the Surface Drinking Water Supply Impoundment1	50	100
Coastal Features	50	50
All Other Surface Waters	50	50
Up-gradient from Natural slopes > %15	25	50
Down-gradient from Building Structures2	10	25
Up-gradient from Building Structures2	10	50
Onsite Wastewater Treatment Systems	15	25
1 Refer to DEM Rules Establishing Minimum Standards Relating to Location, Design, Construction and Maintenance of Onsite Wastewater Treatment Systems, Figures 14-16 for maps of the drinking water impoundments. 2 Setbacks from building structures does not apply where basement or slab is at or above the surface elevation of the permeable pavement.		

E. Conveyance

1. The overland flow path of surface runoff exceeding the capacity of the permeable paving system shall be evaluated to preclude erosive concentrated flow during the overbank events. If computed flow velocities exiting the system over-bank exceed erosive velocities (3.5 to 5.0

feet/second), an overflow channel shall be provided to a stabilized watercourse.

2. All permeable pavement systems shall be designed to fully de-water the entire WQv within 24 hours after the storm event.

F. Treatment

1. Permeable pavements used as infiltration practices shall be designed to exfiltrate the entire WQv through the floor of each practice (sides are not considered in sizing).

2. Base course is a reservoir layer which shall be a minimum 6 inches, but is generally 12 to 24 inches or greater (function of storage needed and frost heave resistance). Base material must be poorly graded (uniform size material), must maintain adequate evaluate bearing capacity, depending on the use, and compaction effort must be adjusted to meet design storage requirements. Base course also includes a filter course above reservoir layer (2 to 6 inches of smaller material).

3. The construction sequence and specifications for permeable pavement areas shall be precisely followed, particularly for infiltrating permeable paving practices. Experience has shown that the longevity of any infiltration practice is strongly influenced by the care taken during construction.

4. For infiltrating permeable pavements, design infiltration rates should be determined by using the Table in § 8.21(E)(4)(a) of this Part based on the soil texture of the underlying soil. These are conservative values that take into account future clogging as the practice is used over the years.

5. For permeable paving practices used for detention only, no runoff reduction is allowed, i.e., impermeable CNs shall be used in hydraulic and hydrologic models when calculating CPv and Qp.

G. Vegetation

1. Other adjacent construction shall be completed and site stabilized before installation of reservoir materials. A dense and vigorous vegetative cover shall be established over any contributing pervious drainage areas before runoff can be accepted into the facility.

2. Pavers that are planted with grass require species with deep root systems. Follow manufacturer's guidelines on appropriate species.

H. Maintenance

1. A legally binding and enforceable maintenance agreement shall be executed between the facility owner and the responsible authority.

2. Areas where infiltrating permeable pavement practices are proposed shall not serve as a temporary sediment control device during site construction phase.

3. Permeable paving surfaces require regular vacuum sweeping or hosing (minimum every three months or as recommended by manufacturer) to keep the surface from clogging. Maintenance frequency needs may be more or less depending on the traffic volume at the site.

4. Minimize use of sand and salt in winter months.

5. Do not repave or reseal with impermeable materials.

6. The SESC Plan shall specify at a minimum:

   a. How sediment will be prevented from entering the pavement area;

   b. A construction sequence;

   c. Drainage management; and

   d. Vegetative stabilization.

8.23 Filtering Systems

A. Feasibility

1. The bottom of filtering systems shall be located at or above the seasonal high groundwater table. The top of filtering systems shall be located at least 3 feet above the seasonal high groundwater table.

2. Unlined filtering systems greater than 1,000 square feet in size shall not be located within 15 feet of any OWTS drainfield.

3. Design criteria for tree filters is identical to bioretention practices.

B. Conveyance

1. If runoff is delivered by a storm drain pipe or is along the main conveyance system, the filter practice shall be designed off-line to the maximum extent practicable. In these cases, a flow regulator (or flow splitter diversion

structure) shall be supplied to divert the WQv to the filter practice, and allow larger flows to bypass the practice.

2. An overflow shall be provided for runoff greater than the WQv to a non-erosive outlet point.

C. Pretreatment

1. Dry or wet pretreatment shall be provided prior to filter media equivalent to at least 25% of the computed WQv.

D. Treatment

1. The entire treatment system (including pretreatment) shall be sized to temporarily hold at least 75% of the WQv. A porosity value (Vv/Vt) of 0.33 shall be used to account for storage within the filter media.

2. The filter media for a sand filter shall consist of a medium sand that meets standards for ASTM C33/C33M - 18 Standard Specification for Concrete Aggregates concrete sand, incorporated above at § 8.4(G) of this Part. Media used for organic filters may consist of peat/sand mix or leaf compost. Peat shall be a reed-sedge hemic peat.

3. Sand and organic filter beds shall have a minimum depth of 18 inches.

4. Bioretention systems shall consist of the following treatment components: A 24 inch to 48 inch deep planting soil bed (depending on requirements of proposed vegetation), a surface mulch layer, and a 6 inch to 9 inch deep surface ponding area. Soils shall consist of United States Department of Agriculture loamy sand to sandy loam classification and meet the following graduation: sand 85-88%, silt 8-12%, clay 0-2%, and organic matter (in the form of leaf compost) 3-5%.

5. The minimum filter area for sand and organic filters shall be sized based on the principles of Darcy's Law. A coefficient of permeability (k) shall be used as follows:

   a. Sand: 3.5 feet/day (City of Austin. 1988. Water Quality Management. In Environmental Criteria Manual. Environmental and Conservation Services. Austin, TX)

   b. Peat: 2.0 feet/day (Galli, J., 1990. Peat-Sand filters: A Proposed Stormwater Management Practice for Urbanized Areas. Metropolitan Washington Council of Governments)

c. Leaf compost: 8.7 feet/day (Claytor, R. and T. Schueler. 1996. Design of Stormwater Filtering Systems. Center for Watershed Protection. Ellicott City, MD)

d. Bioretention soil: 1.0 feet/day for sandy-loam soils

6. The minimum required filter bed area is computed using the following equation (City of Austin. 1988. Water Quality Management. In Environmental Criteria Manual. Environmental and Conservation Services. Austin, TX):

Af = (WQv) (df) / [(k) (hf + df) (tf)]

Where:

Af = Surface area of filter bed (square feet)

Df = Filter bed depth (feet)

K = Coefficient of permeability of filter media (feet/day)

hf = Average height of water above surface of practice (height above the uppermost mulch/organic layer) (feet)

tf = Design filter bed drain time (days) (2 days is the maximum tf for bioretention)

7. The depth of sand and organic filters may be reduced to 12 inches on a case-by-case basis as demonstrated by the designer that 18 inches is not feasible, such as sites with high groundwater or shallow depth to bedrock or clay soils, or in retrofit situations where pre-existing site constraints exist.

8. The depth of bioretention systems may be reduced to 12 inches on a case-by-case basis as demonstrated by the designer that the 24 inch to 48 inch range is not feasible, such as sites with high groundwater or shallow depth to bedrock or clay soils, or in retrofit situations where pre-existing site constraints exist. In these cases, the designer should add 20% (by volume) of well-aged (6-12 months), well-aerated, leaf compost (or approved equivalent) to the planting soil mixture, and will need to demonstrate that the facility meets the required 75% WQv storage.

E. Vegetation

1. A dense and vigorous vegetative cover shall be established over the contributing pervious drainage areas before runoff can be accepted into the facility.

2. Vegetation is critical to the performance and function of bioretention areas; therefore, a planting plan must be provided. The approving agency may require applicants to retain the services of a qualified professional with the educational background and/or experience to select appropriate plants.

F. Maintenance

1. A legally binding and enforceable maintenance agreement shall be executed between the facility owner and the responsible authority to ensure the following:

   a. Sediment shall be cleaned out of the sediment forebay when it accumulates to a depth of more than ½ the design depth. Vegetation within the sediment forebay shall be limited to a height of 18 inches. The sediment chamber outlet devices shall be cleaned/repaired when drawdown times exceed 36 hours. Trash and debris shall be removed as necessary.

   b. Silt/sediment shall be removed from the filter bed when the accumulation exceeds one inch. When the filtering capacity of the filter diminishes substantially (water ponds on the surface of the filter bed for more than 48 hours), the top few inches of discolored material shall be removed and shall be replaced with fresh material. The removed sediments shall be disposed in an acceptable manner at an approved and permitted location.

2. For unique installations in extremely tight sites or redevelopment/infill projects where pretreatment strips have been downsized, enhanced maintenance shall be required through more frequent inspections, more frequent sediment removal, and enhanced landscape maintenance.

3. During the six months immediately after construction, filter practices shall be inspected following at least the first two precipitation events of at least 1.0 inch to ensure that the system is functioning properly. Thereafter, inspections shall be conducted on an annual basis and after storm events of greater than or equal the 1-year, 24-hour Type III precipitation event.

8.24 Green Roofs

A. Feasibility

1. The system shall have a maximum slope of 20%, unless specific measures from the manufacturer are provided to retain the system on steeper slopes.

2. Green roofs can meet water quality treatment goals only, and are not appropriate for Rev, CPv, or Qp.

B. Conveyance

1. The runoff exceeding the capacity of the green roof system shall be safely conveyed to a drainage system or BMP without causing erosion. If an overland path is used, a stabilized channel shall be provided for erosive velocities (3.5 to 5.0 feet/second) for the 1-year storm event.

2. The green roof system shall safely convey runoff from the 100-year storm away from the building and into a downstream drainage system.

C. Treatment: Green roofs shall be designed to manage the WQv.

D. Maintenance: A legally binding and enforceable maintenance agreement shall be executed between the facility owner and the responsible authority to ensure that the vegetation is maintained and that green roofs are inspected on a quarterly basis.

8.25 Open Channel Systems

A. Feasibility

1. Open channels shall have a maximum drainage area of 5 acres draining to any 1 inlet. No maximum drainage area if flow enters via sheet flow along a linear feature, such as a road.

2. Open channels shall have a maximum longitudinal slope of 4%, without check dams.

3. Wet Swales are constructed in groundwater. The bottom of a Dry Swale shall be located at or above the seasonal high groundwater table; the top of a Dry Swale shall be located at least 3 feet above the seasonal high groundwater table.

4. Wet swales shall be placed a minimum 50 feet downgradient of any OWTS drainfield.

B. Conveyance

1. The maximum allowable temporary ponding time within a channel shall be less than 48 hours. An underdrain system shall be used in the dry swale to ensure this ponding time, unless designed as an exfilter in which case an underdrain might not be necessary.

2. The peak velocity for the 1-year storm must be non-erosive (3.5-5.0 feet/second).

3. Open channels shall be designed to safely convey the 10-year storm.

4. Channels shall be designed with moderate side slopes (flatter than 3:1) for most conditions. Designers may utilize a 2:1 maximum side slope, where 3:1 slopes are not feasible.

5. If the site slope is greater than 4%, additional measures such as check dams shall be utilized to retain the water quality volume within the swale system.

C. Pretreatment: Provide 10% of the WQv in pretreatment.

D. Treatment

1. Wet swale length, width, depth, and slope shall be designed to temporarily accommodate the WQv through surface ponding.

2. Dry swales shall consist of the following treatment components: A 30 inch deep bioretention soil bed, a surface mulch layer, and no more than a 12 inch deep average surface ponding depth. Soil media shall meet the specifications outlined for bioretention areas.

3. The minimum filter area for dry swales shall be sized based on the principles of Darcy's Law. A coefficient of permeability (k) shall be used as follows:1.0 feet/day for sandy-loam soils. The minimum required filter area is computed using the following equation:

Af = (WQv) (df) / [(k) (hf + df) (tf)]

Where:

Af = Surface area of filter bed (square feet)

Df = Filter bed depth (feet)

K = Coefficient of permeability of filter media (feet/day)

hf = Average height of water above dry swale surface (feet)

tf = Design filter bed drain time (days)

(2 days is maximum tf for dry swales)

4. Swales shall be designed with a bottom width no greater than 8 feet to avoid potential gullying and channel braiding, but no less than 2 feet.

5. The bioretention soil depth of dry swales may be reduced to 12 inches on a case-by-case basis as demonstrated by the designer that 30 inches is not feasible, such as sites with high groundwater or shallow depth to bedrock or clay soils, or in retrofit situations where pre-existing site constraints exist. In these cases, the designer should add 20% (by volume) of well-aged (6-12 months), well-aerated, leaf compost (or approved equivalent) to the bioretention soil mixture and will need to provide a calculation to demonstrate that an equal WQv is provided as with a 30 inch deep soil bed.

E. Maintenance

1. A legally binding and enforceable maintenance agreement shall be executed between the facility owner and the responsible authority.

2. Open channel practices shall be inspected annually and after storms of greater than or equal to the 1-year, 24-hour Type III precipitation event.

3. Sediment build-up within the bottom of the channel or filter strip shall be removed when 25% of the original WQv volume has been exceeded.

4. Eroded side slopes and channel bottoms shall be stabilized as necessary.

5. In the absence of evidence of contamination, removed debris may be taken to a landfill or other permitted facility.

6. Sediment testing may be required prior to sediment disposal when a LUHPPL is present.

7. Vegetation in dry swales shall be mowed as required to maintain grass heights in the 4-6-inch range, with mandatory mowing once grass heights exceed 10 inches.

8. Woody vegetation in wet swales shall be pruned where dead or dying branches are observed, and reinforcement plantings shall be planted if less than 50% of the original vegetation establishes after two years.

9. If the surface of the dry swale becomes clogged to the point that standing water is observed on the surface 48 hours after precipitation events, the bottom shall be roto-tilled or cultivated to break up any hard-packed sediment, and then reseeded.

8.26 Pretreatment Practices Overview

A. Pretreatment BMPs are designed to improve water quality and enhance the effective design life of practices by consolidating the maintenance to a specific location, but do not meet the water quality performance standard in § 8.9 of this Part on their own. Pretreatment practices must be combined with an acceptable water quality BMP §§ 8.20 through 8.25 of this Part to meet the water quality standard.

B. If required design criteria for a particular pretreatment BMP cannot be met at a site, an alternative pretreatment BMP must be selected, or adequate justification must be provided to the approving agency why the particular criteria is not practicable.

8.27 Pretreatment - Grass Channel

A. Grass channels are similar to conventional drainage ditches, with the major differences being flatter side and longitudinal slopes, as well as a slower design velocity for small storm events.

B. Sizing of the grass channel length is based on flow rate from the water quality storm (WQf) and should be designed to ensure an average residence time of 10 minutes to flow from the inlet to the outlet of the channel (for linear projects with no defined primary inflow location, residence time shall be measured from the mid-point location of the channel).

C. The following maintenance activities shall be performed on an annual basis or more frequently as needed:

1. Sediment removal;

2. Mowing and litter and debris removal; and

3. Stabilization of eroded side slopes and bottom.

8.28 Pretreatment - Filter Strips

A. The filter strip must abut the entire length of the contributing area to ensure that runoff from all portions of the site are treated.

B. Maintenance

1. Ensure that grass has established; if not, replace with an alternative species.

2. Filter strips shall be inspected at least quarterly during the first year of operation and semiannually thereafter. Evidence of erosion and concentrated flows within the filter strip must be corrected immediately. Eroded spots must be reseeded and mulched to enhance a vigorous growth and prevent future erosion problems.

3. The bulk of accumulated sediments will be trapped at the initial entry point of the filter strip. These deposited sediments shall be removed manually at least once per year or when accumulating sediments cause a change in the grade elevation. Reseeding may be necessary to repair areas damaged during the sediment removal process.

4. Filter strips, or areas proposed as such, must be protected by proper SESC control techniques during all phases of construction. These measures must be properly maintained until final site stabilization and subsequent removal of all trapped sediments has occurred.

8.29 Pretreatment - Sediment Forebay

A. The required surface area of the sediment forebay shall be determined using the following equation that is based on Camp-Hazen.

$$A_s = -\frac{Q}{W}\ln(1 - E)$$

Where:

$A_s =$ sedimentation surface area (square feet)

$Q =$ discharge from drainage area (cubic feet/second = %WQv/86,400 sec

$W =$ 0.0004 feet/second particle settling velocity recommended for silt

$E =$ sediment removal efficiency (assume 0.9 or 90%)

The percent of the water quality volume used for the sediment forebay design depends on which treatment BMP is being used.

Therefore, for the purposes of this Part, use:

As = 5,750 * Q

B. The forebay shall have a minimum length to width ratio of 1:1 and a preferred minimum length to width ratio of 2:1 or greater. Designers shall calculate scour potential and provide riprap sizing calculations (diameter required to effectively dissipate erosive velocities).

C. The forebay shall be sized to contain at least 10% of the WQv (depending on the requirements of the treatment BMP) and be of an adequate depth to prevent resuspension of collected sediments during the design storm, often 4 feet to 6 feet deep. Shallower depths shall be evaluated such that flow-through velocities do not exceed 2 feet/second for all design storms up to the 100-year storm. The goal of the forebay is to at least remove particles consistent with the size of medium sand.

D. Direct access for appropriate maintenance equipment needs to be provided to the forebay and may include a ramp to the bottom of the embankment if equipment cannot reach all points within the forebay from the top of the embankment. The forebay can be lined with a concrete pad.

8.30 Pretreatment - Deep Sump Catch Basins

A. Deep sump catch basins shall not be used in place of an oil grit separator for LUHPPLs that have the potential to generate runoff with high concentrations of oil and grease.

B. Feasibility

1. The deep sump catch basin must be designed in a catch basin-to-manhole configuration (not in a catch basin-to-catch basin configuration) to be used as pretreatment for other BMPs. Catch basin-to-catch basin or inlet-to-inlet configurations are acceptable, but they cannot be counted as a pretreatment practice.

2. The contributing drainage area to each deep sump catch basin shall not exceed 0.5 acres of impervious cover.

C. Design

1. The deep sump shall be a minimum 4 feet below the lowest pipe invert or 4 times the diameter of the outlet pipe, whichever value is greater.

2. The inlet grate shall be sized based on the contributing drainage area to ensure that the flow rate does not exceed the capacity of the grate. The grate shall not allow flow rates greater than 3 cubic feet per second for 10-year storm event to enter the sump.

3. Inlet grates designed with curb cuts must reach the back of the curb cut to prevent flow bypass.

4. Hooded outlets shall be used in high litter land uses. Care shall be taken to avoid damaging and displacing hoods during cleaning.

D. Maintenance

1. Inspections shall be performed a minimum of 2 times a year (spring/fall). Units shall be cleaned annually and whenever the depth of sediment is greater than or equal to half the sump depth.

2. The inlet grate shall not be welded to the frame so that the sump can be easily inspected and maintained.

3. Sufficient maintenance access shall be considered when designing the geometry of deep sump catch basins.

8.31 Pretreatment - Proprietary Devices

A. Feasibility

1. To qualify as an acceptable pretreatment device, proprietary devices shall remove a minimum of 25% TSS, as verified by an independent third-party monitoring group. In certain retrofit cases and other cases where higher pretreatment standards may be appropriate, higher removal efficiency for

TSS may be required in order to achieve stormwater treatment goals for the project.

2. Proprietary devices shall be designed per the manufacturer's recommendations.

3. Proprietary devices must be designed as off-line systems or have an internal bypass to avoid large flows and resuspension of pollutants in order to be used as pretreatment for other BMPs.

B. Design

1 Flow-through proprietary devices shall be designed to treat runoff from the entire WQf. For these devices, a minimum detention time of 60 seconds is required for the WQf.

2. A storage proprietary device shall be sized based on the required pretreatment volume (% WQv) or a designer must provide documentation that it is sized appropriately for a verified minimum removal of 25% TSS.

3. For proprietary devices such as oil/grit separators, all baffles shall be tightly sealed at sidewalls and at the roof to prevent the escape of oil.

C. Maintenance

1. Proprietary devices shall be maintained in accordance with manufacturers' guidelines.

2. Proprietary devices shall be located such that it is accessible at times for maintenance and/or emergency removal of oil or chemical spills.

3. Inspections shall be performed a minimum of 2 times a year. Devices shall be cleaned when pollutant removal capacity is reduced by 50% or more, or where 50% or more of the pollutant storage capacity is filled or displaced. Hazardous debris removed shall be disposed of in accordance with State and federal regulations by a properly licensed contractor.

8.32 Storage Practices for Stormwater Quantity Control - Overview

A. The storage practices included in this section (§ 8.32 of this Part) can be used to meet channel protection and flood protection, but must be combined with other BMPs for meeting water quality and recharge criteria.

B. If required design criteria for a particular storage BMP cannot be met at a site, an alternative storage BMP must be selected, or adequate justification must be provided to the approving agency why the particular criteria is not practicable.

8.33 Quantity Control - Stormwater Basins

A. Wet basins may be located in the groundwater table; dry basins do not need a permanent pool and may be designed such that the groundwater table is at or below the bottom of the basin.

B. Feasibility

1. Wet Extended Detention Basins shall have a minimum contributing drainage area of 25 acres, unless groundwater is intercepted.

2. Stormwater basins shall not be located within jurisdictional waters, including wetlands, except that on already developed sites basin designs may be allowed in jurisdictional upland buffers in areas already altered under existing conditions, if acceptable to the approving agency.

3. The use of basins in watersheds draining to cold-water fisheries is restricted to prohibit discharges within 200 feet of streams and any contiguous natural or vegetated wetlands. Discharges beyond 200 feet shall be designed to discharge the CPv through an underdrained gravel trench outlet. Additional storage for Qp may be discharged through traditional basin outlet structures.

4. Basins receiving runoff from LUHPPLs must be lined and shall not intercept groundwater.

5. Basins that do intercept groundwater (allowed as long as not receiving runoff from LUHPPLs) shall not include the volume of the permanent pool in storage calculations.

C. Conveyance

1. The channel immediately below a basin outfall shall be modified to prevent erosion and conform to natural dimensions in the shortest possible distance, typically by use of appropriately sized riprap placed over filter cloth.

2. A stilling basin or outlet protection shall be used to reduce flow velocities from the principal spillway to non-erosive velocities (3.5 to 5.0 feet/second).

3. Outfalls, where needed, shall be constructed such that they do not increase erosion or have undue influence on the downstream geomorphology of any natural watercourse by discharging at or near the stream water surface elevation or into an energy dissipating step-pool arrangement.

4. All basins shall have an emergency outlet to accommodate the storm flow in excess of the 100-year storm event maintaining at least one foot of freeboard between the peak storage elevation and the top of the embankment crest, and to safely convey the 100-year storm without overtopping the embankment.

D. Treatment: Stormwater basins shall not be used for meeting the water quality treatment standard.

E. Using Basins for Additional Pollutant Loading Reduction: In order to use the pollutant removal rates for dry extended detention basins and wet extended detention basins as listed in § 8.38(E) of this Part, the following design criteria must be met.

1. Each basin shall have a sediment forebay or equivalent upstream pretreatment. The forebay shall be sized to contain 10% of the water quality volume (WQv) sized per § 8.29 of this Part. The forebay storage volume counts toward the total WQv requirement.

2. The minimum detention time for the WQv shall be 24 hours.

3. Storage for the channel protection volume (CPv) and the WQv shall be computed and routed separately. The WQv cannot be met simply by providing CPv storage for the one-year storm.

4. Provide water quality treatment storage to capture the computed WQv from the contributing drainage area through a combination of permanent pool and extended detention, as outlined in the table in § 8.33(F) of this Part.

5. The minimum length to width ratio for a basin shall be 1.5:1 (length relative to width).

6. Provide a minimum Drainage Area: Surface Area Ratio of 75:1.

7. Incorporate an aquatic bench that extends up to 15 feet inward from the normal edge of water, has an irregular configuration, and a maximum depth of 18 inches below the normal pool water surface elevation.

F. Minimum Required Storage Volumes for Basins Used for Enhanced Pollutant Removal

Design Variation	%WQv	
	Permanent Pool	Extended Detention
Dry Extended Detention Basin	20% min.	80% max.
Wet Extended Detention Basin	50% min.	50% max.

G. Vegetation

1. The perimeter of all deep pool areas (four feet or greater in depth) shall be surrounded by a safety bench. Except when basin side slopes are 4:1 (h:v) or flatter, provide a safety bench that generally extends 15 feet outward (a 10' minimum bench is allowable on sites with extreme space limitations at the discretion of the approving agency) from the normal water edge to the toe of the basin side slope. The maximum slope of the safety bench shall be 6%.

2. A planting plan for a stormwater basin and its setback shall be prepared to indicate how the basin perimeter will be stabilized and established with vegetation.

H. Basin Setbacks

1. A basin setback from structures, roads, and parking lots shall be provided that extends 25 feet outward from the maximum water surface elevation of the basin.

2. Woody vegetation shall not be planted or allowed to grow on a dam, or within 15 feet of a dam or toe of the embankment, or within 25 feet of a principal spillway outlet.

I. Maintenance

1. Maintenance responsibility for a basin and its setback shall be vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of plan approval.

2. The principal spillway shall be equipped with a removable trash rack, and generally accessible from dry land.

3. A maintenance right-of-way or easement shall extend to a basin from a public or private road.

4. Sediment shall be removed from stormwater basins when the sediment volume exceeds 10% of the total basin volume.

5. For discharges beyond 200 feet from streams (and any contiguous natural or vegetated wetlands) in cold-water fisheries, the gravel trench outlet shall be inspected after every storm in the first 3 months of operation to ensure proper function. Thereafter, the trench shall be inspected at least once every six months. Inspection shall consist of verifying that the wet basin is draining to the permanent pool elevation within the 24-hour design requirement and that potentially clogging material, such as accumulation of decaying leaves or debris, does not prevent the discharge through the gravel. When clogging occurs, at least the top 8 inches of gravel shall be replaced over with new material. Sediments shall be disposed of in an acceptable manner.

6. Annual mowing of the basin setback is only required along maintenance rights-of-way and the embankment. The remaining setback can be managed as rangeland (mowing every other year) or forest.

J. Non-clogging Low-flow Orifice: When CPv is required, a low-flow orifice shall be provided, with the design of the orifice sufficient to ensure that no clogging shall occur.

K. Outlet Control Structure

1. The outlet control structure shall be located within the embankment for maintenance access, safety and aesthetics.

2. The outlet control structure shall be sized and designed for CPv and Qp, as required.

3. For discharges beyond 200 feet from jurisdictional waters in cold-water fisheries, the underdrained gravel trench shall be designed to meet the following requirements:

a. Shall be sized to release the CPv over at least 12 hours and not more than 24 hours to provide adequate cooling of stormwater runoff discharging from the basin;

b. Shall be four feet wide, located at least 2 feet from the permanent pool, and located at the furthest location opposite from the principal inflow location to the facility;

c. The trench shall have a length of 3 feet per 1,000 cubic feet of CPv storage volume, have a depth of at least 3 feet, and maintain 2 feet of gravel cover over a 6-inch diameter perforated pipe outlet (Rigid Schedule 40 PVC or SDR35);

d. Shall utilize geotextile fabric placed between gravel trench and adjacent soil; and

e. Shall utilize clean poorly-graded (uniform size material) gravel.

L. Basin Drain

1. Except where local slopes prohibit this design, each wet basin shall have a drain pipe that can completely or partially drain the permanent pool. The drain pipe shall have an elbow or protected intake within the basin to prevent sediment deposition, and a diameter capable of draining the basin within 24 hours.

2. Access to the drain pipe shall be secured by a lockable structure to prevent vandalism and/or accidental draining of the pond, which could pose a safety hazard due to high drainage velocities.

M. Safety Features

1. Side slopes to the basin shall not exceed 3:1 (h:v) and, for wet basins, shall terminate on a safety bench.

2. The principal spillway opening shall not permit access by small children, and endwalls above pipe outfalls greater than 48 inches in diameter shall be fenced to prevent a hazard.

8.34 Quantity Control - Underground Storage Devices

A. Conveyance

1. Outfalls to the ground surface, where needed, shall be constructed such that they do not increase erosion by discharging near the stream water surface elevation or into an energy dissipating step-pool arrangement.

2. An emergency overflow system shall be designed to convey flows larger than the 100-year storm or to divert water in case system fails for any reason.

B. Design

1. Capacity and discharge rate shall depend on the CPv and Qp requirements. Storage is a function of geometry of the structure, which shall be provided by the manufacturer.

2. Sufficient maintenance access points (manholes) shall be incorporated in design to facilitate easy maintenance. Placement shall, at a minimum, occur near the intake and another at the outlet end of the system. The number of manholes depends on maintenance methods used.

3. The design shall address implications of the depth to groundwater at the site. A high water table can cause structures to displace due to uplift forces if not designed correctly. Anti-floatation calculations are required when system designed below the water table.

C. Maintenance

1. Periodic inspections of the inlet and outlet areas to ascertain correct operation of system and to clean materials trapped on grates protecting catch basins and inlet area.

2. Sediment shall be removed from the system when the sediment volume exceeds 10% of the total vault volume.

8.35 Stormwater Infiltration Practices for Recharge/Storage Only

A. On sites where the soil infiltration rate is high (greater than 8.3 inches/hour), infiltration practices cannot be used to treat the water quality volume. However, they may be used to provide recharge (Rev), channel protection (CPv) and/or overbank flood control (Qp) storage (applicants must provide treatment of 100% of the WQv prior to direct infiltration).

B. Feasibility

1. The bottom of the infiltration facility shall be separated by at least 2 feet vertically from the SHGT or bedrock layer, as documented by on-site soil testing, unless a mounding analysis shows that the system will accept the stormwater without causing breakout or backup into the system with less than 2 feet vertical separation. The SHGT elevation in the area of each infiltration facility must be verified by a DEM-licensed Class IV Soil Evaluator or RI-registered Professional Engineer.

2. Infiltration practices that are designed for the 10-year storm event or greater and have a separation from the bottom of the system to the SHGT of less than 4 feet shall provide a groundwater mounding analysis. The groundwater mounding analysis must show that the groundwater mound

that forms under the infiltration system will not break out above the land or jurisdictional water.

3. Infiltration practices cannot be placed in locations that cause water problems (such as seepage which may cause slope failure) to downgrade properties.

4. Infiltration facilities must meet the minimum horizontal setbacks below:

	Minimum Horizontal Setbacks	
	From small-scale facilities serving residential properties (feet)	From all other infiltration facilities (feet)
Public Drinking Water Supply Well – Drilled (rock), Driven, or Dug	200	200
Public Drinking Water Supply Well – Gravel Packed, Gravel Developed	400	400
Private Drinking Water Wells	50	100
Surface Water Drinking Water Supply Impoundment with Supply Intake[1]	100	200
Tributaries that Discharge to the Surface Drinking Water Supply Impoundment[1]	50	100
Coastal Features	50	50
All Other Surface Waters	50	50
Up-gradient from Natural slopes > %15	25	50
Down-gradient from Building	10	25

	Minimum Horizontal Setbacks	
	From small-scale facilities serving residential properties (feet)	From all other infiltration facilities (feet)
Structures[2]		
Up-gradient from Building Structures[2]	10	50
Onsite Wastewater Treatment Systems	15	25

1 Refer to DEM Rules Establishing Minimum Standards Relating t Location, Design, Construction and Maintenance of Onsite Wastewater Treatment Systems, Figures 14-16 for maps of the drinking water impoundments.

2 Setbacks from building structures applies only where basement of slab is below the ponding elevation of the infiltration facility.

C. Conveyance

1. Adequate stormwater outfalls shall be provided for the overflow associated with the 1-year design storm event (non-erosive velocities on the down-slope).

2. The overland flow path of surface runoff exceeding the capacity of the infiltration system shall be evaluated to preclude erosive concentrated flow during the overbank events. If computed flow velocities exiting the system overbank exceed erosive velocities (3.5 to 5.0 feet/second) for the 1-year storm event, an overflow channel and/or level spreader shall be provided.

D. Design

1. Infiltration practices shall be designed to exfiltrate the design volume through the floor of each practice (sides are not considered in sizing), except where the depth is greater than the square root of the bottom surface area.

2. The construction sequence and specifications for each infiltration practice shall be precisely followed.

3. Design infiltration rates shall be determined in accordance with § 8.21(E)(4) of this Part.

E. Vegetation: Upstream construction shall be completed and stabilized before connection to a downstream infiltration facility. A dense and vigorous vegetative cover shall be established over the contributing pervious drainage areas before runoff can be accepted into the facility.

F. Maintenance: A legally binding and enforceable maintenance agreement shall be executed between the facility owner and the responsible authority to ensure the following:

1. Infiltration practices shall never serve as a sediment control device during site construction phase. Great care must be taken to prevent the infiltration area from compaction by marking off the location before the start of construction at the site and only constructing the infiltration practice last, connecting upstream areas only after construction is complete, and the contributing area stabilized. In addition, the SESC plan for the site shall clearly indicate how sediment will be prevented from entering the site of an infiltration facility.

2. An observation well shall be installed in every infiltration trench or chamber system, consisting of an anchored 4 to 6 inch diameter perforated PVC pipe with a lockable cap installed flush with the ground surface. The approving agency may require multiple observation wells for large underground chamber systems.

8.36 Pollutant Loading Analyses - Overview

A. The permitting agency may require applicants to document that a particular project does not unduly contribute to, or cause, water resource degradation (generally for sensitive resource areas or where an elevated concern for water quality exists) or to document a reduction in pollutant load (generally, as a consequence of a TMDL requirement). In these cases, applicants may be required to calculate potential stormwater pollutant loadings for projects for pre-development and post-development conditions.

B. When such an analysis is required of the applicant, the Simple Method (Schueler, T.R. 1987. Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs, Department of Environmental Programs, Metropolitan Washington Council of Governments, Washington, DC) can be used to demonstrate urban stormwater pollutant loadings. The Simple Method requires estimates of annual rainfall, site percent impervious cover, land use type, and pollutant loading coefficients based on land use.

C. The table below in § 8.36(D) of this Part provides event mean concentrations in milligrams per liter (mg/L) for typical pollutants of concern associated with stormwater runoff (# col/100ml for bacteria). There may be an interest in calculating the loading rates of other pollutants not listed in this table. If this is necessary, an applicant shall use event mean concentration data from a reliable source, as approved by the approving agency, based on the land use category. These event mean concentration values must be documented by scientific studies and referenced by the applicant.

D. Median Event Mean Concentration Values for Differing Land Use Categories

Pollutant (mg/l)	Land Use Category				
	Residential	Commercial	Industrial	Highways	Undeveloped/ Rural[3]
TSS	100[1]	75[1]	120[1]	150[1]	51
TP	0.3[2]	0.2[2]	0.25[2]	0.25	0.11
TN	2.1[2]	2.1[2]	2.1[2]	2.3[2]	1.74
Cu	.005[2]	.096[2]	.002[2]	.001[2]	-
Pb	.012[2]	.018[2]	.026[2]	.035[2]	-
Zn	.073[2]	.059[2]	.112[2]	.051[2]	-
BOD	9.0[2]	11.0[2]	9.0[2]	8.0[2]	3.0
COD	54.5[2]	58.0[2]	58.6[2]	100.0[2]	27.0
Bacteria (#col/100 ml)	7000[2]	4600[2]	2400[2]	1700[2]	300

1 Caraco, D. 2001. The Watershed Treatment Model. Center for Watershed Projection. Ellicott City, Maryland.

2 Pitt, R. E., Maestre, A., and Center for Watershed Protection. 2005. The National Stormwater Quality Database (NSQD), version 1.1. USEPA Office of Water, Washington, D.C.

3 CDM. 2004. Merrimack River Watershed Assessment Study, Screening Level Model.

E. The method outlined in § 8.37 of this Part is most often applied to calculating loadings to surface water bodies. Other pollutant loading methods may be acceptable, provided the applicant submits the methodology and data used along with the reasoning for the chosen method. All information supplied by the applicant will be reviewed by the approving agency to determine the relevance of the model to the situation.

8.37 Pollutant Loading Analyses - Overview of the Simple Method

A. Stormwater pollutant export load (L, in pounds or billion colonies) from a development site can be determined by solving the following equation:

$$L = [(P)(Pj)(Rv)/12](C)(A)(2.72)$$

Where:

P = rainfall depth (inches)

Pj = rainfall correction factor

Rv = runoff coefficient expressing the fraction of rainfall converted to runoff

C = flow-weighted mean concentration of the pollutant in urban runoff (milligrams/liter)

A = contributing drainage area of development site (acres)

12, and 2.72 are unit conversion factors

B. For bacteria, the conversion factor is modified, so the loading equation is:

$$L = 1.03(10^{-3})[(P)(Pj)(Rv)](C')(A)$$

Where:

P = rainfall depth (inches)

Pj = rainfall correction factor

Rv = runoff coefficient expressing the fraction of rainfall converted to runoff

C' = flow-weighted mean bacteria concentration (#col/100 ml)

A = contributing drainage area of development site (acres)

1.03 is a unit conversion factor

C. P (depth of rainfall). The value of P selected depends on the time interval over which loading estimates are necessary (usually annual rainfall – see figure in § 8.37(H) of this Part. Appropriate annual rainfall values for a site specific location can be interpolated from the figure in § 8.37(H) of this Part or obtained from the Northeast Regional Climate Center. If a load estimate is desired for a specific design storm, the user can supply the relevant value of P derived from § 8.6(E) of this Part. Caution is required as event mean concentration values vary as a function of rainfall amount and intensity and those presented in the table in § 8.36(D) of this Part are median values from a range of storms more representative of long-term loading. If a load is desired from a larger storm, applicants shall provide appropriate documentation of the source of the event mean concentration used. All rainfall data used in the analysis must be applicable to site location and referenced for review.

D. Pj (correction factor). Use a value of 0.9 for Pj. This represents the percentage of annual rainfall that produces runoff. When solving the equation for individual storms, a value of 1.0 should be used for Pj.

E. Rv (runoff coefficient).

1. Rv is the measure of site response to rainfall events and is calculated as:

Rv = r/p

Where:

r = storm runoff (inches)

p = storm rainfall (inches)

2. The Rv for a site depends on soil type, topography, and vegetative cover. However, for annual pollutant loading assessments, the primary influence on Rv is the degree of watershed imperviousness. The following equation has been empirically derived from the Nationwide Urban Runoff Program studies (USEPA, 1983) and is used to establish a value for Rv.

$$Rv = 0.05 + 0.009(\%I)$$

Where:

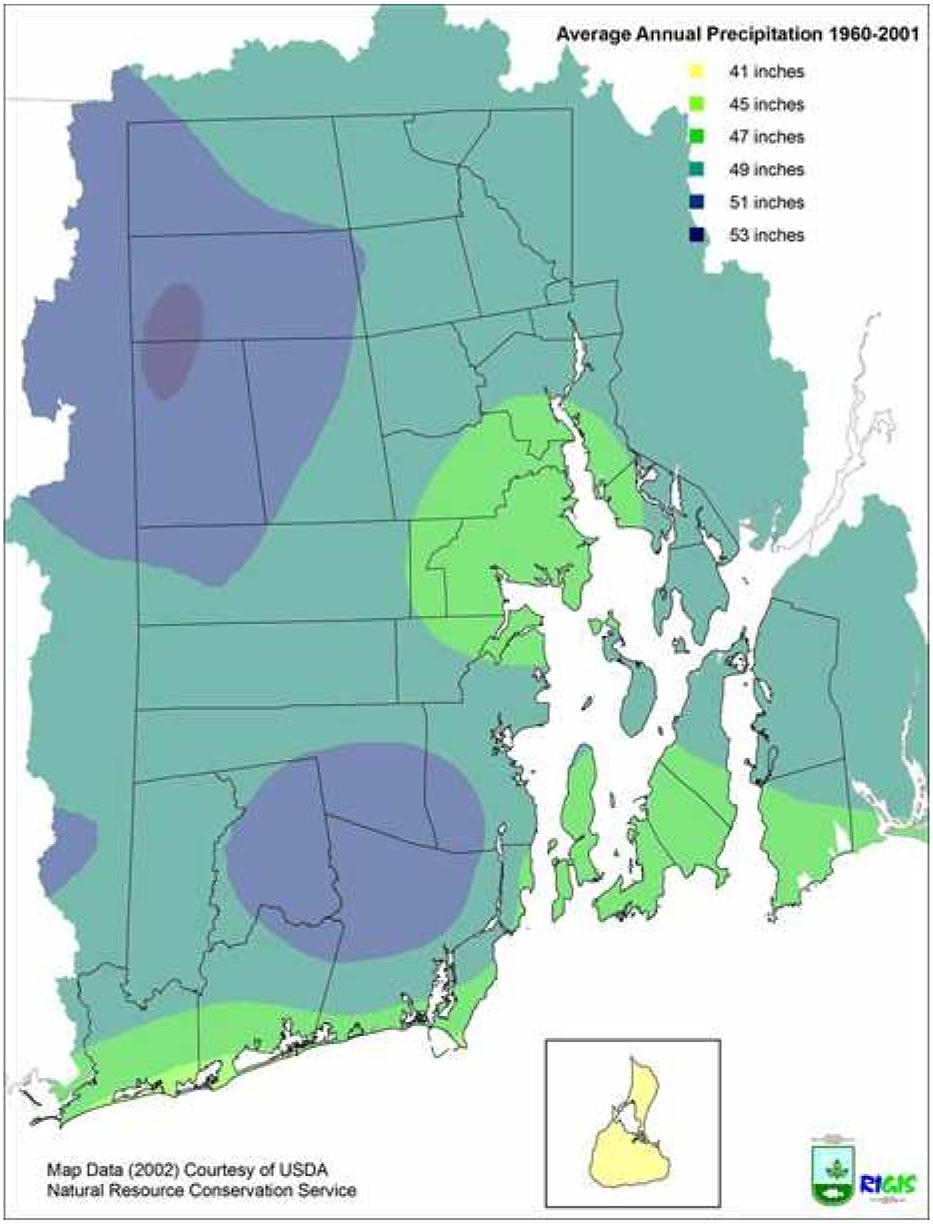
%I = the percent of site impervious

3. A value for I can be calculated by summing the areas of all impervious surfaces and dividing this area by the total contributing drainage area. If more than one land use is present at the site, divide the impervious portion of each land use by its respective total area.

F. A (drainage area). The total contributing drainage area (acres) can be obtained from site plans.

G. C (pollutant concentration). Choose the appropriate value of C from the table in § 8.36(D) of this Part.

H. Average Annual Precipitation Values for Rhode Island



8.38 Pollutant Loading Analyses - Stormwater Practice Pollutant Removal Effectiveness

A. Applicants will frequently need to evaluate the potential pollutant removal effectiveness of stormwater practices when conducting a pollutant loading analysis. To do this, applicants can use the rated pollutant removal effectiveness as listed in the tables in §§ 8.38(D) and (E) of this Part as a basis of estimating pollutant removal. These values have been derived from a variety of sources based on actual monitoring data and modified, where appropriate, to reflect the specific design and sizing criteria contained in §§ 8.19 through 8.35 of this Part.

B. In some cases, the pollutant removal rating values use median values from prior monitoring studies when the studies included a significant number of facilities of similar design criteria as those required in this Part. In other cases, the 75th quartile values (or high end) are reported where it is recognized that the prior monitoring was of insufficient sample size or was of practices with design criteria not as robust as those required in this Part. Lastly, in many cases, there is insufficient prior monitoring of practices for some or all of the reported pollutants, but primary pollutant removal mechanisms are similar to other practices; thus, a removal value is assigned, based on general literature values and/or as a policy decision. In addition, most of the design criteria for water quality BMPs incorporate pre-treatment requirements, such as the requirement for a forebay or grass channel prior to infiltration. In these cases, the rated removal efficiency of the practice is for the total system.

C. In general, where pollutant loading assessments are requested, applicants may use the rated removal values as a basis for estimating pollutant load. However, other pollutant removal estimates may be acceptable, provided the applicant submits the source of these estimates and data used. All information supplied by the applicant will be reviewed by the approving agency to determine the relevance of the removal estimates to the situation.

D. Pollutant Removal Efficiency Rating Values for Water Quality BMPs.

Water Quality BMPs (Those Meeting Minimum Standard 3, § 8.9 of this Part)		Median Pollutant Removal Efficiency (%)			
		TSS	TP	TN	Bacteria
WVTS	Shallow WVTS	85%[2]	48%[3]	30%[2]	60%[2]
	Gravel WVTS	86%[3]	53%[1]	55%[3]	85%[2]
Infiltration Practices	Infiltration Basin	90%[2]	65%[3]	65%[2]	95%[2]
	Infiltration Trench	90%[2]	65%[3]	65%[2]	95%[2]
	Subsurface Chambers	90%[2]	55%[2]	40%[2]	90%[2]

	Dry Well	90%[2]	55%[2]	40%[2]	90%[2]
	Permeable Paving	90%[1]	40%[1]	40%[2]	95%[2]
Filters	Sand Filter	86%[3]	59%[3]	32%[3]	70%[2]
	Organic Filter	90%[2]	65%[2]	50%[2]	70%[2]
	Bioretention	90%[1]	30%[2]	55%[2]	70%[2]
	Tree Filter	90%[1]	30%[2]	55%[2]	70%[2]
Green Roofs	Green Roofs	90%[4]	30%[4]	55%[4]	70%[4]
Open Channels	Dry Swale	90%[1]	30%[2]	55%[2]	70%[2,6]
	Wet Swale	85%[3]	48%[3]	30%[2]	60%[2]

1 UNHSC, Roseen, R., T. Ballestero, and Houle, J. 2007b. UNH Stormwater Center 2007 Annual Report. University of New Hampshire, Cooperative Institute for Coastal and Estuarine Environmental Technology, Durham, NH.

2 Center for Watershed Protection. 2007. Urban Stormwater Retrofit Practices. Urban Subwatershed Restoration Manual Series - Manual 3. Ellicott City, Maryland.

3 Fraley-McNeal, T. Schueler, R. Winer., 2007. National Pollutant Removal Performance Database, v. 3. Center for Watershed Protection. Ellicott City, MD.

4 Prescribed value based on general literature values and/or policy decision.

5 50% of reported values of low end for extended detention basins.

6 Presumed equivalent to bioretention; will require diligent pollutant source control to manage pet wastes in residential areas.

E. BMP Pollutant Removal Rating Values for Other BMPs

Other BMPs		Median Pollutant Removal Efficiency (%)			
		TSS	TP	TN	Bacteria
Pretreatment BMPs	Grass Channel	70%[1,2]	24%[3]	40%[2]	NT
	Sediment Forebay	25%[4]	8%[5]	3%[5]	12%[5]
	Filter Strip	25%[4]	ND	ND	ND
	Deep Sump Catch Basin	25%[4]	NT	NT	NT
	Hydrodynamic Device	25%[1]	NT	NT	NT
	Oil and Grit Separator	25%[4]	NT	NT	NT
Storage BMPs	Dry Extended Detention Basin	50%[2]	20%[2]	25%[2]	35%[2]
	Wet Extended Detention Basin	80%[3]	52%[3]	31%[3]	70%[3]
	Underground Storage Vault	20%[2]	15%[2]	5%[2]	25%[2]

"ND" means no data.

"NT" means no treatment.

1 UNHSC, Roseen, R., T. Ballestero, and Houle, J. 2007b. UNH Stormwater Center 2007 Annual Report. University of New Hampshire, Cooperative Institute for Coastal and Estuarine Environmental Technology, Durham, NH.

2 Center for Watershed Protection. 2007. Urban Stormwater Retrofit Practices. Urban Subwatershed Restoration Manual Series - Manual 3. Ellicott City, Maryland.

3 Fraley-McNeal, T. Schueler, R. Winer., 2007. National Pollutant Removal Performance Database, v. 3. Center for Watershed Protection. Ellicott City, MD.

4 Prescribed value based on general literature values and/or policy decision.

5 50% of reported values of low end for extended detention basins.

6 Presumed equivalent to bioretention; will require diligent pollutant source control to manage pet wastes in residential areas.

F. Using the rated efficiencies from the tables in §§ 8.38(D) and (E) of this Part, applicants can reduce post-development loadings to receiving waters when BMPs are designed, installed, and maintained in accordance with the provisions of this Part.

G. Estimating Pollutant Removal of BMPs in Series

1. In some cases, applicants may have one or more BMPs installed in a series as a so-called “treatment train.” In these cases, available research has shown that the pollutant removal efficiency of specific BMPs, for specific pollutants, is reduced for subsequent BMPs in the treatment train arrangement. As stormwater migrates through the treatment train, coarser-grained particles are preferentially removed by the prior BMP, leaving progressively finer particles for practices down the line. The result is that for pollutants associated with fine particulates, removal efficiency drops off significantly.

2. To account for this phenomenon, a widely applied and generally accepted method has been to discount the rated removal efficiency of the second BMP by a factor of between 75% and 50%, with subsequent BMPs being reduced accordingly.

3. The Georgia Manual Method applies BMP removals as below. This method does not apply to bacteria, where removal is more a function of die-off than settling/attenuation; thus, the full efficiency is applied to subsequent BMPs.

a. 100% of the rated TSS removal efficiency to the first BMP

(1) If the TSS removal efficiency > 80% for the first BMP; removal efficiency for the second BMP = 50% (regardless of the pollutant constituent).

(2) If the TSS removal efficiency <80% for the first BMP; removal efficiency for the second BMP = 75% (regardless of the pollutant constituent).

b. For succeeding BMPs, removal efficiency is applied at either 50% or 75% depending on the equivalent TSS removal efficiency for the preceding BMPs (regardless of the pollutant constituent).

8.39 Technology Assessment Protocol for Innovative and Emerging Technologies - Overview

A. New treatment practices must undergo a third-party evaluation using the Technology Assessment Protocol prior to approval for usage for both primary treatment and pretreatment purposes. Reciprocity is given for practices approved elsewhere under Technology Acceptance Reciprocity Partnership and Technology Assessment Protocol – Ecology provided that any deficiencies are addressed with respect to the eleven Minimum Standards presented in §§ 8.7 through 8.17 of this Part.

B. The Technology Assessment Protocol describes testing and reporting procedures to evaluate the effectiveness of innovative and emerging stormwater treatment technologies. The objectives of this protocol are to characterize, with a reasonable level of statistical confidence, an emerging technology's effectiveness in removing pollutants from stormwater runoff for an intended application. The protocol requires an independent third-party verification that will ensure stormwater treatment systems meet the stormwater performance goals and criteria for new development, redevelopment and retrofit situations established in this Part.

C. Approval will be contingent on submission of objective, verifiable data that meets the Performance Standards and Criteria outlined in §§ 8.6 through 8.17 of this Part. Stormwater treatment technologies will be designated as either i) primary treatment practices for meeting water quality criteria, or ii) pretreatment, and/or quantity control (CPv and Qp) stormwater management practices. Achieving primary treatment designation is dependent upon meeting the Minimum Standard 3 in § 8.9 of this Part. By obtaining accurate and relevant data, the regulatory community can assess performance claims for a particular BMP.

D. The Technology Assessment Protocol strongly recommends parallel testing evaluation under rigorous and uniform conditions. The utility of parallel testing is that site characteristics (land use, contaminant loading, sediment characteristics) are consistent for all tested practices and rainfall event characteristics (depth, intensity, duration, antecedent dry period) will be uniform for given performance periods. Identical site and rainfall characteristics enable rigorous performance evaluations that would otherwise complicate direct performance comparisons. This is especially critical given the well know limitations of stormwater solids sampling and its implications on performance testing.

E. The Technology Assessment Protocol requires independent third party work for all reports that contain field data regardless of where this data were collected. Parties that do not have a direct financial interest in the outcome of testing a treatment practice are not required to obtain an independent third party review. At a minimum, an independent professional must:

1. Complete the data validation report verifying that monitoring was conducted in accordance with an approved QAP; and

2. Prepare a Technical Evaluation Report that includes a testing results, summary, conclusions, and comparison with the standards and performance criteria outlined in § 8.9 of this Part (Minimum Standard 3).

F. Treatment Performance Goals

1. Treatment performance goals are the standards and performance criteria outlined in § 8.9 of this Part (Minimum Standard 3). These include performance measures for solids, phosphorous, nitrogen, and bacteria. There are several categories of solids in stormwater. These include total solids, total suspended solids, suspended solids concentration, total dissolved solids, and gross solids. For treatment performance goals, for the purposes of the Technology Assessment Protocol, performance is measured with respect to total suspended solids. Total solids refers to all particles regardless of size.

2. Primary Treatment: The stormwater performance goals are outlined in § 8.9 of this Part (Minimum Standard 3). Systems will be approved for primary treatment if they meet the TSS, bacteria, TP, and TN standards.

3. Pretreatment Applications: The pretreatment devices do not meet the requirements of § 8.9 of this Part (Minimum Standard 3). They are designed to improve water quality and enhance the effective design life of practices by concentrating the maintenance to a specific, easily serviceable location. The pretreatment applications generally apply to all

treatment systems where pretreatment is needed to assure and extend performance of the downstream basic or enhanced treatment facilities.

8.40 Technology Assessment Protocol Methodology

A. The objectives of this protocol are to characterize, with a reasonable level of statistical confidence, an emerging technology's effectiveness in removing pollutants from stormwater runoff and to compare test results with proponents' claims.

B. Primary treatment level designation is granted based on the information submitted and best professional judgment. Submitting the appropriate amount of data does not guarantee that primary treatment designation will be given. Decisions are based on system performance and other factors such as maintenance burden, operation, and integrity. Technologies not granted primary treatment will automatically be considered as pretreatment or secondary treatment.

C. Quality Assurance Plan: Before initiating testing, a QAP must be prepared based on this protocol. The QAP must be submitted for review before conducting field tests. The QAP must specify the procedures to be followed to ensure the validity of the test results and conclusions. The QAP must specify the name, address, and contact information for each organization and individual participating in the performance testing. Include project manager, test site owner/manager, field personnel, consultant oversight participants, and analytical laboratory that will perform the sample analyses. Identify each study participant's roles and responsibilities and provide key personnel resumes. In addition, provide a schedule documenting when the vendor's equipment will be installed, the expected field testing start date, projected field sampling completion, and final project report submittal.

D. Field Testing and Site Characterization: Sites must provide influent concentrations typical of stormwater for those land use types for the technology's intended applications. National median stormwater concentrations contains about 43, 49, 81, and 99 mg/L TSS for commercial, residential, industrial, and freeway land use classifications respectively (Pitt, R. E., Maestre, A., and Center for Watershed Protection. 2005. The National Stormwater Quality Database, version 1.1. USEPA Office of Water, Washington, D.C.). Include the following information about the test site:

1. Field test site catchment area, tributary land uses, (roadway, commercial, high-use site, residential, industrial, etc.) and amount of impervious cover;

2. Description of potential pollutant sources in the catchment area;

3. Baseline stormwater quality information to characterize conditions at the site. For sites that have already been developed, it is recommended that the investigator collect baseline data to provide a sizing basis for the practice, and to determine whether site conditions and runoff quality are conducive to performance testing;

4. Site map showing catchment area, drainage system layout, and treatment practice and sampling equipment locations;

5. Catchment flow rates (i.e., water quality design flow, 1-year, 10-year, and 100-year peak flow rates) at 15-minute and 1-hour time steps as provided by an approved continuous runoff model;

6. Make, model, and capacity of the treatment device, if applicable;

7. Location and description of the closest receiving water body;

8. Description of bypass flow rates and/or flow splitter designs necessary to accommodate the treatment technology;

9. Description of pretreatment system, if required by site conditions or technology operation; and

10. Description of any known adverse site conditions such as climate, tidal influence, high groundwater, rainfall pattern, steep slopes, erosion, high spill potential, illicit connections to stormwater catchment areas, industrial runoff, etc.

E. Stormwater Data Collection Requirements: The stormwater data and event requirements are provided in the table in § 8.40(F) of this Part to assist in developing the sampling plan.

F. Stormwater Data Collection Requirements

Item	Stormwater Data Collection Requirement
1	Water level in practice shall be continuously recorded throughout the field testing program, including non-sampled storms and non-rainfall days.
2	Range of recorded water levels shall extend below normal, low flow or dry weather level in practice to above treatment capacity.
3	Recorded water levels shall be plotted along with rainfall.

4	Include a description of each maintenance task performed, reason for maintenance, quantities of sediment removed, and a discussion of any anomalous, irregular, or missing maintenance data.
5	To determine practice's required maintenance interval, the minimum duration of the overall field testing program shall be 1 year beginning at installation, commissioning or the beginning of the removal rate testing, whichever is greater.
6	Storm event must have a minimum total rainfall depth of 0.1 inches.
7	Inter-event dry period between storms shall begin when runoff from prior storm ceases.
8	Minimum of 20 storms sampled, although 25 or more are recommended.
9	Storms do not need to be consecutive.
10	Peak runoff of at least 3 storms shall exceed 75% of the practice's capacity.
11	Minimum total rainfall for all storms sampled shall be 15 inches.
12	Minimum number of samples collected shall be 10 for storms lasting longer than 1 hour or more.
13	Minimum number of samples collected shall be 6 for storms lasting less than 1 hour.
14	Samples shall be taken over time to cover a minimum of 70% of total runoff volume.
15	Rainfall shall be recorded continuously during events with max time interval of 5 minutes for runoff collection based on time and max rainfall interval of 0.01 inches for runoff collection based on volume.
16	Rainfall shall be recorded throughout the sampling program.
17	Rainfall from non-sampled events can be recorded with same gauge or

	obtained from a nearby gauge provided that gauge has minimum recording interval of 1 hour.
18	Maximum 15 minute rainfall intensity shall be 5 inches/hour.
19	Maximum total rainfall shall be 3 inches.
20	1 storm sampled may exceed previous two requirements.

G. Stormwater Field Sampling Procedures

1. Sampling methods: Collect samples using automatic samplers, except for chemical constituents that require manual grab samples. Use teflon tubing if samples will be analyzed for organic contaminants. To use automatic sampling equipment for insoluble total petroleum hydrocarbon/oil, a determination is needed that any total petroleum hydrocarbon/oil adherence to the sampling equipment is accounted for and meets QA/QC objectives. This determination requires support with appropriate data. The responsible project professional should certify that the sampling equipment and its location would likely achieve the desired sample representativeness, aliquots, frequency, and compositing at the desired influent/effluent flow conditions. The following three sampling methods have been identified for evaluating whether new treatment technologies will meet the stormwater treatment goals:

   a. Automatic flow-weighted composite sampling. Collect samples over the storm event duration and composite them in proportion to flow. This sampling method generates an event mean concentration and can be used to determine whether the treatment technology meets the pollutant removal goals on an average annual basis. For this method, samples should be collected over the entire runoff period. The greater the number of aliquots and storm coverage the greater the confidence that the samples represent the event mean concentration for the entire storm.

   b. Discrete flow composite sampling.

      (1) For this method, program the sampler to collect discrete flow-weighted samples. Combine samples representing relatively constant inflow periods to assess performance under specific flow conditions. The monitoring approach must also address the effect of lag time within the practice

that would affect the comparability of influent and effluent samples paired for purposes of evaluating a particular flow rate. One way to achieve this is to set the flow pacing so that each discrete sample bottle fills when the total runoff volume passing the sampler is equal to 8 times the treatment unit's detention volume. Other ways to account for lag time may also be considered.

(2) Proponents can use this method to determine whether the treatment technology achieves the pollutant removal goals at the design hydraulic loading rate. For this method, collect samples over a flow range that includes the manufacturer's recommended treatment system design flow rate. Sample other flow ranges if needed to characterize the efficiencies of the practice over a reasonable range of hydraulic loading rates. Distribute samples over a range of flow rates from 50-150% of the practice's design loading rate. This technique is necessary for practices where the influent and effluent flowrate are nearly equal because the system does not control the effluent flowrate. This technique is required to verify how the practice functions at varying flowrates.

c. Combination method. For flow-through practices, proponents can use a combination of the above two methods to evaluate treatment goals. For the combination method, collect discrete flow composite samples as allowed during a single storm event and process for analysis. Composite the remaining bottles in the sampler into a single flow-weighted composite sample to capture the entire runoff event for analysis. Mathematically combine the results from the discrete flow composite samples and the single flow-weight composite sample to determine the overall event mean concentration.

2. Sampling locations

a. Provide a site map showing all monitoring/sampling station locations and identify the equipment to be installed at each site. To accurately measure system performance, samples must be collected from both the inlet and outlet from the treatment system. Sample the influent to the treatment technology as close as possible to the treatment practice inlet. To ensure that samples represent site conditions, design the test site so that influent samples can be collected from a pipe that conveys the total influent to the unit. To avoid skewing influent pollutant concentrations, sample the influent at a location unaffected by accumulated or stored pollutants in, or adjacent to, the treatment practice.

b. Influent, effluent, and bypass sampling shall be conducted upstream and downstream of any practice diversions and/or bypass so that the entire sampled storm runoff can be included in sampling. In some instances bypass sampling may not be possible.

c. Sample the effluent at a location that represents the treated effluent. If bypass occurs, measure bypass flows and calculate bypass loadings using the pollutant concentrations measured at the influent station. In addition, be aware that the settleable or floating solids, and their related bound pollutants, may become stratified across the flow column in the absence of adequate mixing. Collect samples at a location where the stormwater flow is well-mixed.

3. Sampler installation, operation, and maintenance. Provide a detailed sampling equipment description (make and model) as well as equipment installation, operation, and maintenance procedures. Discuss sampler installation, automatic sampler programming, and equipment maintenance procedures. Install and maintain samplers in accordance with manufacturer's recommendations. Indicate any deviations from manufacturer's recommendations. Provide a sampling equipment maintenance schedule. When developing the field plan, pay particular attention to managing the equipment power supply to minimize the potential for equipment failure during a sampling event.

4. Flow monitoring. Measure and record flow into and out of the treatment practice on a continuous basis over the sampling event duration. The appropriate flow measurement method depends on the nature of the test site and the conveyance system. Depth-measurement practices and area/velocity measurement practices are the most commonly used flow measurement equipment. For offline systems or those with bypasses, measure flow at the bypass as well as at the inlet and outlet. Describe the flow monitoring equipment (manufacturer and model number), maintenance frequency and methods, and expected flow conditions at the test site. For offline flow, describe the flow splitter that will be used and specify the bypass flow set point. Identify site conditions, such as tidal influence or backwater conditions that could affect sample collection or flow measurement accuracy. Flow is typically logged at a 5-minute or shorter interval, depending on site conditions.

5. Rainfall monitoring. Measure and record rainfall at 15-minute intervals or less during each storm event from a representative site. Indicate the type

of rain gauge used, provide a map showing the rain gauge location in relation to the test site, and describe rain gauge inspection and calibration procedures and schedule. Install and calibrate equipment in accordance with manufacturer's instructions. At a minimum, inspect the rain gauge after each storm and if necessary, maintain it. In addition, calibrate the gauge at least twice during the field test period. If the onsite rainfall monitoring equipment fails during a storm sampling event, use data from the next-closest, representative monitoring station to determine whether the event meets the defined storm guidelines. Clearly identify any deviations in the Technical Evaluation Report, required pursuant to § 8.40(I) of this Part. Nearby third party rain gauges may only be used in the event of individual rain gauge failure and only for the period of failure. If third party rain gauges are used to fill in data gaps, establish a regression relationship between site and third party gauges and use the regression equation to adjust the third-party data to represent site rainfall when needed.

6. Sampling for TSS, Suspended Sediment Concentration, Nutrients, and Bacteria

   a. Standardized test methods should be used.

   b. This protocol defines TSS as matter suspended in stormwater, excluding litter, debris, and other gross solids.

   c. Sampling for nutrients will include dissolved inorganic nitrogen, total Kjeldahl Nitrogen, total nitrogen (TN), soluble reactive phosphate (orthophosphate), and total phosphorous.

   d. Sampling for bacteria will include Total Coliform, Enterococci, and Escherichia coli.

   e. It is understood that sampling and analyses for nutrients and bacteria can be problematic for 6-hour holding times with anything other than grab samples. Automated samplers will need to maintain sample storage at 1-4°C.

   f. To determine percent reduction, the samples must represent the vertical cross section (be a homogeneous or well-mixed sample) of the sampled water at the influent and the effluent of the practice. Select the sampling location and place and size the sampler tubing with care to ensure the desired representativeness of the sample and the stormwater stream. Performance goals apply on an average annual basis to the entire annual discharge volume (treated plus bypassed).

g. Accumulated Sediment Sampling Procedures

(1) Measure the sediment accumulation rate to help demonstrate facility performance and design a maintenance plan. Practical measurement methods would suffice, such as measuring sediment depth, immediately before sediment cleaning and following test completion. Particle size distribution analyses are determined using wet sieving and hydrometer.

(2) Use several grab samples (at least four) collected from various locations within the treatment system to create a composite sample. For QA/QC purposes, collect a field duplicate sample. Keep the sediment sample at 4 degrees centigrade during transport and storage prior to analysis. If possible, remove and weigh (or otherwise quantify) the sediment deposited in the system. Quantify or otherwise document gross solids (debris, litter, and other particles). Use volumetric sediment measurements and analyses to help determine maintenance requirements, calculate a total sediment mass balance, and determine if the sediment quality and quantity are typical for the application.

7. Sampling for Particle Size Distribution

a. To meet the solids removal goals, treatment technologies must be capable of removing TSS across the size fraction range typically found in urban runoff. Field data show most TSS particles are silt sized particles. Particle size distribution analyses must be performed for 3 paired events per year for influent, effluent, and accumulated residual sediments at the end of the monitoring period. Comparisons of particle size distribution in the influent and effluent and the accumulated residual sediments will demonstrate the particle range of sediments removed and un-removed. Particle size distribution data can also provide information regarding total solids transport during a storm.

b. Of the analytical procedures available, the Coulter Counter (Model 3) and the laser-diffraction method are used for samples obtained by auto-sampler and for measuring smaller particles. Sieving can only be used to quantify large volume samples with sediment volumes typically in excess of 500 grams. Due to the potential differences in precision among analytical procedures, use the same analytical apparatus and procedure for each evaluation test program. A recommended particle size distribution analytical procedure using laser diffraction instrumentation and sieve analysis is included. It must be recognized that particle size distributions obtained by optical measure (laser diffraction and Coulter Counter) will have limited direct comparison with sieving and hydrometer analysis.

H. Field Quality Assurance and Quality Control. Field QA/QC should include the elements listed below:

1. Equipment calibration: Describe the field equipment calibration schedule and methods, including automatic samplers, flow monitors, and rainfall monitors.

2. Recordkeeping: Maintain a field logbook to record any relevant information noted at the collection time or during site visits. Include notations about any activities or issues that could affect the sample quality. At a minimum, the field notebook should include the date and time, field staff names, weather conditions, number of samples collected, sample description and label information, field measurements, field QC sample identification, and sampling equipment condition. Also, record measurements tracking sediment accumulation. In particular, note any conditions in the tributary basin that could affect sample quality. Provide a sample field data form in the QAP.

3. Laboratory Quality Assurance Procedures: Laboratories performing stormwater sample analysis must be certified by a national or state agency regulating laboratory certification or accreditation programs. Report results in the Technical Evaluation Report or use level designation application. Include a table with the following:

   a. Analyte;

   b. Sample matrix;

   c. Laboratory performing the analysis;

   d. Number of samples;

   e. Analytical method (include preparation procedures as well as specific methods especially when multiple options are listed in a method); and

f. Reporting limits for each given analytical method (include the associated units).

4. Data Management Procedures: Include a quality assurance summary with a detailed case narrative that discusses problems with the analyses, corrective actions if applicable, deviations from analytical methods, QC results, and a complete definitions list for each qualifier used. Specify field/laboratory electronic data transfer protocols (state the percent of data that will undergo QC review) and describe corrective procedures. Indicate where and how the data will be stored.

5. Data Review, Verification, and Validation

   a. Describe procedures for reviewing the collection and handling of the field samples.

   b. Establish the approach that will be used to determine whether samples meet all flow sampling and rainfall criteria.

   c. Validation requires thoroughly examining data quality for errors and omissions. Establish the process for determining whether data quality objectives have been met. Include a table indicating percent recovery and relative standard deviation for all QC samples. Determine whether precision and bias goals have been met. Establish a procedure to review reporting limits to determine whether non-detected values exceed reporting limit requirements.

   d. Analyze all data for statistical significance.

I. Technical Evaluation Report

1. After testing has been completed, submit a Technical Evaluation Report to DEM or CRMC. The Technical Evaluation Report supports the technologies ability to obtain a primary treatment level designation. The Technical Evaluation Report must contain performance data from a minimum of 1 test site, and a statement of the QAP objectives including the vendor's performance claims for specific land uses and applications. A prescriptive reporting approach is provided to insure completeness of reporting and to facilitate an effective and rapid review. The framework is listed below.

   a. Summary: Executive Summary with rated performance rating, Study Summary, Data Collection Summary;

   b. Definitions;

c. Site Conditions: longitude, latitude, land cover type, land use activities, site conditions, site elevations and slopes, location of sampling equipment, location of on-site stormwater collection system, and a description of any upstream BMPs;

d. Technology Description:

(1) The specific device used (model number, size, operating rate or volumetric flow rate);

(2) Functionality of treatment mechanisms including pretreatment and bypass requirements;

(3) Physical description: engineering plans, site installation requirements;

(4) Sizing methodology used for test: either manufacturers sizing methodology or approving agency specific sizing requirements (flows, volumes, runoff depth, etc.); and

(5) Maintenance procedures.

e. Test Methods and Procedures:

(1) Particle size for influent, effluent, and residuals, mass based, concentration based;

(2) Water quality parameters monitored;

(3) Data Quality Objectives, QA methods, and measurement accuracy for the observations;

(4) Measuring instruments, sampling frequency, and sampling program information; and

(5) Sampling Locations and Peak Concentration Timing.

f. Testing and Sampling Event Characteristics:

(1) Storm date, depth, antecedent dry period, intensity, duration, season, type of runoff (precipitation, snowmelt, groundwater, etc.);

(2) Number of influent and effluent aliquots; storm volume, % storm treated influent, effluent, peak flow rate, calculation of

peak reduction and lag coefficients, number of storms exceeding design criteria;

(3) Comparisons with Data Quality Objectives;

(4) System timeline (start and completion, sample events, rainfall events, maintenance occurrence); and

(5) Water level within system and rainfall for testing duration.

g. Performance Results and Discussion:

(1) Event mean concentrations for influent and effluent with summary statistics (N, mean, median, coefficient of variation, standard deviation, one – tailed sign t-test);

(2) Detection limits and confidence intervals;

(3) Performance metrics: removal efficiency for event mean concentration and mass loads, efficiency ratio;

(4) Statistical Evaluation: time series plot, box and whisker with confidence intervals, effluent probability method, linear regression;

(5) Solids characterization: influent, effluent, residuals particle size analysis;

(6) Accumulated mass reductions;

(7) Individual Storm Reports with event characteristics (§§ 8.40 (l)(1)(f)((1)) and ((2)) of this Part), combination event hydrograph and hyetograph with sample times; system performance characteristics (§§ 8.40(l)(1)(g)((1)) through ((3)) of this Part), monitoring details;

(8) Quality Assurance, rejection criteria and rejection summary; and

(9) Maintenance findings: discussion on recommended maintenance schedules.

h. Conclusions, performance claims, and limitations;

i. Appendices: raw data and credentials; and

j. Third Party Review. The testing and reporting, if not performed by an independent professional third party, must be reviewed.

2. Confidential Information Submitted by the Applicant

a. Certain records or other information furnished in the Technical Evaluation Report may be deemed confidential. In order for such records or information to be considered confidential, the proponent of such technology must certify that the records or information relate to the processes of production unique to the manufacturer, or would adversely affect the competitive position of such manufacturer if released to the public or to a competitor. The proponent must request that such records or information be made available only for the confidential use.

b. To make a request for confidentiality, clearly mark only those pages that contain confidential material with the words “confidential.” Include a letter of explanation as to why these pages are confidential. A notice will be sent granting or denying the confidentiality request.

3. Treatment Efficiency Calculation Methods

a. Calculate several efficiencies, as applicable. Consider lag time and steady-state conditions to calculate loads or concentrations of effluents that represent the same hydraulic mass as the influent. State the applicable performance standard on the table or graph.

b. For technologies sized for long residence times (hours versus minutes), the proponent must consider cumulative event mean performance of several storms, wet season or annual time periods. For short residence times (several minutes), event mean comparisons are recommended.

c. Method #1: Individual storm reduction in pollutant concentration. The reduction in pollutant concentration during each individual storm calculated as:

$$\frac{100[A - B]}{A}$$

Where:

A = flow-weighted influent concentration

B = flow-weighted effluent concentration

d. Method #2: Aggregate pollutant loading reduction. Calculate the aggregate pollutant loading removal for all storms sampled as follows:

$$\frac{100[A - B]}{A}$$

Where:

A = (Storm 1 influent concentration) * (Storm 1 volume) + (Storm 2 influent concentration) * (Storm 2 volume) +… (Storm N influent concentration) * (Storm N volume)

B = (Storm 1 Effluent concentration) * (Storm 1volume) + (Storm 2 effluent concentration) +…(Storm N effluent concentration) * (Storm N volume)

Concentrations are flow-weighted and flow = average storm flow or total storm volume (vendor's choice)

e. Method #3: Individual storm reduction in pollutant loading. Calculate the individual storm reduction in pollutant loading as follows:

$$\frac{100[A - B]}{A}$$

Where:

A = (Storm 1 influent concentration) * (Storm 1 volume)

B = (Storm 1 effluent concentration) * (Storm 1 volume)

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TITLE 250 - DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

CHAPTER 150 - WATER RESOURCES

SUBCHAPTER 10 - WASTEWATER & STORM WATER

PART 8 - STORMWATER MANAGEMENT, DESIGN, AND INSTALLATION RULES

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