11.0 Post Construction BMPs Standards and Specifications

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11.12 Constructed Wetlands

11.12.1 Constructed Wetlands are practices that mimic natural wetland areas to treat urban stormwater by incorporating permanent pools with shallow storage areas. Constructed Wetlands are explicitly designed to provide stormwater detention for larger storms (Cv and Fv) above the RPv storage. Design variants include:

11.12.1.1 Traditional Constructed Wetlands

11.12.1.2 Wetland Swales

11.12.1.3 Ephemeral Constructed Wetlands

11.12.1.4 Submerged Gravel Wetlands

11.12.2 Constructed Wetland Stormwater Credits

11.12.2.1 Constructed wetlands receive 0% retention credit (Rv).

11.12.2.2 Constructed wetlands shall be sized in accordance with these requirements to receive full pollutant removal credit.

11.12.2.3 Traditional Constructed Wetlands Performance Credits

11.12.2.3.1 Traditional Constructed Wetlands receive 0% runoff reduction credit for the RPv, Cv, and Fv.

11.12.2.3.2 Traditional Constructed Wetlands receive not less than 30% pollutant removal efficiency for total nitrogen reduction.

11.12.2.3.3 Traditional Constructed Wetlands receive not less than 40% pollutant removal efficiency for total phosphorous reduction.

11.12.2.3.4 Traditional Constructed Wetlands receive not less than 80% pollutant removal efficiency for total suspended solids reduction.

11.12.2.4 Wetland Swale Performance Credits

11.12.2.4.1 Wetland Swales receive the following runoff reduction credits:

11.12.2.4.1.1 Wetland Swales located in HSG A or B soils receive 15% annual runoff reduction for the RPv.

11.12.2.4.1.2 Wetland Swales located in HSG C or D soils receive 10% annual runoff reduction for the RPv.

11.12.2.4.1.3 Wetland Swales receive 1% of the RPv allowance for the Cv.

11.12.2.4.1.4 Wetland Swales receive 0% runoff reduction credit for the Fv.

11.12.2.4.2 Wetland Swales receive 100% of the load reduction plus not less than 20% pollutant removal efficiency for total nitrogen reduction.

11.12.2.4.3 Wetland Swales receive 100% of the load reduction plus not less than 30% pollutant removal efficiency for total phosphorous reduction.

11.12.2.4.4 Wetland Swales receive 100% of the load reduction plus not less than 60% pollutant removal efficiency for total suspended solids reduction.

11.12.2.5 Ephemeral Constructed Wetland Performance Credits

11.12.2.5.1 Ephemeral Constructed Wetlands receive the following runoff reduction credits:

11.12.2.5.1.1 Ephemeral Constructed Wetlands located in HSG A or B soils receive 40% annual runoff reduction for the RPv.

11.12.2.5.1.2 Ephemeral Constructed Wetlands located in HSG C or D soils receive 10% annual runoff reduction for the RPv.

11.12.2.5.1.3 Ephemeral Constructed Wetlands receive 1% of the RPv allowance for the Cv.

11.12.2.5.1.4 Ephemeral Constructed Wetlands receive 0% runoff reduction credit for the Fv.

11.12.2.5.2 Ephemeral Constructed Wetlands receive 100% of the load reduction plus not less than 20% pollutant removal efficiency for total nitrogen reduction.

11.12.2.5.3 Ephemeral Constructed Wetlands 100% of the load reduction plus not less than 30% pollutant removal efficiency for total phosphorous reduction.

11.12.2.5.4 Ephemeral Constructed Wetlands receive 100% of the load reduction plus not less than 60% pollutant removal efficiency for total suspended solids reduction.

11.12.2.6 Submerged Gravel Wetland Performance Credits

11.12.2.6.1 The RPv, Cv and Fv runoff reduction performance credit for Submerged Gravel Wetlands is 100% of the detention storage.

11.12.2.6.2 Submerged Gravel Wetlands receive not less than 30% pollutant removal efficiency for total nitrogen reduction.

11.12.2.6.3 Submerged Gravel Wetlands receive not less than 40% pollutant removal efficiency for total phosphorous reduction.

11.12.2.6.4 Submerged Gravel Wetlands receive not less than 80% pollutant removal efficiency for total suspended solids reduction.

11.12.3 Constructed Wetland Conveyance Criteria

11.12.3.1 Principal Spillway

11.12.3.1.1 The principal spillway must be accessible from dry land.

11.12.3.1.2 A structure-pipe spillway shall be designed with anti-flotation, anti-vortex and trash rack devices on the structure.

11.12.3.1.3 The outfall pipe and all connections to the outfall structure shall be made watertight. Soil tight only joints are not acceptable.

11.12.3.1.4 Anti-seep collars shall be used in accordance with Pond Code 378, as amended.

11.12.3.1.5 When the principal spillway is composed of a weir wall discharging to a channel, the channel below the weir must be reinforced with riprap or other acceptable material to prevent scour.

11.12.3.1.6 When a low flow orifice is specified, it must be adequately protected from clogging by either an acceptable external trash rack or by internal orifice protection. Orifice diameters shall not be less than 3 inches.

11.12.3.2 The design shall specify an outfall that can discharge the maximum design storm event in a non-erosive manner at the project point of discharge.

11.12.3.3 Emergency Spillway

11.12.3.3.1 Constructed Wetlands must be designed to pass the maximum design storm event (Fv) if the Fv is being routed through the Constructed Wetland rather than bypassing. An earthen emergency spillway designed to convey the Fv shall be cut in natural ground or, if cut in fill, shall be constructed and stabilized with methods to prevent erosion and structural failure.

11.12.3.3.2 When the maximum design storm passes through the principal spillway, the principal spillway outlet pipe must have a minimum cross sectional area of 3 square feet.

11.12.3.4 Inflow Points

11.12.3.4.1 Inflow points into the Constructed Wetland must be stabilized to ensure that non-erosive conditions exist during storm events up to the conveyance event (Cv).

11.12.3.4.2 For Submerged Gravel Wetlands, the inflow volume shall enter the gravel substrate directly via a pipe manifold or inflow chimneys.

11.12.4 Constructed Wetland Pretreatment Criteria

11.12.4.1 A forebay shall be provided at each concentrated inflow location, and a micropool pool shall be located at the outlet. Forebays shall be designed as follows:

11.12.4.1.1 A safety bench is required at the shoreline for forebay depths greater than 3 feet.

11.12.4.1.2 The forebay must be sized to contain 10% of the volume of runoff from the contributing drainage area for the Resource Protection event.

11.12.4.1.3 Discharge from the forebay shall be non-erosive.

11.12.5 Constructed Wetland Design Criteria

11.12.5.1 Constructed Wetlands constructed to meet regulatory stormwater management requirements shall be designed and constructed in accordance with the USDA NRCS Pond Code 378 as amended.

11.12.5.2 Trash Racks.

11.12.5.2.1 Trash racks shall be provided for low-flow pipes and for all riser structure openings.

11.12.5.2.2 All metal trash racks shall be coated with a rust inhibitor to increase longevity of the device.

11.12.5.2.3 The low flow extended detention orifice shall be protected from clogging by an external trash rack.

11.12.5.3 When a riser is used, it must be located such that it is accessible from the side slope for the purposes of inspection and maintenance.

11.12.5.4 Safety Features

11.12.5.4.1 Any opening 12 inches or greater discharging to a closed drainage system shall include safety grates.

11.12.5.4.2 The emergency spillway must be located so that downstream structures will not be impacted by spillway discharges.

11.12.5.4.3 The emergency spillway exit channel must be designed to direct runoff to a point of discharge without impact to downstream structures.

11.12.5.5 All Constructed Wetlands must be designed so as to be accessible for maintenance.

11.12.5.5.1 Adequate maintenance access must extend to the forebays, micropools, riser, and outlet structure.

11.12.5.5.2 A maintenance right-of-way or easement must extend to the Constructed Wetland from a public or private road.

11.12.5.5.3 Maintenance access must meet the following criteria:

11.12.5.5.3.1 Minimum width of 15 feet.

11.12.5.5.3.2 Profile grade that does not exceed 10H:1V.

11.12.5.5.3.3 Minimum 10H:1V cross slope.

11.12.5.6 Maintenance Set-Aside Area

11.12.5.6.1 The maintenance set-aside area shall accommodate the volume of 50% of the collective forebay volume.

11.12.5.6.2 The maximum depth of the set aside area shall be 1 foot.

11.12.5.6.3 The slope of the set aside area shall not exceed 5%.

11.12.5.7 Traditional Constructed Wetlands

11.12.5.7.1 The permanent pool volume, or the volume below the normal water surface elevation, shall be equivalent to a minimum of 25% of the total storage volume.

11.12.5.7.2 Traditional Constructed Wetlands shall be sized so that the RPv has a maximum ponding depth of 12 inches above the normal water surface elevation.

11.12.5.7.3 The RPv shall be attenuated for a minimum of 24 hours with no greater than 6 inches of water ponded for more than 48 hours.

11.12.5.7.4 The Fv shall have a maximum ponding depth of 2.5 feet above the normal water surface elevation. The extents of the Fv or highest design storm shall be clearly delineated.

11.12.5.7.5 Flow Path

11.12.5.7.5.1 The total length of the flow path compared to the linear length through the Traditional Constructed Wetland shall be a minimum ratio of 2:1.

11.12.5.7.5.2 When an inlet is located near the outlet, the ratio of the shortest flow path through the system to the overall length shall be a minimum of 0.5:1.

11.12.5.7.5.3 The drainage area served by any inlets located less than a 0.5:1 ratio shall constitute no more than 20% of the total contributing drainage area.

11.12.5.7.6 The flow through the Traditional Constructed Wetland shall be limited to maximum of 1% average slope excluding any drops or riffles.

11.12.5.7.7 Traditional Constructed Wetlands shall be composed of the following zones:

11.12.5.7.7.1 Zone 1: Deep Pools.

11.12.5.7.7.1.1 The volume of water stored in the deep pools, also referred to as micropools, shall be at least 25% of the total water storage volume.

11.12.5.7.7.1.2 A minimum of two deep pools in addition to the forebay shall be provided, one of which shall be located prior to the outlet location to provide for additional sediment deposition.

11.12.5.7.7.1.3 Deep pools shall range from a minimum of 18 inches to a maximum of 36 inches in depth below the normal pool elevation and shall be designed to remain permanently saturated.

11.12.5.7.7.1.4 The deep pools shall be hydraulically connected within the water flow path.

11.12.5.7.7.1.5 The deep pools shall be designed with a slope not steeper than 3:1.

11.12.5.7.7.2 Zone 2: Transition Zone.

11.12.5.7.7.2.1 Zone 2 is a short transition zone between the deeper pools and the low marsh zone, and ranges from a minimum of 6 to a maximum of 18 inches below the normal pool elevation.

11.12.5.7.7.2.2 The transition zone shall have a maximum slope of 3:1, or flatter, from the deep pool to the low marsh zone.

11.12.5.7.7.3 Zone 3: Low Marsh Zone.

11.12.5.7.7.3.1 The low marsh zone ranges from a maximum of 6 inches below the normal pool elevation to the normal pool elevation.

11.12.5.7.7.3.2 The slope within the low marsh zone shall not be steeper than 4:1.

11.12.5.7.7.4 Zone 4: High Marsh Zone.

11.12.5.7.7.4.1 The upper end of the marsh zone is the high marsh zone, which ranges from the normal pool elevation to a maximum of 12 inches above the normal pool elevation, allowing the RPv to inundate to the top of the high marsh zone.

11.12.5.7.7.4.2 The slope within the high marsh zone shall not be steeper than 4:1.

11.12.5.7.7.5 Zone 5: Floodplain.

11.12.5.7.7.5.1 A low floodplain shall range between a minimum of 12 inches and a maximum of 18 inches above the normal water surface elevation and be planted with plants suited for infrequent to temporary saturations.

11.12.5.7.7.5.2 The slope within the floodplain shall not be steeper than 4:1.

11.12.5.7.8 A minimum 50-foot-wide vegetated perimeter around the wetland area shall be planted with appropriate grasses, trees, and shrubs.

11.12.5.7.9 If the hydrology for the permanent pools is not supplied by groundwater or dry weather flow inputs, a simple water balance calculation shall be performed to ensure that the deep pools will not go completely dry during a 30-day summer drought.

11.12.5.8 Wetland Swales

11.12.5.8.1 Wetland Swale Sizing.

11.12.5.8.1.1 Wetland swales shall contain the Cv event.

11.12.5.8.1.2 If the Fv event is not contained within the Wetland swale top of bank, then the area of inundation and discharge route shall be delineated.

11.12.5.8.1.3 The maximum RPv water surface elevation shall be no greater than 6 inches above the normal water surface elevation.

11.12.5.8.2 The average groundwater elevation shall be below the bottom of the Wetland Swale. Only the seasonal high groundwater may intersect the bottom of the Wetland Swale.

11.12.5.8.3 Wetland Swales shall not have side slopes steeper than 3:1.

11.12.5.8.4 The maximum longitudinal slope shall be an average of 1%.

11.12.5.8.5 A minimum 10-foot-wide vegetated perimeter on both sides of the wetland swale shall be planted with appropriate grasses, trees and shrubs.

11.12.5.9 Ephemeral Constructed Wetlands

11.12.5.9.1 Ephemeral Constructed Wetland Sizing.

11.12.5.9.1.1 The RPv event shall pond a minimum of 6 inches and a maximum of 12 inches of water above the ground surface of the Ephemeral Constructed Wetland.

11.12.5.9.1.2 The Fv water surface shall be a maximum of 30 inches above the ground surface of the Ephemeral Constructed Wetland.

11.12.5.9.1.3 The average groundwater elevation shall be below the wetland bottom of the Ephemeral Constructed Wetland. Only the seasonal high groundwater may intersect the bottom of the Ephemeral Constructed Wetland. If the seasonal high groundwater intersects the bottom of the Ephemeral Constructed Wetland, the wetland shall be modeled considering the elevation of the seasonal high groundwater.

11.12.5.9.2 The side slopes of the buffer area and within the wetland shall be 4:1 or flatter.

11.12.5.9.3 A minimum 50-foot-wide vegetated perimeter around the wetland area shall be planted with appropriate grasses, trees, and shrubs

11.12.5.10 Submerged Gravel Wetlands

11.12.5.10.1 Submerged Gravel Wetland Sizing.

11.12.5.10.1.1 Submerged Gravel Wetlands shall be designed so that the RPv discharges over a 48-hour period.

11.12.5.10.1.2 The maximum surface ponding depth for the RPv shall not exceed 2 feet.

11.12.5.10.1.3 Submerged Gravel Wetlands having a contributing drainage area greater than 20,000 square feet shall have a minimum of 6 inches of freeboard from the maximum elevation of the Fv to the top of bank of the storage area.

11.12.5.10.1.4 The surface of the Submerged Gravel Wetland shall be designed to:

11.12.5.10.1.4.1 Dewater the Fv within 72 hours, or

11.12.5.10.1.4.2 Manage the Fv on site with no adverse impact.

11.12.5.10.2 Gravel substrate.

11.12.5.10.2.1 The gravel substrate shall be a minimum of 2 feet and a maximum of 4 feet in depth.

11.12.5.10.2.2 The gravel substrate shall be sized to contain a minimum of 25% of the RPv volume considering 40% void ratio.

11.12.5.10.2.3 The gravel substrate shall be composed of clean washed gravel, with a maximum of 2.0% passing the #200 sieve. Gravel shall have a maximum diameter of 2.5 inches and a minimum diameter of 0.5 inches. A porosity value of 0.4 shall be used for areas of stone in the design of gravel substrate. Sand shall not be an acceptable substitute for gravel.

11.12.5.10.3 A wetland soil layer shall be included on the surface of the Submerged Gravel Wetland. The wetland soil layer shall be a minimum of 8 inches thick. The wetland soil layer shall not be included in the storage volume computations.

11.12.5.10.4 Underdrain.

11.12.5.10.4.1 An underdrain shall be provided at an elevation 3 inches above the invert of the gravel substrate.

11.12.5.10.4.2 The underdrain shall be a minimum of 4-inch perforated corrugated polyethylene pipe (CPP).

11.12.5.10.4.3 The underdrain shall connect to a stand pipe within the outlet structure to control the discharge elevation at 4 inches below the wetland soil surface.

11.12.5.10.5 There shall be a minimum of 15 feet separation distance between all gravel substrate inflow points and all underdrain outlet points.

11.12.5.10.6 Side slopes above the gravel substrate shall not be steeper than 3:1.

11.12.6 Constructed Wetland Landscaping Criteria

11.12.6.1 A planting plan is required for all Constructed Wetlands. Invasive species shall not be specified within Constructed Wetlands.

11.12.6.2 The planting plan shall be certified by a qualified professional knowledgeable in wetland species.

11.12.6.3 The planting plan shall outline a detailed schedule for the care, maintenance and possible reinstallation of vegetation in the wetland and its buffer for the first 10 years of establishment.

11.12.7 Constructed Wetland Construction

11.12.7.1 Approval from the Department or the appropriate Delegated Agency must be obtained before any planned Constructed Wetlands can be used as a sediment basin. If a Constructed Wetlands serves as a sediment basin during project construction, the volume of the sediment basin must be based on the more stringent sizing rule.

11.12.7.2 The Sediment and Stormwater Plan must include conversion steps from sediment basin to permanent Constructed Wetlands in the construction sequence.

11.12.7.2.1 The Department or Delegated Agency must be notified and provide approval prior to conversion from sediment basin to the final configuration of the Constructed Wetlands.

11.12.7.2.2 Appropriate procedures must be implemented to prevent discharge of turbid waters when the sediment basin is being converted into a Constructed Wetland.

11.12.7.3 Construction reviews are required during the following stages of construction, and shall be noted on the plan in the sequence of construction:

11.12.7.3.1 Pre-construction meeting

11.12.7.3.2 Initial site preparation including installation of erosion and sediment controls

11.12.7.3.3 Construction of the embankment, including installation of the principal spillway and the outlet structure as applicable

11.12.7.3.4 Excavation and grading including interim and final elevations

11.12.7.3.5 Construction of wetland features including grading of microtopography, introduction of soil amendments and staking of planting zones

11.12.7.3.6 Construction of the underdrain, installation of gravel substrate and wetland soils as applicable

11.12.7.3.7 Implementation of the planting plan and vegetative stabilization

11.12.7.3.8 Final inspection including development of a punch list for facility acceptance

11.12.7.4 All areas surrounding the Constructed Wetlands that are graded or denuded during construction must be planted with turf grass, native plantings, or other approved methods of soil stabilization.

11.12.7.5 Temporary seed, such as annual rye or winter wheat, may be used to stabilize the soil, but permanent species shall then be planted or seeded at a later date.

11.12.7.6 Stabilization matting shall be utilized in Wetland Swales and in all areas of concentrated flow or slopes 3:1 or steeper.

11.12.7.7 Upon facility completion, the owner shall submit Post Construction verification documents to demonstrate that the Constructed Wetlands has been constructed within allowable tolerances in accordance with the approved Sediment and Stormwater Management Plan and accepted by the approving agency. Allowable tolerances for Constructed Wetlands practices are as follows:

11.12.7.7.1 The constructed top of bank elevation may be no lower than the design elevation for top of bank.

11.12.7.7.2 The constructed volume of the Constructed Wetlands surface storage shall be no less than 90% of the design volume.

11.12.7.7.3 The constructed volume of the gravel substrate storage for Submerged Gravel Wetlands shall be no less than 90% of the design volume.

11.12.7.7.4 The constructed elevation of any structure shall be within 0.15 foot of the design.

11.12.7.8 When the allowable tolerances are exceeded for Constructed Wetlands surface area or volume or structure elevations, supplemental calculations must be submitted to the approval agency to determine if the Constructed Wetlands, as constructed, meets the design requirements.

11.12.8 Constructed Wetland Maintenance Criteria

11.12.8.1 During the first two years following construction, the Constructed Wetland shall be reviewed twice each year, once in the spring and once in the fall after a storm event that exceeds 1/2 inch of rainfall.

11.12.8.2 Repair of critical structural features such as embankments and risers shall be performed by responsible personnel that have successfully completed the Department Contractor Training Program.

11.12.8.3 Project closeout shall not occur until a minimum of 70% of the wetland area is permanently vegetated.

11.12.8.4 Sediment removal in the pretreatment forebay shall occur when 50% of total forebay capacity has been lost.

11.12.8.5 The Department or the Delegated Agency shall be notified before a Constructed Wetland is drained.