Section 3.6 Vegetated Stormwater Conveyances (VSC)

Vegetated Stormwater Conveyances serve to prevent scour and erosion and provide water quality treatment while conveying stormwater. They are constructed trapezoidal or parabolic channels lined with vegetation that inhibits erosion. From a water quality perspective, they are preferable to pipes because they allow more soil/water contact and more opportunity for infiltration. There are three types of vegetated conveyances: Dry Swales, Step Pool Conveyance, and Wet Swales.

Dry Swales (DS) are shallow channels with a series of check dams to provide temporary storage and to allow infiltration of the desired Treatment Volume (Tv). Dry Swales use an engineered soil media as the channel bed unless existing soils are permeable enough to infiltrate runoff into underlying soils. In most cases, however, the runoff treated by the soil media flows into an underdrain, which conveys treated runoff to a conveyance system downstream. The underdrain system consists of a perforated pipe within a gravel layer on the bottom of the swale, beneath the filter media. Dry Swales can be planted with turf grass or other suitable ground cover.

Wet Swales (WS) are shallow channels with check dams that create permanent pools that intercept groundwater and provide enhanced pollutant removal within the conveyance. The saturated soil and wetland vegetation provide an ideal environment for gravitational settling, biological uptake, and microbial activity. On-line or off-line cells are formed within the channel to create saturated soil or shallow standing water conditions.

Step Pool Conveyance Swales (SPCS) are defined channels that convert surface runoff to shallow groundwater through attenuation pools and sand seepage filters. These safely convey, attenuate, and treat stormwater with a series of constructed pools and riffles using engineered soil media.

Policies Regarding VSC

Vegetated Stormwater Conveyances shall not be used to modify or channelize existing drainage. All of these practices shall meet the Level 1 baseline design criteria. Dry and Wet Swales may be enhanced to a Level 2 design in accordance with the Clearinghouse guidelines. Step Pool Conveyance Swales shall only be considered after all other measures have been evaluated.

A. Purpose

- Vegetated Stormwater Conveyances shall not be used to modify or channelize existing drainage.
- Vegetated Stormwater Conveyances shall not convey flows from an intermittent or perennial stream.
- Riprap lining and concrete hardening are not eligible activities.
- Step Pool Conveyance Swales shall only be considered after all other measures have been evaluated.

B. Site Feasibility

- Dry Swales and Wet Swales shall apply to manmade swales and ditches or eroded with a maximum contributing drainage area of 5 acres.
- Dry Swale sites must have soils capable of infiltrating at a rate of ½ inch per hour or greater. Ponded water should be retained no longer than 48 hours.
- Dry Swales shall have a depth to water table or bedrock greater than 2 feet from bottom of excavation. A 1-foot separation is allowed in the Coastal Plain.
- Wet Swale sites should have poorly draining soils or high water table elevations.
- Step Pool Conveyance Systems shall apply to small headwater ephemeral swales, below storm pipe outfalls, or steep gullies with a maximum contributing drainage area of 25 acres.

C. Design Criteria

- Dry Swales and Wet Swales must be sized to treat the 1-inch rainfall volume per DEQ Stormwater BMP Clearinghouse Specifications. See appendix A.1 for calculation procedures.
- VSCs should be designed with a trapezoidal or parabolic cross section. The bottom width of the channel shall be between 4 to 8 feet wide. A wider channel should incorporate benches, or a gravel diaphragm to prevent braiding and erosion.
- Should be designed with enough capacity to convey runoff from the 10-year design storm event within the channel banks and be non-erosive during the 10-year design storm events. See Appendix A.2 and A.4 for calculation procedures.
- Design must include at least 3 inches of freeboard at the top of the channel during the 10-year storm for conveyance draining a single lot. Conveyances draining more than one (1) lot or more than 1 acre shall provide a minimum of 6 inches of freeboard above the 10-year storm elevation to the foundation of adjacent structures.
- Adequate conveyance of stormwater into and out of the practice shall be in accordance with procedures outlined in Appendix A.4 of this Manual.
- It must be verified that temporary and permanent channel linings are adequate for design flows. See Appendix A.4 of this Manual.
- All channel linings should be installed according to the manufacturer's recommendations. Manufactured products should have maximum permissible velocity specifications available.
- At least one check dam is required at the outfall of DS and WS and spaced according to the slope. Compacted earthen berm check dams are preferred. Prefabricated check dams, such as timber, metal, or concrete may be used where slope or length limitations exist.
- The VSC should not discharge directly into a natural stream channel and must be dispersed into a stable riparian buffer or vegetated filter strip. Design must ensure a stable, adequate outfall condition will exist. See Appendix A.4 of this Manual.
- Required density and minimum ground covers for all plantings will be based on mature size of approved species within the approved site-specific plans. Suggested spacing: Plugs – 6 inches; perennials – 1 foot; grasses – 2 to 3 feet; small shrubs (< 6 feet tall) – 3 to 5 feet;
- Plant species must be considered native in the "Flora of Virginia." Only native plants will be allowed in a vegetated stormwater conveyance plant list or planting plan.
- Cost-share for the removal of invasive species is only allowable within the footprint of the BMP. Invasive species removal outside of the footprint of the BMP is not eligible for cost-share and is to be addressed in the Operation and Maintenance Plan. Invasive or noxious species are identified by the DCR invasive species list and/or the USDA noxious weed list.
- Only the minimum amount of fertilizer necessary to establish vegetation growth shall be utilized (according to soil test report).

- All of these practices shall meet the Level 1 baseline design criteria. Dry and Wet Swales may be enhanced to a Level 2 design in accordance with the Clearinghouse guidelines.

- **VSC-1 Dry Swale (DS)**
  - The longitudinal slope of the channel should be less than 4%.
  - Temporary pool depth for the Treatment Volume shall be no more than 9 inches.
  - The side slopes should be no steeper than 3:1 (H:V), flatter slopes are encouraged
  - where adequate space is available.
  - Compost Amendments are used when the infiltration rate is greater than ½ inch per hour; and engineered soil media with under drain is needed when infiltration rate is less than ½ inch per hour.
  - All material specifications and construction details shall be in accordance with the Virginia Stormwater BMP Clearinghouse Specification No. 10.

- **VSC-2 Wet Swale (WS)**
  - The longitudinal slope of the channel should be less than 2%.
  - Permanent pool depth for the Treatment Volume shall be no more than 6 inches.
  - Temporary ponding depth for the 10-year design storm shall not exceed 12 inches above the permanent pool elevation.
  - A landscaping plan is required for WS. See Constructed Wetland (CW) plant reference.
  - The side slopes should be no steeper than 4:1 (H:V) to enable wetland plant growth. Flatter slopes are encouraged where adequate space is available, to enhance pre-treatment of sheet flows entering the channel.
  - All material specifications and construction details shall be in accordance with the Virginia Stormwater BMP Clearinghouse Design Specification No. 11.

- **VSC-3 Step-Pool Conveyance Swale (SPCS)**
  - The longitudinal slope of the channel should be greater than 2% and less than 10%. Steeper slopes may be considered if adequate outfall stabilization measures are implemented.
  - Riffles and pools shall not be more than 10 feet long.
  - Riffles shall have a depth of less than 12 inches. Pools should have a depth of 18 inches.
  - Boulder cascade shall have an elevation drop of 5 feet or less. Three pools separated by cobble riffles shall be used below a boulder cascade.
  - The width to depth ratio (W/D) shall be greater than two (2).
  - For other design specifications refer to Anne Arundel County, MD Step Pool Storm Conveyance Systems Design Guidelines and Calculator.
  - Construction practices of the Maryland Department of Natural Resources Regenerative Stormwater Conveyance Construction Guidance should be followed.

D. Plans and Specifications

- A design plan, with a professional seal, must be submitted by the applicant; or a waiver of liability may be accepted on a case-by-case basis (Form 5).
- The installed practice must be in accordance with the approved design unless changes were pre-approved by the Steering Committee. Information required in the design plan includes everything in the VCAP Submission Checklist in addition to the following:
  - An infiltration test should be conducted to a minimum depth of 12 inches, and the infiltration test results must be submitted with the application.
  - Provide adequate conveyance calculations.

  - Landscape plan. Plant list can include the common plant name but must include the scientific name. Vegetables, herbs, and annual plants are not allowed in the landscape plan.
  - A suitable Erosion and Sediment Control Plan to stabilize the flow area.
  - A statement regarding compliance with any permitting requirements or local codes.
  - Other information as requested by the local District.
- Certification by a Licensed Professional may be required by the District to verify practice installation.
  - It is the VCAP participant's responsibility to ensure that contractors meet all local codes and responsibilities.

E. Operation and Maintenance

- Maintenance inspection shall be conducted annually by the landowner, or a designated sub-contracted agent of the landowner.
- Maintenance will follow guidelines on the Virginia Stormwater BMP Clearinghouse Design Specifications No. 10 and 11.
- Maintenance to include pretreatment, inlet/outlet, and check dams or grade control structures.
- Applying fertilizer after vegetation has been established is prohibited as one of the purposes of VCAP is to reduce sources of nutrient pollution.

F. Cost-Share Rates/Incentives

- See **District Guide to VCAP** for practice cost-share rates and caps.
- Eligible costs may include: excavation, grading, soil amendments, installation costs (planting/seeding), engineered soil, plant material (including live stakes and fascine cuttings), geotextile fabric, check dams, erosion and sediment controls (matting), riffle substrate, riprap/boulders, underdrain components, pretreatment costs.

G. Helpful Technical References

- Virginia Stormwater BMP Clearinghouse Design Specification No. 10 and 11.
- Virginia Erosion and Sediment Control Handbook, 3rd Edition.
- Regenerative Step Pool Storm Conveyance (SPSC) Design Guidelines. Anne Arundel
- County Maryland. December 2012.
- Regenerative Stream Conveyance: Construction Guidance. Maryland Department of Natural Resources. November 2018.