Regenerative Stormwater Conveyance (RSC) as an Integrated Approach to Sustainable Stormwater Planning

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Regenerative Stormwater Conveyance is a large name for an open-channel approach to collecting and conveying runoff from developed surfaces. The key element in this name is the term ‘regenerative’, which cannot be applied to grass swales, rock channels, or other features constructed with the singular intent of discharging stormwater from a developed surface to a natural area. For a practice to be characterized as regenerative, it should create resource value, function as a part of a larger system, should be self maintaining, and resilient to seasonal and annual variations. The major components of the regenerative stormwater conveyance approach include a:

- porous, carbon-rich bed material to filter runoff associated with smaller volume storms and support fungal and microbial metabolism;
- system of riffles and pools to interrupt the development of water depth and velocity along the flow path to maintain non-erosive flows; and
- native plant community that knits the site together, produces native habitat, and contributes carbon to the system.

Stormwater conveyance practices are grounded in industrial design that neglects integration with system processes, economics, and aesthetics. As a result, the greater volume of runoff from impervious surfaces, coupled with smooth and hardened conveyance systems (e.g., pipes and trapezoidal concrete channels), magnifies and transfers energies to the discharge or outfall. Conventional stormwater outfalls cause erosion, conveyance structures fail, stream channels are degraded, in-stream sedimentation increases the influence of localized erosion upstream and downstream of the outfall, and an increasing spiral of degradation results. Local governments are forced to spend scare public funds on remediation measures. Alternatively, using stream restoration techniques to create a dependable open channel conveyance with pools and riffle-weir grade controls is a regenerative design since the use of these elements result in a system of physical features, chemical processes, and biological mechanisms that can have dramatic positive feedback effects on the ecology of a drainage area. This approach results in the delivery of low energy storm water discharge, potential volume loss through infiltration and seepage, increased temporary water storage, restoration of lowered groundwater, increases in vernal pool wetland area, improved water quality treatment, improvements in local micro-habitat diversity, and provides a significant aesthetic value. These projects are generally a win-win-win arrangement, as conventional construction practices and materials are more expensive, conventional conveyance provides no environmental benefits and are more difficult to permit, and people generally enjoy the aesthetics associated with a well vegetated channel form when compared to the conventional conveyance alternative.

Regenerative Storm Conveyance (RSC) is an ecologically-friendly SWM solution that seeks to safely convey surface water flows while recharging the groundwater resources and improving water quality through soil media filtration, floodplain connection, and vegetative measures. These solutions are unique in their reliance on native and natural material to mitigate for SWM
impacts and for the retrofit of degraded outfalls and stressed ravines. Shortly after construction, RSC solutions become an indistinguishable part of the environment, making them a truly sustainable environmental restoration alternative.

RSC is a surface collection, treatment, and conveyance systems that converts and dissipates, through storage pools and sand seepage filters, polluted surface stormwater flow to clean shallow groundwater flow. RSC is primarily composed of a series of shallow aquatic pools, riffles and cascades formed by native stones, dense and varied native vegetation adapted to the varied wetness zones, and an underlying water quality sand filter bed. RSC can be considered an edge-of-perennial stream application, meaning that these systems can be used as the primary conveyance/water quality treatment train from upmost headwater locations and downstream to the connecting perennial stream.

Used as the primary conveyance system on the site, RSC systems reduce the need for curb and gutter and closed stormdrain infrastructure. Unlike closed stormdrains, they have the added benefit of providing habitat for a range of plants, animals, amphibians, and insects. These habitats enhance pollutant uptake and assimilation and provide a natural and native aesthetic to sites. The geometric cross-section of the RSC riffle segments is parabolic in shape. The RSC riffle/cascade segments are hydraulically designed to safely convey flows up to and including the extreme floods (i.e. 100-year return frequency storm events). The depth and spacing of the aquatic pools are designed to dissipate the incoming energies to a level where the design flows within the pools are non-erosive (i.e. less than 4 ft/sec).

In addition to the stormwater conveyance functions, constructed segments within the RSC system can provide full water quality treatment and groundwater recharge comparable to filtering and infiltration systems as prescribed by the Maryland Department of the Environment (MDE 2000). The geometric design of the aquatic pools and sand filter bed are formulated to provide filtration of the required water quality volume associated with the first inch of runoff. A secondary benefit provided by the pools and plant material is to reduce flow velocity and enhance the removal of suspended particles and their associated nutrients and/or pollutants. Additionally, uptake of dissolved nutrients by the plant material is expected to yield secondary water quality benefits above and beyond the benefits achieved through the primary filter.

RSC systems are effective flow attenuation/flood control measures. They can successfully be designed as zero surface discharge systems; i.e., all input surface flows are conveyed and converted to shallow groundwater flows that discharge as seeps at the receiving stream or wetland. This can be achieved by sizing the pools and voids within the filter bed to accommodate the entire storage volume for the desired design storm. Additionally, the energy dissipation in the plunge pools results in reduced level of hydraulic power comparable to pre-development or reference conditions. The reduced energy and velocity at the downstream end of these structures result in reduced channel erosion impacts commonly seen between conventional stormwater practice outfalls and ultimate receiving waters. RSC systems are relatively easy to maintain as compared with other conventional SWM systems requiring, in the first five years, invasive plant management, plant restocking to ensure survivability, and excess debris removal. As RSC systems mature, maintenance activity is expected to lessen.
RSC can be used both in new development and to replace existing piped outfalls. They can be used as a significant component of our restoration and conversion of conventional SWM ponds by providing wetland features with a natural outfall. While a relatively new application, RSC systems appear able to withstand large events while providing water quality treatment for smaller storms. Field personnel have witnessed significant surface flow in these systems with no apparent sign of degradation. The management of stormwater quantity and quality achieved through these RSC systems will contribute significantly to our pursuit of attenuating erosive stormwater flows as well as achieving water quality standards and design.