Riparian/Forested Buffer

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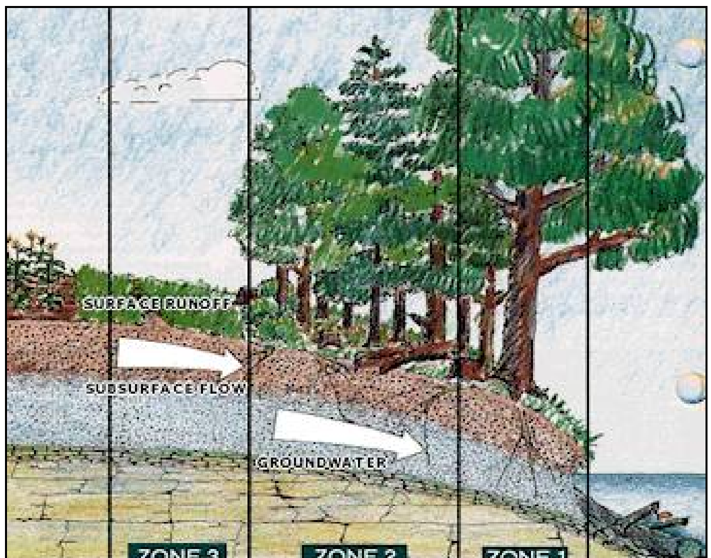
Minimum Measure: Post-Construction Stormwater Management in New Development and Redevelopment

Subcategory: Innovative BMPs for Site Plans

Description



Sketch of a typical riparian forest buffer (Source: Chesapeake Bay Program, 2000)

A riparian or forested buffer is an area along a shoreline, wetland, or stream where development is restricted or prohibited. The primary function of aquatic buffers is to physically protect and separate a stream, lake, or wetland from future disturbance or encroachment. If properly designed, a buffer can provide stormwater management, and can act as a right-of-way during floods, sustaining the integrity of stream ecosystems and habitats. As conservation areas, aquatic buffers are part aquatic ecosystem and part urban forest.

There are three types of buffers: water pollution hazard setbacks, vegetated buffers, and engineered buffers. Water pollution hazard setbacks are areas separating potential pollution hazards from waterways. Such buffer setbacks reduce the potential for pollution. Vegetated buffers are natural areas that divide land uses or provide landscape relief. Engineered buffers are specifically designed to treat stormwater before it enters streams, lakes, or wetlands.

Applicability

Buffers can be applied to new development though the establishment of specific preservation areas and by sustaining management through easements or community associations. For existing developed areas, an easement may be needed from adjoining landowners. A local ordinance can help set specific criteria for buffers to achieve stormwater management goals.

In many regions of the country, the benefits of buffers can be amplified if they are managed in a forested condition. In some settings, buffers can remove pollutants in stormwater or groundwater. Shoreline and stream buffers situated in flat soils effectively remove sediment, nutrients and bacteria from stormwater runoff and septic system effluent. This was found in a variety of rural and agricultural settings along the East Coast and to a lesser extent in urban settings. Buffers can provide wildlife habitat and recreation. They can also be re-established in urban areas as part of a urban forest.

Siting and Design Considerations

There are ten key criteria to consider when establishing a stream buffer:

- Minimum total buffer width
- Three-zone buffer system
- Mature forest as a vegetative target
- Conditions for buffer expansion or contraction
- Physical delineation requirements
- Conditions where buffer can be crossed
- Integrating stormwater and stormwater management within the buffer
- Buffer limit review
- Buffer education, inspection, and enforcement
- Buffer flexibility.

In general, a minimum width of at least 100 feet is recommended to provide adequate stream protection. The three-zone buffer system, consisting of inner, middle, and outer zones, is an effective technique for establishing a buffer. The zones are distinguished by function, width, vegetative target, and allowable uses.

The inner zone protects physical and ecological integrity. It consists of a minimum of 25-feet plus wetland and critical habitats. The vegetative target consists of mature forest. Its allowable uses are very restricted (flood controls, utility right-of-ways, footpaths, etc.).

The middle zone provides distance between upland development and the inner zone. It is typically 50 to 100 feet depending on stream order, slope, and 100-year floodplain. The vegetative target for this zone is managed forest. Usage is restricted to some recreational activities, some stormwater BMPs, and bike paths.

The outer zone is the first zone to encounter runoff. It functions to prevent encroachment while slowing and filtering backyard runoff. The outer zone's width is at least 25 feet, and while forest is encouraged turf-grass can be a vegetative target. The outer zone's uses are unrestricted. They can include lawn, garden, compost, yard wastes, and most stormwater BMPs.

For optimal stormwater treatment, the following buffer designs are recommended. The buffer should consist of three lateral zones: a stormwater depression area leading to a grass filter strip that in turn leads to a forested buffer. The stormwater depression is designed to capture and store stormwater during smaller storm events and bypass larger stormflows directly into a channel. Runoff captured within the stormwater depression can then be spread across a grass filter designed for sheetflow conditions. The grass filter then discharges into a wider forest buffer designed to have zero discharge of surface runoff to the stream (i.e., full infiltration of sheetflow).

Stream buffers must be engineered to satisfy these demanding hydrologic and hydraulic conditions. In particular, simple structures are needed to store, split, and spread surface runoff within the stormwater depression area. Although past efforts to engineer urban stream buffers were plagued by hydraulic failures and maintenance problems, recent experience with similar bioretention areas has been much more positive (Claytor and Schueler, 1996). Consequently, it may be useful to consider elements of bioretention design for the first zone of an urban stream buffer (shallow ponding depths, partial underdrains, drop inlet bypass, etc).

Limitations

Only a handful of studies have measured the ability of stream buffers to remove pollutants from stormwater. One limitation is that urban runoff concentrates rapidly on paved and hard-packed turf surfaces and often crosses the buffer as channel flow, effectively shortcutting through the buffer. To achieve optimal pollutant removal, the engineered buffer should be carefully designed with a stormwater depression area, grass filter, and forested strip.

Maintenance Considerations

An effective buffer management plan should include establishment, management, and distinctions of allowable and prohibited uses in the buffer zones. Buffer boundaries should be well defined and visible before, during, and after construction. Without clear signs or markers defining the buffer, boundaries become invisible to local governments, contractors, and residents. Buffers designed to capture urban stormwater runoff will require more maintenance if the first zone is designated as a bioretention or other engineered depression area.

Effectiveness

The pollutant removal effectiveness of buffers depends on the design of the buffer. While water pollution hazard setbacks are designed to prevent possible contamination from neighboring land uses, they are not designed for pollutant removal during a storm. With vegetated buffers, some pollutant removal studies have shown that their effectiveness varies widely (Table 1). Proper buffer design can increase the pollutant removal from stormwater runoff (Table 2).

Table 1: Pollutant removal rates in buffer zones

Reference	Buffer Vegetation	Buffer Width (meters)	Total % TSS Removal	Total % Phosphorous Removal	Total % Nitrogen Removal
Dillaha et al., 1989	Grass	4.6-9.1	63-78	57-74	50-67
Magette et al., 1987	Grass	4.6-9.2	72-86	41-53	17-51
Schwer and Clausen, 1989	Grass	26	89	78	76
Lowrance et al., 1983	Native hardwood forest	20-40	-	23	-
Doyle et al., 1977	Grass	1.5	-	8	57
Barker and Young, 1984	Grass	79	-	-	99
Lowrance et al., 1984	Forested	-	-	30-42	85
Overman and Schanze, 1985	Grass	-	81	39	67

Table 2: Factors that enhance/reduce buffer pollutant removal performance

Factors that Enhance Performance	Factors that Reduce Performance
Slopes less than 5%	Slopes greater than 5%

Contributing flow lengths <150 feet.	Overland flow paths over 300 feet
Water table close to surface	Ground water far below surface
Check dams/level spreaders	Contact times less than 5 minutes
Permeable but not sandy soils	Compacted soils
Growing season	Nongrowing season
Long length of buffer or swale	Buffers less than 10 feet
Organic matter, humus, or mulch layer	Snowmelt conditions, ice cover
Small runoff events	Runoff events >2 year event.
Entry runoff velocity less than 1.5 feet/sec	Entry runoff velocity more than 5 feet/sec
Swales that are routinely mowed	Sediment buildup at top of swale
Poorly drained soils, deep roots	Trees with shallow root systems
Dense grass cover, 6 inches tall	Tall grass, sparse vegetative cover

Cost Considerations

Several studies have documented the rise in property values for areas adjacent to buffers. For local governments, the costs of instituting a buffer program include extra staff, plan review training, technical assistance, field delineation, construction, and ongoing buffer education programs. A community seeking to implement a stream buffer program will need to adopt an ordinance, develop technical criteria, and invest in additional staff resources and training. Buffer programs also require an investment to train plan reviewers and consultants. To explain the new requirements to stakeholders and land developers, communities will need to provide manuals, workshops, seminars, and direct technical assistance. Lastly, buffers need to be maintained. Resources should include systematic inspections of the buffer networks before and after construction, as well as increasing resident awareness about buffers.

One way to relieve some of the significant financial hardships for developers is to provide flexibility through buffer averaging. Buffer averaging allows developers to narrow the buffer width at some points if the average width of the buffer and the overall buffer area meet the minimum criteria. Variances can also be granted if the developer or landowner can demonstrate severe economic hardship or unique circumstances that make compliance with the buffer ordinance difficult.

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