Definitions/Descriptions of BMPs:

Dry Detention Ponds and Hydrodynamic Structures

Dry detention basins are depressions or basins created by excavation or berm construction that temporarily store runoff and release it slowly via surface flow or groundwater infiltration following storms. Dry detention ponds are designed to dry out between storm events, in contrast with wet ponds, which contain standing water permanently. The surface of the detention basin itself often consists of planted grass, as seen in the photographs above, or can consist of concrete or some other liner. The grassed surfaces require periodic mowing, but may improve trapping of sediments compared with smooth surfaces such as concrete, and may also allow infiltration of stormwater if the underlying soil is permeable. Structures to reduce flow velocity such as rock berms may also be included, for example as seen in the second photograph above. Dry detention basins can also consist of belowground tanks or vaults that temporarily store stormwater.

Hydrodynamic structures are devices designed to improve quality of stormwater using features such as swirl concentrators, grit chambers, oil barriers, baffles, micropools, and absorbent pads that are designed to remove sediments, nutrients, metals, organic chemicals, or oil and grease from urban runoff. These are generally proprietary devices such as Stormceptor®, StormVault®, and Vortechs® that are installed belowground, thereby allowing use of aboveground space for parking or other uses. They also may be effective in removing contaminants that are not removed by less highly-engineered systems. However, they may also require greater maintenance than other BMPs and may not be economical for large runoff volumes.

The water quality functions of dry detention ponds operate primarily by removing suspended particles via settling due to decreased water velocity. If plants such as grasses are present they may further reduce velocity by increasing roughness of the surface. Nitrogen and phosphorus may be removed via settling of particulate forms and plant and microbial uptake. Phosphorus may also sorb to soil particles. Significant removal of nitrate is unlikely because the aerobic soil conditions are not favorable to microbial denitrification. These stormwater BMPs are designed to store surface runoff water and release it slowly to streams, attenuating flood peaks resulting from storms. This hydrologic function of detention basins is often considered a water quality function that helps to reduce stream channel incision, bank erosion, and loss of instream habitat structures that is typical of streams in urban areas with extensive watershed areas covered by impervious surfaces such as building, roads, and parking lots (Schueler 1994).

Detention basins provide little habitat value for organisms other than soil invertebrates, and if they are constructed from cement, even that function is negligible. Hydrodynamic structures provide essentially zero habitat other than for microbial communities.

A number of definitions of various configurations of urban dry detention basin and hydrodynamic structure BMPs have been developed. These include:

- Dry detention ponds and hydrodynamic structure practices are used to moderate flows and remain dry between storm events. These are storm water design features that provide a gradual release of water in order to increase the settling of pollutants and protect downstream channels from frequent storm events. A variety of products for these storm water inlets known as swirl separators, or hydrodynamic structures, are modifications of the traditional oil-grit separator and include an internal component that creates a swirling motion as storm water flows through a cylindrical chamber. These designs allow sediment to settle out as storm water moves in this swirling path. Additional compartments or chambers are sometimes present to trap oil and other floatables. (Chesapeake Bay Program 2006)

- Dry Pond: Designed to moderate influence on peak flows and drains completely between storm events (Idaho Department of Environmental Quality 1998).

- Underground Dry Detention Facility: Designed to dry out between storms and provides storage below ground in tanks and vaults (Idaho Department of Environmental Quality 1998).

- Hydrodynamic structures are not considered a stand alone BMP. They act similar to a dry detention pond and therefore are included in this group.

Dry Extended Detention Ponds

The author recommends renaming this BMP dry extended detention basin, instead of dry extended detention ponds, as this BMP does not hold or pond water for a significant period of time. Dry extended detention (ED) basins are depressions created by excavation or berm construction that temporarily store runoff and release it slowly via surface flow or groundwater infiltration following storms. Dry ED basins are designed to dry out between storm events, in contrast with wet ponds, which contain standing water permanently. As such, they are similar in construction and function to dry detention basins, except that the duration of detention of stormwater is designed to be longer, theoretically improving treatment effectiveness. In the literature, dry ED basins are often lumped together with or considered as dry detention basins (evaluated in a separate report). However, some sources clarify that dry ED basins have specific structures that act to retain stormwater for some minimum period of time (e.g. 24 hr) following a storm event, using a secondary low-flow orifice feature such at that illustrated in the schematic above. Dry detention basins are distinguished from dry extended detention basins in that the design of the later uses a control low flow outlet that releases water over a given period of time. A dry detention basin does not use a low flow outlet directly discharging to the stream and retaining water for a shorter period of time than the dry extended basin design.

The surface of the detention basin itself often consists of planted grass, as seen in the photograph above, or can consist of concrete or some other liner. The grassed surfaces require periodic mowing, but may improve trapping of sediments compared with smooth surfaces such as concrete, and may also allow infiltration of stormwater if the underlying soil is permeable. Ancillary treatment structures such as wetlands or permanent pools may also be built in series with dry ED basins, an arrangement sometimes referred to as a “treatment train.”

The water quality functions of dry extended detention ponds operate primarily by removing suspended particles via settling due to decreased water velocity. If plants such as grasses are present they may further reduce velocity by increasing roughness of the surface. Nitrogen and phosphorus may be removed via settling of particulate forms and plant and microbial uptake. Phosphorus may also sorb to soil particles. Significant removal of nitrate is unlikely because the aerobic soil conditions are not favorable to microbial denitrification. These stormwater BMPs are designed to store surface runoff water and release it slowly to streams, attenuating flood peaks resulting from storms. This hydrologic function of detention basins is often considered a water quality function that helps to reduce stream channel incision, bank erosion, and loss of instream habitat structures that is typical of streams in urban areas with extensive watershed areas covered by impervious surfaces such as building, roads, and parking lots (Schueler 1994).

Detention basins provide little habitat value for organisms other than soil invertebrates, and if they are constructed from cement, even that function is negligible.

A number of definitions of various configurations of urban dry extended detention basin BMPs have been developed. These include:

- A storm water design feature that provides gradual release of volume of water in order to increase settling of pollutants and protects downstream channels from frequent storm events.

- Dry extended detention pond (peak quantity control only): Dry extended detention ponds (a.k.a dry ponds, extended detention basins, detention ponds, extended detention ponds) are basins whose outlets are designed to detain the stormwater runoff from a water quality “storm” for some minimum duration (e.g., 24 hours) which allow sediment particles and associated pollutants to settle out. Unlike wet ponds, dry extended detention ponds do not have a permanent pool. However, dry extended detention ponds are often designed with small pools at the inlet and outlet of the pond, and can also be used to provide flood control by including additional detention storage above the extended detention level (www.stormwatercenter.net)

- Extended detention basin: An impoundment that temporarily stores runoff for a specified period and discharges it through a hydraulic outlet structure to a downstream conveyance system. An extended detention basin is usually dry during non-rainfall periods (VA DCR website).

- Enhanced extended detention basins: An enhanced extended detention basin has a higher efficiency than an extended detention basin because it incorporates a shallow marsh in the bottom. The shallow marsh provides additional pollutant removal and helps to reduce the resuspension of settled pollutants by trapping them (VA DCR website).

- Dry detention and dry extended detention (ED) basins are surface facilities intended to provide for the temporary storage of stormwater runoff to reduce downstream water quantity impacts. These facilities temporarily detain stormwater runoff, releasing the flow over a period of time. They are designed to completely drain following a storm event and are normally dry between rain events. Dry detention basins are intended to provide overbank flood protection (peak flow reduction of the 25-year storm, Qp25) and can be designed to control the extreme flood (100-year, Qf) storm event. Dry ED basins provide downstream channel protection through extended detention of the channel protection volume (CP_v), and can also provide Qp25 and Qf control. For a dry ED basin, a low flow orifice capable of releasing the channel protection volume over 24 hours must be provided (Haubner et al 2001). (The channel protection volume (CP_v) is defined in the Code of Maryland Regulations 26.17.02 as "…the volume used to design structural management practices to control stream channel erosion." The rationale for this criterion is that runoff will be stored and released in such a gradual manner that critical erosive velocities during bankfull and near-bankfull events will seldom be exceeded downstream. Source: http://www.mde.state.md.us/assets/document/Channel%20Protection%20Volume%20Implementation.pdf).

Urban Erosion and Sediment Control

Development of land for industrial, commercial, or residential includes activities such as forest clearing and grading. The removal of vegetation and disturbance of soil from development and construction leave soil particles exposed and susceptible to erosion by wind and water. Nitrogen and phosphorus may also be transported from development sites via adsorption to eroded soil particles or dissolution in runoff from exposed areas. Erosion and sediment control practices protect water resources from sediment pollution and increases in runoff associated with land development activities. By retaining soil on-site, sediment and attached nutrients are prevented from leaving disturbed areas and polluting streams (MD DNR, 2003).

The goal of the erosion and sediment control practices evaluated in this document is the same as those of other BMPs designed to reduce transport of sediment and nutrients to aquatic downstream water bodies, such as wet ponds and constructed wetlands. Some of the technologies used to control erosion and sediment loss at development sites share the design and function of BMPs receiving runoff from existing developments (e.g. sediment detention ponds such as the one pictured above are the same as wet ponds, with the exception that one receives runoff from construction sites and the other from roads, buildings, or lawns). Another distinction from BMPs for existing developments is that typically a range of sediment and erosion control technologies and management practices is applied at a given development site (again as depicted in the photograph above). Furthermore, land development activities have the potential to generate much higher concentrations of sediment in runoff than do developed lands where vegetation has been established.

The water quality functions of erosion and sedimet control BMPs result from diversion of surface runoff treatment areas (e.g. using terracing, berms, or swales), reducing water velocity (e.g., using check dams), filtration (e.g., by silt fences), and by removing suspended particle via settling or infiltration. Grasses are often planted on exposed soils, sometimes stabilized with nets or mats, to reduce erosion, and in swales to reduce velocity by increasing roughness of the surface. Nitrogen and phosphorus may be removed via settling of particulate forms and plant and microbial uptake. Phosphorus may also sorb to soil particles. Significant removal of nitrate is unlikely because the aerobic soil conditions are not favorable to microbial denitrification (an exception would be sediment ponds with permanent standing water). The combined effect of these types of BMPs are likely to promote infiltration, reduce runoff velocity, and store surface runoff water, attenuating flood peaks resulting from storms. This hydrologic function is considered a water quality function that helps to reduce stream channel incision, bank erosion, and loss of instream habitat structures that is typical of streams in urban areas with extensive watershed areas covered by impervious surfaces such as building, roads, and parking lots (Schueler 1994).

Erosion and sediment control BMPs provide little habitat value for organisms other than soil invertebrates

A number of definitions of various configurations of urban erosion and sediment control BMPs have been developed. Descriptions of these methods, abbreviated from USEPA (1993), include:

Sediment Basins. Sediment basins, also known as silt basins, are engineered impoundment structures that allow sediment to settle out of the urban runoff. They are installed prior to full-scale grading and remain in place until the disturbed portions of the drainage area are fully stabilized. They are generally located at the low point of sites, away from construction traffic, where they will be able to trap sediment-laden runoff.

Sediment Trap. Sediment traps are small impoundments that allow sediment to settle out of runoff water. Sediment traps are typically installed in a drainageway or other point of discharge from a disturbed area. Temporary diversions can be used to direct runoff to the sediment trap.

Filter Fabric Fence [“silt fence”]. Filter fabric fence is available from many manufacturers and in several mesh sizes. Sediment is filtered out as urban runoff flows through the fabric. Such fences should be used only where there is sheet flow (i.e., no concentrated flow).

Straw Bale Barrier. A straw bale barrier is a row of anchored straw bales that detain and filter urban runoff. Straw bales are less effective than filter fabric, which can usually be used in place of straw bales. However, straw bales have been effectively used as temporary check dams in channels. As with filter fabric fences, straw bale barriers should be used only where there is sheet flow.

Inlet Protection. Inlet protection consists of a barrier placed around a storm drain drop inlet, which traps sediment before it enters the storm sewer system. Filter fabric, straw bales, gravel, or sand bags are often used for inlet protection.

Construction Entrance. A construction entrance is a pad of gravel over filter cloth located where traffic leaves a construction site. As vehicles drive over the gravel, mud, and sediment are collected from the vehicles' wheels and offsite transport of sediment is reduced.

Vegetated Filter Strips. Vegetated filter strips are low-gradient vegetated areas that filter overland sheet flow. Runoff must be evenly distributed across the filter strip. Channelized flows decrease the effectiveness of filter strips.

Additional guidelines for effective sediment erosion control, again from USEPA (1993) include:

Wind erosion controls. Wind erosion controls limit the movement of dust from disturbed soil surfaces and include many different practices. Wind barriers block air currents and are effective in controlling soil blowing. Many different materials can be used as wind barriers, including solid board fence, snow fences, and bales of hay.

Earth dikes, perimeter dikes or swales, or diversions can be used to intercept and convey runoff above disturbed areas. These practices should be used to intercept flow from denuded areas or newly seeded areas to keep the disturbed areas from being eroded from the uphill runoff.

Pipe slope drain. Also known as a pipe drop structure, this a temporary pipe placed from the top of a slope to the bottom of the slope to convey concentrated runoff down the slope without causing erosion (Delaware DNREC, 1989 in USEPA 1993).

Benches, terraces, or ditches break up a slope by providing areas of low slope in the reverse direction. This keeps water from proceeding down the slope at increasing volume and velocity. Instead, the flow is directed to a suitable outlet, such as a sediment basin or trap.

Retaining walls. Often retaining walls can be used to decrease the steepness of a slope. If the steepness of a slope is reduced, the runoff velocity is decreased and, therefore, the erosion potential is decreased.

Linings for urban runoff conveyance channels. Often construction increases the velocity and volume of runoff, which causes erosion in newly constructed or existing urban runoff conveyance channels. If the runoff during or after construction will cause erosion in a channel, the channel should be lined or flow control BMPs installed. The first choice of lining should be grass or sod since this reduces runoff velocities and provides water quality benefits through filtration and infiltration. If the velocity in the channel would erode the grass or sod, then riprap, concrete, or gabions can be used.

Check dams. Check dams are small, temporary dams constructed across a swale or channel (see photo above). They can be constructed using gravel or straw bales. They are used to reduce the velocity of concentrated flow and, therefore, to reduce the erosion in a swale or channel.

Seeding, mulching/matting/netting, and sods. Seeding establishes a vegetative cover on disturbed areas. Seeding is very effective in controlling soil erosion once a dense vegetative cover has been established. However, often seeding and fertilizing do not produce as thick a vegetative cover as do seed and mulch or netting. Mulching involves applying plant residues or other suitable materials on disturbed soil surfaces. Mulches/mats used include tacked straw, wood chips, and jute netting and are often covered by blankets or netting. The mulching/mats protect the disturbed area while the vegetation becomes established. Mulching and/or sodding may be necessary as slopes become moderate to steep, as soils become more erosive. Plastic mats should be avoided.

Wildflower cover. Because of the hardy drought-resistant nature of wildflowers, they may be more beneficial as an erosion control practice than turf grass. While not as dense as turfgrass, wildflower thatches and associated grasses are expected to be as effective in erosion control and contaminant absorption. Because thatches of wildflowers do not need fertilizers, pesticides, or herbicides, and watering is minimal, implementation of this practice may result in a cost savings (Brash et al., undated in USEPA 1993). In 1987, Howard County, Maryland, spent $690.00 per acre to maintain turfgrass areas, compared to only $31.00 per acre for wildflower meadows (Wilson, 1990 in USEPA 1993). Only native wildflower mixes should be used.

Urban Wetponds and Wetlands

Description/Definition

Wet ponds and wetlands used as a Best Management Practice (BMP) for management of urban stormwater runoff are man-made landscape features that have characteristics and functions similar to their natural counterparts. Wet ponds are depressions or basins created by excavation or berm construction that receive sufficient water via runoff, precipitation, and groundwater to contain standing water year-round at depths too deep to support rooted emergent or floating-leaved vegetation (in contrast with dry ponds, which dry out between precipitation events). Wetlands, on the other hand, have soils that are saturated with water or flooded with shallow water that support rooted floating or emergent aquatic vegetation (e.g. cattails). Some systems may contain submergent vegetation, or emergent vegetation along the shorelines, blurring the distinction between the two.

While there are similarities between natural and stormwater wetlands or wet ponds, there are also differences. In general, stormwater systems have a water balance dominated by surface runoff (rather than groundwater), "flashy" hydroperiods, well-defined boundaries, low species diversity and habitat value, and elevated contaminant and sediment concentrations compared with their natural counterparts (Schueler 1992a).

The water quality functions of urban wet ponds and wetland BMPs operate via similar mechanisms to those occurring in natural systems. Suspended particles are removed via settling resulting from low water velocities in the systems (and physical filtration by plants if present), a process called sedimentation (Schueler 1992a; Brix 1993). Nitrogen is removed primarily via plant and microbial uptake, the nitrification-denitrification reactions, and particulate settling, while phosphorus is removed primarily via soil sorption and settling of phosphorus sorbed to particulate matter. Wetlands and wet ponds may also remove, transform, or retain metals, pesticides, pathogens, oils, and other organic and inorganic constituents of surface runoff (Kadlec and Knight 1996; Mitsch and Gosselink 2000a; BMP Database 2007). Furthermore, many stormwater

BMPs are designed to store surface runoff water, releasing it slowly to streams with the goal of attenuating flood peaks resulting from storms. This hydrologic function of wet ponds and wetlands is often considered a water quality function that helps to reduce stream channel incision, bank erosion, and loss of instream habitat structures that is typical of streams in urban areas with extensive watershed areas covered by impervious surfaces such as building, roads, and parking lots (Schueler 1994).

In addition to water quality functions, wetland, and to a lesser extent wet pond, BMPs provide habitat for fish, aquatic invertebrates, birds, mammals, reptiles, and amphibians (Schueler 1992a; Baldwin, personal observation). However, if not designed properly these structures may also provide habitat for disease vectors such as mosquitoes (NC State 2005). Wet ponds and wetland BMPs can also be important for human quality of life, providing aesthetic or recreational value. Because they are often small and isolated from other habitats such as forests and streams, plant and wildlife species diversity may be low. Nonetheless, their presence in otherwise highly developed landscapes may increase their value as habitat for wildlife as well as use by humans (Mitsch and Gosselink 2000b).

A number of definitions of various configurations of urban wet pond and wetland BMPs have been developed. The following were taken from the Chesapeake Bay Programs (CBP) trib tools webpage, and are the CBP's current definitions of BMP categories and types developed by its Urban Stormwater Workgroup (2002):

Wet pond: A stormwater management pond designed to obtain runoff and always contains water (Prince George's LID Report 1999)

Wet extended detention pond: Combines the pollutant removal effectiveness of a permanent pool of water with the flow reduction capabilities of an extended storage volume (Idaho Department of Environmental Quality 1998).

Multiple pond system: A group of ponds that collectively treat the water quality volume (New York Stormwater Management Design Manual 2003).

"Pocket" pond: A wetland that has such a small contributing drainage area where little or no baseflow is available to sustain water elevations during dry weather. Water elevations are highly influenced, and in some cases, maintained by a locally high water table (Center for Watershed Protection 1996).

Practices that have a combination of a permanent pool, extended detention or shallow wetland equivalent to the entire water quality storage volume. Practices that include significant shallow wetland areas to treat urban stormwater but often incorporate small permanent pools and/or extended detention storage (Center for Watershed Protection and Maryland Department of the Environment 2000).

Shallow wetland: A wetland that provides water quality treatment entirely in a wet shallow marsh (New York Stormwater Management Design Manual 2003).

Extended detention wetland: A wetland system that provides some fraction of the water quality volume by detaining storm flows above the marsh surface (New York Stormwater Management Design Manual 2003).

Pond/wetland system: A wetland system that provides a portion of the water quality volume in the permanent pool of a wet pond that precedes the marsh for a specified minimum detention time (New York Stormwater Management Design Manual 2003).

"Pocket" wetland: A stormwater wetland design adapted for the treatment of runoff from small drainage areas (<5 acres) and which has little or no baseflow available to maintain water elevations and relies on groundwater to maintain a permanent pool (Center for Watershed Protection and Maryland Department of the Environment 2000).

Submerged gravel wetland: One or more treatment cells that are filled with crushed rock designed to support wetland plants. Stormwater flows subsurface through the root zone of the constructed wetland where pollutant removal takes place (Haubner et al. 2001)

Constructed wetland: Constructed wetlands are systems that perform a series of pollutant removal mechanisms including sedimentation, filtration, absorption, microbial decomposition and vegetative uptake to remove sediment, nutrients, oil and grease, bacteria and metals. Wetland systems reduce runoff velocity thereby promoting settling of solids. Plant uptake accounts for removal of dissolved constituents. In addition, plant materials can serve as an effective filter medium and Denitrification in the wetland can remove nitrogen (EPA 1993).

Retention pond (wet): Surface pond with a permanent pool.

Wetland basin with open water surfaces: Similar to retention ponds except that a significant portion (usually 50% or more) of the permanent pool volume is covered by emergent wetland vegetation (Best Management Practice database).

Retention basin: Capture a volume and retain that volume until it is displaced in part or in total by the next runoff event. Maintains a significant permanent pool volume of water between runoff events (EPA 1999)