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Best Management Practice Fact Sheet 15:

Extended Detention Ponds

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This fact sheet is one of a 15-part series on urban *stormwater management* practices.

Please refer to definitions in the glossary at the end of this fact sheet.
Glossary terms are *italicized* on first mention in the text. For a comprehensive list, see Virginia Cooperative Extension (VCE) publication 426-119, "Urban Stormwater: Terms and Definitions."

What Is an Extended Detention Pond?

Extended detention ponds (EDs) are dry detention ponds that provide 12 to 24 hours of runoff storage during *peak runoff* events (see figure 1). Releases from the ED ponds are controlled by an *outlet structure*. During a storm event, as the discharge restriction is reached, water backs up into the ED pond. The pool slows flow velocities and enables *particulate pollutants* to *settle*. Peak flows are also reduced. ED ponds have the lowest overall pollutant-removal rate of any *stormwater* treatment option, so they are often combined with other upstream, *low-impact development* (LID) practices to better maximize pollutant-removal rates. Due to their placement at the exit point of the *watershed*, ED is often the last opportunity to treat stormwater before it is discharged to a stream. Because of its low treatment performance, an ED should be viewed as the treatment option of last resort.

Figure 1. Extended detention pond during wet period (VA-DCR 2011).

Where Can Extended Detention Ponds Be Used?

Extended detention ponds are widely applicable and can be used in a range of locations with few exceptions. All regions and climates are capable of supporting an ED, though some adjustments may be needed for cold climates or areas with *karst terrain*. An adequate size is needed for the pond, so urban areas may pose some spacing issues.

Steeper slopes are acceptable for EDs (up to 15 percent) provided the pond bank side slopes are relatively flat to reduce safety risks. Sandy soils or karst areas may pose a risk from *infiltration* to groundwater, and they require an *impermeable liner* that can be used to help the pond hold water and minimize *seepage* losses.

How Do Extended Detention Ponds Work?

EDs fill during storm events and reduce and retard *peak stream flows* by acting like a buffer or shock absorber for flows in the stream. Water is pooled and released at a controlled rate until the pond reaches capacity. Controlling stream flow also reduces the potential for downstream *erosion* (see figure 2).

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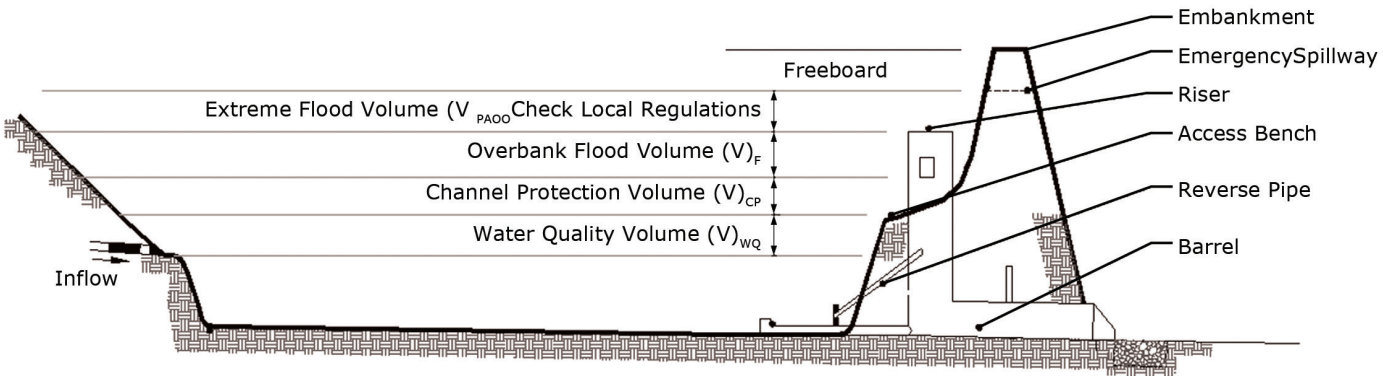

Figure 2. Typical extended detention pond profile. Source: Minnesota Stormwater Manual, 2011.

While in the pond, water quality improves through natural processes, including *biological uptake*, *microbial decomposition*, and *settling*. After the specified *detention time,* detained water is released through the outlet structure that connects to a *stormwater conveyance system* that eventually discharges to the environment.

Limitations

- May be difficult to provide sufficient *hydraulic head* to drain the pond in low-lying areas.
- Can be considered an aesthetic nuisance and decrease property values.
- May raise water temperatures because stored water is heated by the sun.
- Can provide a breeding area for mosquitoes, so some control measures may be necessary.
- Are not effective at removing soluble pollutants, such as nitrates and phosphorus.
- Treatment of settleable solids and nutrients attached to *sediment* is generally good. However, sediment may *resuspend* in the next storm event and be discharged, thus lowering performance.

Maintenance

Routine Maintenance (annual)

- Seed and sod to restore any bare patches.
- Inspect the ED regularly, e.g., are the inlet and outlet structures functioning and clear of debris? Repair as needed.
- Remove trash and debris from pond area (perform during dry periods).

Nonroutine maintenance (as needed)

- Remove excess accumulated sediment when pond volume has been reduced by 25 percent.
- Control pest populations as needed.

Performance

Extended detention ponds have relatively low dissolved pollutant-removal capabilities, particularly with *nutrients*. A typical ED is expected to reduce total phosphorus (TP) by 15 percent and total nitrogen (TN) by 10 percent (VA-DCR 2011). In a more advanced design, the ED includes a shallow marsh at the bottom of the pond that enhances treatment. Advanced ED designs can improve this expected reduction of TP to 20 percent and of TN to 30 percent (VA-DCR 2011).

Expected Cost

EDs are one of the least expensive *stormwater treatment practices* when compared to other alternatives. An average preliminary estimate of the construction cost of an ED pond of 1 acre-foot is $41,000. Compared to *wet ponds* (VCE publication 426-133), EDs are more cost-effective on a per-unit-area treated basis. Annual mainte-

nance cost is estimated to be 3 percent to 5 percent of the construction cost, or $1,800 to $3,500 (EPA 2006). The value of land is not included in this analysis. EDs are usually located on undevelopable land to minimize this cost.

Additional Information

The Virginia departments of Conservation and Recreation (VA-DCR) and Environmental Quality (VA-DEQ) are the two state agencies that address nonpoint source pollution. The VA-DCR oversees agricultural conservation; VA-DEQ regulates stormwater through the Virginia Stormwater Management Program.

Additional information on best management practices can be found at the Virginia Stormwater BMP Clearinghouse website at http://vwrrc.vt.edu/swc. The BMP Clearinghouse is jointly administered by the VA-DEQ and the Virginia Water Resources Research Center, which has an oversight committee called the Virginia Stormwater BMP Clearinghouse Committee. Committee members represent various stakeholder groups involved with stormwater management.

Online Resources

Alameda Countywide (California) Clean Water Program – www.eoainc.com/download/8_Extended_Detention_Basin_Technical_Guidance.pdf

Chesapeake Bay Program – http://archive.chesapeakebay.net/pubs/bmp/Year_1_Reports/Dry%20Extended%20Detention%20Basins.pdf

Eugene (Oregon) Stormwater Management Manual – www.eugene-or.gov/portal/server.pt/gateway/PTARGS_0_0_12093_689_1795_43/http%3B/ceppcontent.eugene1.net%3B7087/publishedcontent/publish/pw/stormwater/docs/ch2m.pdf

Georgia Stormwater Management Manual – www.georgiastormwater.com/vol2/3-4-1.pdf

Idaho Department of Environmental Quality, *Stormwater Catalog*, Volume 4: Permanent Stormwater Controls, Dry Extended Detention Ponds (page 76) – www.deq.idaho.gov/media/6223-stormwater.pdf

Knox County (Tennessee) Stormwater Management Manual – www.knoxcounty.org/stormwater/pdfs/vol2/4-3-3 Dry Extended Detention Ponds.pdf

New Jersey Department of Environmental Protection – www.state.nj.us/dep/watershedmgt/DOCS/BMP_DOCS/chapter5_basins.PDF

U.S. Department of Agriculture – ftp://ftp-fc.sc.egov.usda.gov/WSI/UrbanBMPs/water/quality/dryextdetent.pdf

U.S. Environmental Protection Agency – http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=67

Virginia Department of Conservation and Recreation – www.dcr.virginia.gov/stormwater_management/documents/Chapter_3-07.pdf

Virginia Stormwater BMP Clearinghouse – http://vwrrc.vt.edu/swc/

Companion Virginia Cooperative Extension Publications

Daniels, W., G. Evanylo, L. Fox, K. Haering, S. Hodges, R. Maguire, D. Sample, et al. 2011. *Urban Nutrient Management Handbook*. Edited by M. Goatley. VCE Publication 430-350.

Gilland, T., L. Fox, M. Andruczyk, and L. Swanson. 2009. *Urban Water-Quality Management: What Is a Watershed?* VCE Publication 426-041.

Sample, D., et al. 2011-2012. Best Management Practices Fact Sheet Series 1-15. VCE Publications 426-120 through 426-134.

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References

U.S. Environmental Protection Agency (EPA). 2006. *Dry Detention Ponds*. National Pollutant Discharge Elimination System (NPDES) Fact Sheet. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse.

Virginia Department of Conservation and Recreation (VA-DCR). 2011. *Virginia DCR Stormwater Design Specification No. 15: Extended Detention (ED) Pond*, Version 1.9. http://vwrrc.vt.edu/swc/NonPBMPSpecsMarch11/DCR%20BMP%20Spec%20No%2015_EXT%20DETENTION%20POND_Final%20Draft_v1-9_03012011.pdf.

Glossary of Terms

Best management practice (BMP) – Any treatment practice for urban lands that reduces pollution from stormwater. A BMP can be either a physical structure or a management practice. Agricultural lands use a similar, but different, set of BMPs to mitigate agricultural runoff.

Biological uptake – The process by which plants absorb nutrients for nourishment and growth.

Detention time – See *residence time***.**

Erosion – A natural process by either physical processes, such as water or wind, or chemical means that moves soil or rock deposits. Excessive erosion is considered an environmental problem that is very difficult to reverse.

Extended detention ponds – A stormwater treatment practice that mitigates peak flow rates by retaining runoff for 12 to 24 hours before slowly releasing water back to the natural system.

Hydraulic head – The difference in elevation between two points of flowing water.

Impermeable liner – A material designed to retard *seepage* from ponds and wetlands.

Impervious surfaces – Hard surfaces that do not allow *infiltration* of rainfall into it, or not *pervious*.

Infiltration – The process by which water (surface water, rainfall, or runoff) enters the soil.

Karst terrain – Areas where the underlying bedrock is high in limestone composition, making the site subject to underground erosion that often results in sinkholes and unstable building conditions.

Low-impact development (LID) – Growth and development that attempts to maintain predevelopment hydrologic function at a site.

Microbial decomposition – The breakdown of compounds or organic matters into smaller ones with the aid of microorganisms.

Nutrients – The substances required for growth of all biological organisms. When considering water qualities, the nutrients of greatest concern in stormwater are nitrogen and phosphorus, because they are often limiting in downstream waters. Excessive amounts of these substances are pollution and can cause algal blooms and dead zones to occur in downstream waters.

Outlet structure – A structure that regulates water discharge from best management practices and serves as an exit point from the BMP. Also known as control structure.

Particulate pollutants – A mixture of small (2.5 to 10 micrometers) particles of acids, organic chemicals, metals, and soil or dust particles.

Peak runoff – The highest water flow off of a surface during a storm event.

Peak stream flows – The highest water flows within a stream during a storm event.

Residence time – The average time it takes water to travel through a treatment system, such as an extended detention pond. Residence time can also be called detention time.

Resuspension – When sediment that has settled becomes suspended in water after being disturbed.

Sediment – Soil, rock, or biological material particles formed by weathering, decomposition, and erosion. In water environments, sediment is transported across a watershed via streams.

Seepage – Water lost through the bottom of a lake or pond.

Settling – The process by which particles that are heavier than water fall to the bottom under the influence of gravity.

Stormwater – Water that originates from *impervious surfaces* during rain events, often associated with urban areas and is also called runoff..

Stormwater conveyance system – Means by which stormwater is transported in urban areas.

Stormwater treatment practice – A type of best management practice that is structural and reduces pollution in the water that runs through it.

Watershed – A unit of land that drains to a single "pour point." Boundaries are determined by water flowing from higher elevations to the pour point. The pour point is the point of exit from the watershed, or where the water would flow out of the watershed if it were turned on end.

Wet ponds – Stormwater impoundments that have a permanent pool of water used to treat water pollution.