U-1 URBAN STORMWATER RETROFITS

PRACTICE AT A GLANCE

- Stormwater retrofits are usually a major element of every community's pollutant reduction plan, regardless of their size, development intensity or geographic location.
- A wide range of retrofit design options have been developed, and they can be built as new stormwater practices or by modifying existing ones.
- Most communities possess dozens or even hundreds of good candidate sites for stormwater retrofits, especially if they have a long history of stormwater management.
- It can take a lot of detective work to find the most feasible and cost-effective retrofit projects in your community that are also acceptable to adjacent residents.
- The work is well worth the trouble, as well-designed retrofits can provide many benefits in a community beyond pollutant removal.

PRACTICE DESCRIPTION

Stormwater retrofits are a diverse group of projects that provide nutrient and sediment reduction on existing development that is currently untreated or is inadequately treated by an existing stormwater management practice. Although there are many different kinds of retrofit designs, they all work in the same basic manner. They capture polluted urban stormwater runoff in temporary storage areas in the urban landscape where physical and biological treatment mechanisms help keep sediment and nutrients out of the Chesapeake Bay.

Stormwater retrofits can also provide other important benefits to a community. For example, retrofits can also:

- Remove toxic pollutants and harmful bacteria from local waterways
- Protect local streams from severe bank erosion and improve aquatic health
- Prevent or reduce flood damage to local property and infrastructure
- Green up local streets, parks and schools and create urban wildlife habitat
- Provide a makeover on older, overgrown stormwater practices that have become community eyesores.

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Stormwater retrofits can be classified into two broad project categories: new retrofit facilities and existing retrofit facilities.

New retrofit facilities - new retrofit projects that create storage to reduce nutrients from existing developed land that is not currently receiving any stormwater treatment. Examples include:

- Near stormwater outfalls or within the existing stormwater conveyance system
- Adjacent to large parking lots or other areas of impervious cover
- Green street retrofits
- Residential stormwater practices (Fact Sheet U-3)

Existing BMP retrofits – an existing stormwater practice is either converted into a different type of practice that is more effective at removing pollutants, enhanced by increasing the amount of runoff it can treat and/or increasing its hydraulic retention time, or restored to renew its performance. Examples of the three types of retrofits to existing stormwater management facilities are as follows:

- **BMP Conversions:**
  - Convert large dry pond to wetland or wet pond
  - Convert small dry pond to bioretention
- **BMP Enhancements:**
  - Re-design old dry pond to increase treatment volume, prevent short circuiting, or extend hydraulic residence time.
- **BMP Restoration:**
  - Remove major sediment from ponds
  - Harvest & re-plant vegetation from stormwater wetlands
  - Replace contaminated soil in ponds

One category of stormwater retrofits involves construction of small stormwater practices on existing residential properties. Due to their special nature, these on-site retrofits are featured in their own Fact Sheet, see U-3.

NEW RETROFIT FACILITIES

Example of an open channel retrofitted to provide better water quality treatment

Example of a retrofit installed adjacent to large area of impervious cover

Example of a “green street” retrofit

Example of a residential rain garden

WHERE TO FIND THE BEST OPPORTUNITIES IN YOUR COMMUNITY

Most communities will want to focus their detective work in three broad areas to discover the best retrofit opportunities.

First, every Bay community usually has a large inventory of older stormwater practices, many of which were built several decades ago, need major repairs and maintenance, and have little capability to remove sediment and nutrients. Many of these older practices are prime candidates for retrofitting, since the land is already devoted to stormwater management.

The second targets are new retrofits that can be installed on municipal land, such as parks and schools. These high visibility properties are ideal locations for demonstration projects to show the public that retrofits can be an attractive community amenity.

The third targets are future municipal construction projects where stormwater practices can be integrated into the street right of way, parking lots or public buildings. These green streets and buildings can often be "piggy-backed" on municipal streetscape or neighborhood revitalization budgets.

GENERAL COST INFORMATION

The cost of retrofits can vary widely from project to project, ranging from $5,000 to 200,000 per impervious acre treated. Therefore, it is critical to assess multiple candidate retrofit projects to find the ones that are most cost-effective to build and maintain. Retrofits of existing older stormwater ponds are often an attractive investment.

Most communities finance retrofit construction through their long term capital improvement budgets, although some grant funds may be available from the state or EPA to defray some of the costs.

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TIPS FOR GETTING STARTED IN YOUR COMMUNITY

If your community has an MS4 permit, your state stormwater agency often requires that you conduct one or more field inspections on all the stormwater practices within your jurisdiction during each five year permit cycle. Complying with this requirement can be a headache, but it also can help you quickly assess all of the older legacy stormwater practices in your community that may be good candidates for retrofits.

This process is known as a retrofit reconnaissance investigation. Several great resources on how to do the field and desktop work to find good retrofits can be found in the Resources section.

It often makes sense to target your search efforts within smaller "subwatersheds" within your community that are known to have existing flooding or water quality problems. By clustering your retrofits (and other restoration practices), it may be possible to achieve impressive improvements in local stream health.

WHAT DEGREE OF TECHNICAL SUPPORT IS NEEDED

Retrofit design and construction can be fairly complex, and requires a lot of engineering skills, project management and construction oversight. While most communities have the in-house talent to manage retrofit projects, they often find it helpful to hire consultants to conduct retrofit investigations and upgrade stormwater management tracking systems. Several great resources on the retrofit process can be found in the Resources section.

KEY DELIVERY ISSUES TO KEEP IN MIND

Expect to take a minimum of at least one year to go from concept to construction for individual retrofit projects. It is not uncommon to take two years, if there are significant permits or neighborhood outreach needed for the projects.

At the outset, check out each project to see if there are any “project killers" that may stall, delay, or even kill an otherwise fine retrofit project. Examples include projects that may require special stream, wetland or dam safety permits, result in the loss of existing trees or open space, or create neighborhood opposition.

Since you will be building many retrofits over the years, you will want to think carefully on how to efficiently "bundle" the procurement process so you spend more time on project management than project paperwork.

COMPUTING THE POLLUTANT REMOVAL CREDIT

At first glance, it looks like the expert panel developed a real complex method for estimating retrofit pollutant rates, but all you need to know are three basic things about each individual retrofit project:

1. What type of stormwater practice does the retrofit employ?
2. How much runoff storage volume does it create?
3. How many impervious acres exist in its contributing watershed?

To calculate pollutant removal credits towards the Chesapeake Bay TMDL, retrofits are first classified as either **Stormwater Treatment (ST)** or **Runoff Reduction (RR)** practices:

- **Stormwater Treatment**: practices that reduce pollutant loads through mechanisms such as settling or filtering through sand or other media.

- **Runoff Reduction**: practices that accomplish the above, but also do a good job of reducing runoff volumes through infiltration, interception of rainfall by vegetation, absorption in a soil or similar media, or storage and VERY slow release of water through an underdrain. Correspondingly, overall pollutant removal is better than that of the Stormwater Treatment practices.

Table 1 below shows a list of common stormwater practices and in which category they are classified.

Table 1. Classification of Stormwater Treatment and Runoff Reduction Practices

Stormwater Treatment (ST) Practices	**Runoff Reduction (RR) Practices**
Constructed Wetland	Bioretention, Dry Swale
Filtering Practice (e.g., sand filter)	Infiltration
Wet Swale	Permeable Pavement
Wet Pond	Green Roof

Special Retrofit Notes:

- An expert panel concluded dry channel regenerative conveyance projects (aka step pool conveyance and coastal plain outfalls) could be classified as a runoff reduction retrofit practice, using the same retrofit adjustor curve crediting approach.
- An expert panel is currently working on special method to compute the effect of adding floating treatment wetlands to existing wet ponds to improve nutrient reduction, and expects to have recommendations later in 2015.
- Another expert panel developed specific methods to compute removal for urban filter strips used in a retrofit context, please consult their report (link) to see how credit is provided for this practice.

The objective of the EPA Expert Panel on retrofits was to create a "level playing field" for crediting stormwater retrofits, so that projects in any of the Bay states would be scored using a similar metric. In response, they developed "adjustor curves" for Total Phosphorus (TP), Total Nitrogen (TN), and Total Sediment (TS) removal, and a standard equation that each state could

use to account for the volume of water treated through a site's stormwater management practices. **Table 2** shows the adjustor curves as well as the standard retrofit equation. The expert panel report goes into more detail on how to use the equation and curves.

The curves show percent removal for TP, TN, and TS based on the runoff depth captured by the practice per impervious acre in its drainage area. Those using the graphs refer to either the RR or ST curve based on the type of stormwater management practice being used (Table 1). They then find the corresponding percent pollutant removal shown on the y-axis and apply it to the pollutant load generated by the drainage area. This computes the load of TP/TN/TS reduced by the stormwater practice.

Table 2. Adjustor Curves and the Standard Equation for Using Them

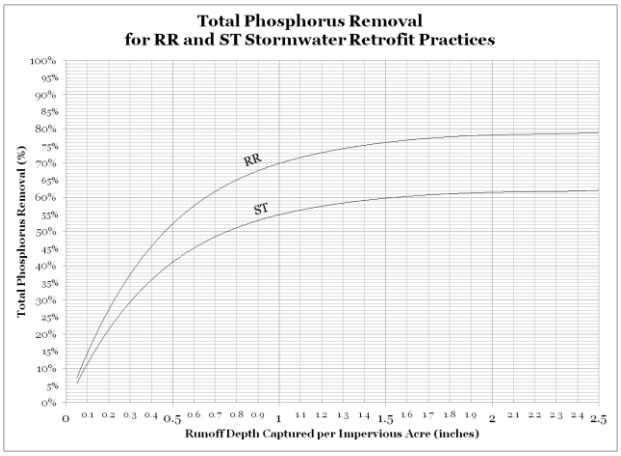
These are the 3 sets of adjustor curves for Total Phosphorus (top right) Total Nitrogen (bottom left), and Total Sediment (bottom right).

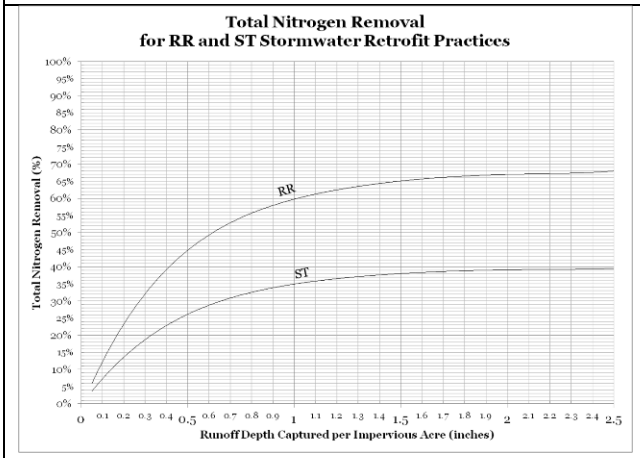
Use the standard equation for "Runoff Depth Captured per Impervious Acre" (in inches) to find the appropriate location on the X-axis:

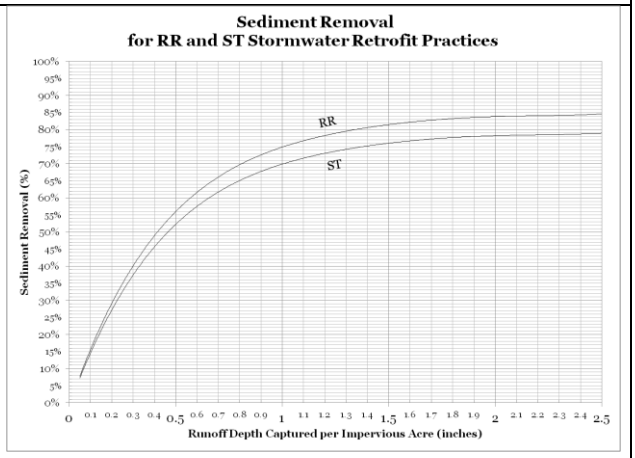
$$\frac{12 \times RS}{IA}$$

RS = Runoff Storage Volume (acre-feet) is the amount of volume treated by the stormwater practice

IA = Impervious Area in acres







For Conversions & Enhancements, there is an extra step to calculate the "Credited Pollutant Removal." This is the removal accomplished by the retrofit minus the removal assigned to the existing practice (with relevant efficiency modifications). NOTE: Existing practice removal rates for dry ponds and dry extended detention ponds are derived from **Table A-5 in the**

Retrofits Expert Panel report. These two types of practices DO NOT use the adjustor curves, since they are not considered ST practices in the Expert Panel report.

- Conversion Credited Pollutant Removal = Conversion Removal from Adjustor Curves – Existing Practice Removal from Table A-5 x Applied efficiency modification

- Enhancement Credited Pollutant Removal = Enhancement Removal from Table A-5 – Existing practice removal x Applied efficiency modification

Table A-5 (undiscounted) rates are listed in the table below (lbs/acre per yr):

Table 3. Pollutant Removal Rates for Dry & Extended Detention Ponds taken from table A-5 in the Retrofit Expert Panel Memo			
	TP	**TN**	**TSS**
Dry Detention Pond	10	5	10
Dry ED Pond	20	20	60

No Double Counting. A removal rate cannot be granted if the retrofit project is built to offset, compensate or otherwise mitigate for a lack of compliance with new development stormwater performance standards elsewhere in the jurisdiction.

Because the ability of retrofits to remove pollutants is based on three factors: (1) type of stormwater treatment employed, (2) the amount of runoff depth captured by the practice and (3) the total amount of impervious acres in the drainage area, it makes sense that the best performing retrofits (in terms of pollutant removal) will be those retrofits that use the runoff reduction technique to remove pollutants, maximize the amount of runoff captured and primarily from large swaths of impervious cover.

HOW TO REPORT THE PRACTICE TO THE STATE

To be revised by PA DEP after they define requirements for retrofits.

Localities need to check with their state stormwater agency on the specific data to report individual retrofit projects, and must meet the practice reporting and tracking procedures established by their state. It is recommended that the following information be reported to the state:

- Retrofit class (i.e., new retrofit facility or existing facility retrofit; if it is an 'existing facility retrofit' then you must identify if it is a conversion, enhancement or restoration project)
- GPS coordinates
- Year of installation (and expected rate duration)
- 12 digit watershed in which it is located
- Total drainage area and impervious cover area treated
- Runoff volume treated and identify "type" of retrofit (e.g., ST or RR)
- Projected sediment, nitrogen and phosphorus removal rates

WHAT IS REQUIRED TO VERIFY THE PRACTICE OVER TIME

The maximum duration for the retrofit removal rate is 10 years but it can be renewed based on a field inspection that confirms that the retrofit is still performing its pollutant removal function.

Jurisdictions need to provide a post-construction certification that the retrofit was installed properly, meets or exceeds the design standards under its retrofit classification and is achieving its hydrologic function.

The agency that installs the retrofit should maintain a more extensive project file for each urban retrofit project installed (i.e., construction drawings, as-built survey, digital photos, inspection records, and maintenance agreement, etc). The file should be maintained for the lifetime for which the retrofit removal rate will be claimed.

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STATE-SPECIFIC INFORMATION

Section still under development

For more information about urban stormwater retrofits in the state of Pennsylvania:

State Contact for Retrofits	Ken Murin	kmurin@state.pa.us
State Contact for Reporting Retrofits	Ted Tesler	thtesler@state.pa.us
Link to Additional State-Specific Information on Retrofits		

RESOURCES

The following resources are available for help with all aspects of retrofits:

Type of Resource	Title of Resource	Web link
Expert Panel Report	Recommendations of the Expert Panel to Define Removal Rates for Urban Stormwater Retrofit Projects (2012)	http://chesapeakestormwater.net/wp-content/uploads/dlm_uploads/2012/10/Final-CBP-Approved-Expert-Panel-Report-on-Stormwater-Retrofits-short_012015.pdf
Archived webcast on Retrofit Accounting	Accounting for Urban Stormwater Retrofits Webcast (2014)	http://chesapeakestormwater.net/events/webcast-ms4-implementers-and-the-bay-tmdl-retrofits/
Training Module(s) on the Retrofit Process	Fairfax Retrofit Workshop Presentations	http://chesapeakestormwater.net/wp-content/uploads/downloads/2013/04/FairfaxPPTscomplete.pdf
'FAQ' document	Frequently Asked Questions for Urban Stormwater Retrofits (2013)	http://chesapeakestormwater.net/wp-content/uploads/downloads/2013/10/Perf-Standards-and-Retrofits_FAQ-Document_090913.pdf
Retrofit Manual	Urban Subwatershed Restoration Manual 3: Urban Stormwater Retrofit Practices (2007)	http://chesapeakestormwater.net/wp-content/uploads/downloads/2012/06/Urban-Stormwater-Practices.pdf
Expert Panel Appendix A	Appendix A: Review of BMP Performance Monitoring Studies	http://chesapeakestormwater.net/wp-content/uploads/dlm_uploads/2015/02/Appendix-A-Review-of-BMP-Peformance-Monitoring-Studies_012015.pdf
Expert Panel Appendix B	Appendix B: Derivation of the Retrofit Removal Adjustor Curves	http://chesapeakestormwater.net/wp-content/uploads/dlm_uploads/2015/02/Appendix-B-Derivation-of-the-Retrofit-Removal-Adjustor-Curves_012015.pdf
More Tools & Resources	Including: Retrofit Prioritization Worksheet	http://chesapeakestormwater.net/training-library/urban-restoration-techniques/stormwater-retrofits/