U-1 URBAN STORMWATER RETROFITS

PRACTICE AT A GLANCE

- Stormwater retrofits will usually be 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.
- In many communities, dozens or even hundreds of good candidate sites exist 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 beyond pollutant removal.

PRACTICE DESCRIPTION

Stormwater retrofits are a diverse group of projects that provide nutrient and sediment reduction from existing development that is currently untreated or is inadequately treated by an existing stormwater 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 local waterways and the Chesapeake Bay. Stormwater retrofits can also provide other important benefits to a community. For example, retrofits can also:

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

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

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

- Near stormwater outfalls or within the existing stormwater conveyance system
- Adjacent to large parking lots or other areas of impervious cover
- Within green streets
- Residential properties (Fact Sheet U-3)

Existing 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 existing retrofits include:

- **Conversions:**
  - Convert large dry pond to wetland or wet pond
  - Convert small dry pond to bioretention
- **Enhancements:**
  - Re-design old dry pond to increase treatment volume, prevent short circuiting, or extend hydraulic residence time.
- **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.

Every Bay community usually has a large inventory of older stormwater practices, many of which were built several decades ago, need major repairs or 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 target is 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 target includes future municipal construction projects where stormwater practices can be integrated into the street right of way, parking lot or public buildings. These retrofits can often be "piggy-backed" onto municipal streetscape, neighborhood revitalization or other capital improvement project budgets.

GENERAL COST INFORMATION

The cost of retrofits vary widely from project to project, ranging from $5,000 to $200,000 per impervious acre treated. Therefore, it is critical to assess multiple retrofit projects to find the most cost-effective ones 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.

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 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 do a retrofit investigation can be found in the Resources section of this document.

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 or where large capital projects are planned or needed. 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, particularly if the project requires significant permits or neighborhood outreach.

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, cause the loss of existing trees or open space, or attract 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 method for estimating retrofit pollutant rates is very complex, 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 to see how credit is provided for this practice located here: http://chesapeakestormwater.net/bay-stormwater/baywide-stormwater-policy/urban-stormwater-workgroup/urban-filter-strips/ • Retrofits of existing **dry ponds or dry extended detention ponds** do NOT use the adjustor curves to define their pre-retrofit performance. They use lower pollutant removal rates shown in Table A-5 of the "Expert Panel Report" (see Resources section).	

There are "adjustor curves" to estimate the nutrient and sediment removal achieved by retrofits, as well as a standard equation to account for the runoff volume treated by each individual retrofit project. **Table 2** shows the adjustor curves as well as the standard retrofit equation. The "Expert Panel Report" provides several design examples to show how to use them on real projects (see Resources section).

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. The user selects either the RR or ST curve, depending on what type of stormwater treatment is being used (Table 1) and can 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

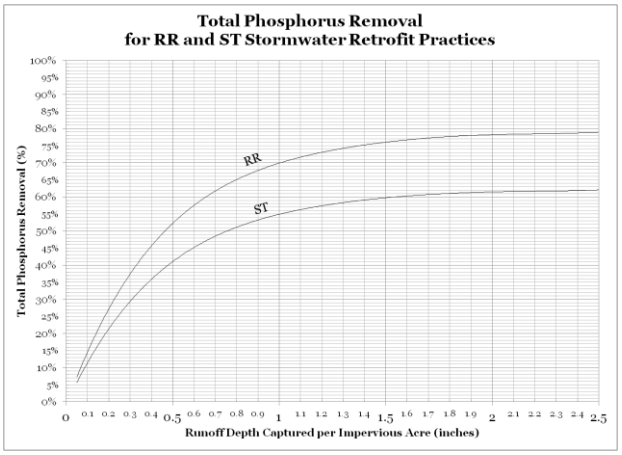
These are the 3 sets of adjustor curves for Total Phosphorus (top right) Total Nitrogen (bottom left), and Total Sediment (bottom right).

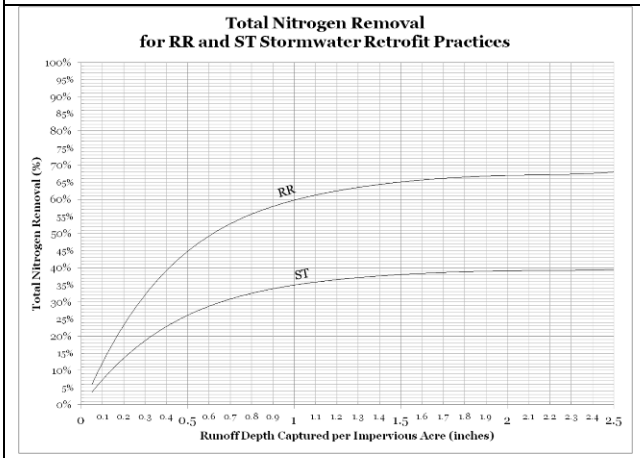
Use the standard equation for "Runoff Depth Captured per Impervious Acre" (in inches) to find the appropriate location on the X-axis:

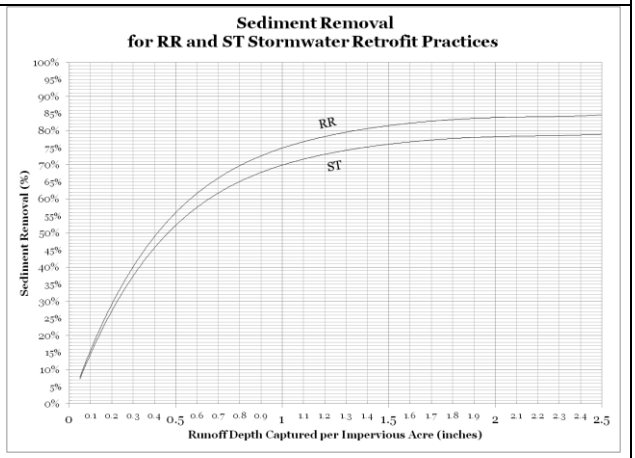
$$\frac{12 \times RS}{IA}$$

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

IA = Impervious Area in acres







When existing practices are converted or enhanced, there is an extra step to calculate the incremental pollutant removal credit. The higher removal rate associated with the new retrofit is

adjusted to subtract out the original removal rate for the practice prior to the retrofit, as shown below.

- Conversion Pollutant Calculation: If the practice being converted involves a significant increase in runoff capture volume and/or an increase in runoff reduction, than an incremental rate is used. The removal rate for the existing practice should be determined from the adjustor curves as seen in Table 2. The newly converted practice will get a higher removal rate that reflects the higher degree of runoff treatment and/or runoff reduction associated with the retrofit, as determined from the retrofit removal adjustor curves.

- Enhancements: are defined as the difference between the new rate and the original rate. The new rate for the enhanced retrofit is taken from the curves in Table 2, while the original rate is taken from Table A-5 in the "Expert Panel Report" (see Resources section). By subtracting the original removal rate from the new removal rate you get the enhanced removal rate.

Maximizing Retrofit Pollutant Removal. The ability of retrofits to remove pollutants is based on three factors:

- Type of stormwater treatment employed,
- Amount of runoff depth captured by the practice and
- Total amount of impervious acres in the drainage area

Therefore, it makes sense that the best performing retrofits will use the runoff reduction practices, maximize the volume of runoff captured and treat the largest drainage areas.

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.

HOW TO REPORT THE PRACTICE TO THE STATE

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 *minimum* amount of information be reported to the state:

- BMP Name (e.g., ST or RR)
- Location: GPS coordinates, HUC, County or State
- Date of installation
- Total drainage area treated
- Total impervious area treated
- Volume of water treated by the practice (e.g., Runoff Storage Volume)

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 still exists, is being properly maintained and is still performing its pollutant removal function.

These 'performance verification field inspections' can be piggybacked onto routine local regulatory inspections already slated to occur and can be done by the use of simple visual indicators to assess the facility for functionality. For more information on the visual indicator or verification guidance see the resources section.

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.

RESOURCES

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

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/
	Final Recommended Guidance for Urban Stormwater BMP Verification	http://chesapeakestormwater.net/wp-content/uploads/dlm_uploads/2013/01/USWG-Approved-Urban-BMP-Verification-Guidance-08112014.pdf
	Bioretention Illustrated: A Visual Guide for Constructing, Inspecting, Maintaining and Verifying the Bioretention Practice	http://chesapeakestormwater.net/wp-content/uploads/downloads/2013/10/FINAL-VERSION-BIORETENTION-ILLUSTRATED-102113.pdf
	Watershed Implementation Tools	http://www.chesapeakebay.net/about/programs/watershed_implementation_plan_tools/