Stormwater Credits

Stormwater credits reduce the stormwater management requirements that must be met on a given development site in exchange for conserving forests, using site design techniques that reduce the amount of paved surfaces created, or using low impact development practices (LID). Low impact development is a stormwater management approach that seeks to manage runoff using distributed, micro-scale practices. The goal is to mimic the site's pre-development hydrology using design techniques that infiltrate, filter, store, evaporate and detain runoff close to its source.

Often times, LID practices are not used because there is no local system to get them approved on development plans. Even if all parties involved (plan reviewers, developers, design consultants) are interested in LID practices, they cannot be fully incorporated unless they are considered coequal to more conventional best management practices (BMPs), and their benefits for water quality and runoff reduction are counted in the local compliance process. Most conventional BMPs have well-defined sizing and water quality computation procedures by which the local reviewer can establish compliance. However, computational methods for LID are more uncertain and less widely known and accepted.

Even with these difficulties, there are many benefits to conserving forests and other natural areas, reducing impervious cover, and incorporating LID into site design. These include:

- In some cases, LID can be more economical for the developer while still providing effective stormwater treatment (if properly designed, implemented, and maintained) because reducing impervious cover and limiting clearing can reduce costs to the developer and because LID can reduce the size and/or footprint of conventional, structural stormwater conveyance and treatment systems needed at a site.
- Most LID techniques have aesthetic benefits and can enjoy wider homeowner acceptance compared to certain conventional practices. For instance, a restored riparian buffer and grass channels are usually more acceptable to the public than a conventional "backyard" basin.
- Trees and forests provide a host of other benefits besides reducing runoff. They provide shade, reduce heating and cooling costs, improve air quality, increase property values, and provide recreational opportunities and wildlife habitat.
- Use of LID allows the site designer to tailor stormwater solutions to the particular conditions and opportunities at the site. For example, if a site has many unbuffered streams or open spaces previously used for agriculture, restoration plans can become part of the stormwater mix.
- Certain LID techniques can be coordinated with land use strategies to protect water resources. An example is encouraging shared parking, and thus a reduced parking lot footprint, in areas where the locality wishes to encourage infill and redevelopment.

Most stormwater credit systems are based on the ability of stormwater practices to reduce the overall volume of runoff from a development site, and do not directly account for other benefits provided, such as filtering of pollutants and biological transformation. Most states and local governments that have established credit systems allow the site designer to subtract conservation areas or areas treated by an LID practice from the total site area or impervious area when computing the water quality volume and/or recharge volume. A number of states and local governments have adopted this type of stormwater credit system as part of their stormwater management programs (Table 1).

The range of BMPs eligible for credits under the programs described in Table 1 include natural area conservation, reforestation, impervious cover disconnection, sheetflow to buffers or filter strips, open channels, green roofs, permeable pavers and environmental site design. An important note is that equal credits are not provided for forest conservation and reforestation because with reforestation, a long time may be needed to realize the full stormwater benefit. For example, reforesting one acre of land may only receive 1/3 to ½ of the credit provided for conserving one acre of existing forest.

Table 1. State and Local Stormwater Credit Systems

State or Local Stormwater Guidance Document	Web Link
Vermont Stormwater Management Manual	http://www.anr.state.vt.us/dec/waterq/stormwater.htm
Minnesota Stormwater Manual	http://www.pca.state.mn.us/water/stormwater/stormwater-manual.html
Philadelphia Stormwater Management Guidance Manual	http://www.phillyriverinfo.org/
New Jersey Stormwater Best Management Practices Manual	http://www.njstormwater.org/bmp_manual2.htm
Maryland Stormwater Design Manual	http://www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/stormwater_design/index.asp
Georgia Stormwater Management Manual	http://www.georgiastormwater.com/
Pennsylvania Stormwater Best Management Practices Manual	http://www.depweb.state.pa.us/watershedmgmt/cwp/view.asp?a=1437&q=529063&watershedmgmtNav=|
Commonwealth of the Northern Marianas Islands and Guam Stormwater Management Manual - Draft	http://www.deq.gov.mp/article.aspx?secID=6&artID=55
Ontario Stormwater Management Planning and Design Manual	http://www.ene.gov.on.ca/envision/gp/4329eindex.htm
Stormwater Management Manual for Western Washington	http://www.ecy.wa.gov/programs/wq/stormwater/manual.html

A handful of municipalities have adopted or are considering stormwater credit programs that encourage the addition of more trees into a development or redevelopment site. These programs give credit on an individual tree basis for runoff reduced through rainfall interception, evapotranspiration, and infiltration. A summary is provided in Table 2.

Table 2. Stormwater Credits for Individual Trees		
Community	**Description of Credits**	**Web Link**
Pine Lake, GA	Ordinance passed in 2003 that provides credits for saving trees. Credits help meet site runoff requirements and are determined based on size class of tree: • Trees < 12” DBH = 10 gallons/inch • Trees > 12” DBH = 20 gallons/inch	http://www.pinelakega.com/pdf_docs/Waterfirst_Plan.pdf
Sacramento, CA	2007 Stormwater Quality Design Manual includes credits for new or existing ‘interceptor trees.’ Credits are accompanied by design criteria and a list of approved interceptor trees. A portion of impervious cover underneath tree canopy may be subtracted from the site impervious cover as follows: • New deciduous trees = 100 ft^2 • New evergreen trees = 200 ft^2 • Existing trees = ½ the existing canopy	http://www.sacramentostormwater.org/SSQP/documents/DesignManual/SWQ_DesignManual_May07_062107.pdf
Portland, OR	2004 Stormwater Management Manual includes credits for new or existing trees within 25 feet of impervious surfaces. Credits are accompanied by design criteria and a list of approved species. A portion of impervious cover underneath tree canopy may be subtracted from the site impervious cover as follows: • New deciduous trees = 100 ft^2 • New evergreen trees = 200 ft^2 • Existing trees = ½ the existing canopy	http://www.portlandonline.com/bes/index.cfm?c=35122&a=55791
Indianapolis, IN	2007 Draft Stormwater Green Infrastructure Supplemental Document provides credits for new or existing tree canopy that is within 20 feet of impervious surfaces. Trees must be on approved species list and standards are provided for tree size. An impervious cover reduction credit of 100ft^2 is given for each new tree.	http://www.indygov.org/NR/rdonlyres/BE4975CF-9088-4721-9647-6E088015F2B4/0/DRAFT_SWGreenDoc.pdf

Developing a simple program that provides credit for individual trees can be challenging since the amount of runoff reduced through these processes can vary greatly based on tree species and size, climate, season, and tree maintenance practices and health. In order to give sufficient credit that truly accounts for the value provided by trees, we must have reliable data to quantify the benefits of trees that can also be simplified in such a way to provide specific values and a simple process so that engineers can calculate credits.

An emerging way to incorporate LID into stormwater compliance systems is to consider the ability of various practices to reduce the overall volume of runoff based on data from research studies. “Runoff reduction” tends to level the playing field between LID and conventional practices because it provides a common denominator that can be ascertained for a fuller range of practices than are typically allowed in local and state stormwater manuals. It differs from the typical approach to crediting (which allows subtraction of conservation areas or areas treated by an LID practice from the total site or impervious area when computing treatment volume) because it is based on field research studies that quantify runoff reduction provided by each BMP through infiltration, evaporation, or other process.

Runoff reduction can be defined as the total annual runoff volume reduced through canopy interception, soil infiltration, evaporation, transpiration, rainfall harvesting, engineered infiltration, or extended filtration. BMPs that reduce the overall volume of runoff also reduce pollutant loads, and they can also help mitigate other stormwater concerns, such as downstream channel erosion and insufficient groundwater recharge. Various state programs (e.g., Delaware, Georgia, Virginia) are updating their stormwater regulations and handbooks to incorporate the principles of runoff reduction.

Table 3 lists the runoff reduction capabilities of various conventional and LID practices based on an extensive literature search (Hirschman et al. 2008). The values in the table are generally average annual runoff reduction rates from research studies, and they pertain chiefly to smaller storm events (e.g., 90^{th} percentile rainfall event or less—equivalent to the “water quality volume”). Hirschman et al. (2008) provides a comprehensive compliance system, including a spreadsheet, that can be used or adapted to provide credit for runoff reduction practices.

The runoff reduction system outlined in Hirschman et al. (2008) does not currently assign a runoff reduction value to design practices that reduce impervious cover, conserve forests, natural areas and undisturbed soils, or improve the infiltration capacity of disturbed soils. Instead, the spreadsheet provided allows the designer to compute runoff coefficients for impervious cover, forest cover and disturbed soils to calculate a site-specific target treatment volume. Thus, reducing impervious cover and conserving natural areas reduces the required treatment volume and associated stormwater management costs.

Table 3. Runoff Reduction for Various BMPs	
Stormwater Practice	**Runoff Reduction Rates from Literature (%)[a]**
Green Roof	45–60
Rooftop Disconnection	25–50
Raintanks and Cisterns	Amount captured and reused
Pervious Parking	45–75
Grass Channel	10–20
Bioretention	40–80
Dry Swale	40–60
Wet Swale	Less than 10%
Infiltration	50–90
Extended Detention Pond	0–15
Soil Amendments	50–75
Filter Strip; Sheetflow to Open Space	50–75
Filtering Practice	Less than 10%
Constructed Wetland	Less than 10%
Wet Pond	Less than 10%

[a]*Where a range of values is presented, the range reflects the varying ability of different design components to promote runoff reduction. For instance, bioretention that is designed for infiltration into the subsoil has a higher runoff reduction rate than bioretention with an underdrain, where infiltration rates are less.*

Also, values represent average annual reductions based on research studies. The values are relevant chiefly for smaller storm events— approximately the 90th percentile rainfall event or less. Some runoff reduction can also be achieved for larger events (channel protection and/or flood control runoff events), but the values would likely be adjusted depending on site runoff characteristics.

Source: Hirschman et al. (2008)

For state and local programs incorporating runoff reduction credits, it is important that the stormwater design manual describe each credit, indicate how it is computed, outline required site conditions, highlight restrictions to where it can be applied, and conclude with a design example. Not all credits are available for each development site, and certain site-specific conditions must be met to receive each credit. These minimum conditions include site factors like maximum flow length or contributing area. These “eligibility criteria” help to avoid situations that lead to runoff concentration, erosion, and possible drainage complaints. An example of eligibility criteria needed to receive a stormwater credit for grass channels is provided in Table 4.

Table 4. Eligibility Criteria for Grass Channel Credit
Eligibility: A qualifying grass channel meets the following criteria:
• Primarily serves low to moderate residential development, with a maximum density of 4 dwelling units per acre • The bottom width of the channel should be between 4 and 8 feet wide. • If suitable soil amendments are provided for channels in C/D soils, the 20% runoff reduction rate may be used. For channels in A/B soils, soil amendments are not needed so long as soils are protected during site construction. • Channel side-slopes should be no steeper than 3H:1V • The longitudinal slope of the channel should be no greater than 2%. (Checkdams or a terraced swale design may be used to break up slopes on steeper grades.) • The maximum contributing drainage area to any individual grass channel should be 5 acres. • The dimensions of the channel should ensure that runoff velocity is non-erosive during the 2-year design storm event and safely convey the local design storm (e.g., 10-year design event). • Designers should demonstrate that the channel will have a maximum flow velocity of 1 foot per second during a 1-inch storm event.
Source: Hirschman and Kosco (2008)

Although the details of individual stormwater credit systems may vary, the most effective ones specify minimum criteria to be eligible for the credit, and provide simple guidance on how to calculate the credit. Some additional factors that are important in establishing an effective stormwater credit system include:

- Strong interest and some experience in the use of LID techniques.
- A development review process that emphasizes early stormwater design consultations during and prior to initial site layout. Such procedures as pre-submittal meetings and concept plans are strongly encouraged.
- Effective working relationships between plan reviewers and design consultants.
- A commitment by both parties to field verification to ensure that credits are not a paper exercise.

Stormwater credit systems promote the use of practices that maintain or mimic the site pre-development hydrology. These credit systems directly translate into cost savings for the developer by reducing the size of stormwater storage and conveyance systems required. Future efforts in refining stormwater credit systems may include research to increase the strength of the data on runoff reduction and developing effective methods to credit trees and forests that are simple but also account for the economic, environmental and community benefits they provide.

References

Hirschman, D.; Collins, K.; Schueler, T. (2008). *The Runoff Reduction Method;* Technical Memorandum; Center for Watershed Protection: Ellicott City, Maryland. Available at: www.cwp.org

Hirschman, D.; Kosco, J. (2008). *Managing Stormwater in Your Community: A Guide for Building an Effective Post-Construction Program.* Developed by the Center for Watershed Protection and TetraTech, Inc. for the U.S Environmental Protection Agency.

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