TREE CREDIT SYSTEMS AND INCENTIVES AT THE WATERSHED SCALE

FINAL REPORT

Stone Project ID 12-161

March 6, 2014

Prepared for:

Urban and Community Forestry, Vermont Dept. of Forests, Parks & Rec.
Danielle Fitzko
1 National Life Drive, Davis 2
Montpelier, VT 05620-3801
Tel. / 802.598.9992
E-Mail / Danielle.fitzko@state.vt.us

Prepared by:

Stone Environmental, Inc.
Julie Moore, Amy Macrellis, Kate Bailey
535 Stone Cutters Way
Montpelier, VT 05602
Tel. / 802.229.1881
E-Mail / jmoore@stone-env.com

STONE ENVIRONMENTAL INC

ACKNOWLEDGEMENTS

This project was performed by Stone Environmental, Inc. for the Vermont Department of Forests, Parks, and Recreation with funding provided by the U.S. Forest Service Northeastern Area State and Private Forestry Competitive Allocation.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

The effects of land use change on stream and watershed health are well-documented—and the management of stormwater in order to protect water quality and aquatic habitat has become a critical issue at the local, state and national level. Expanded efforts to manage and treat stormwater are needed to improve water quality, protect cold-water fisheries and mitigate flooding.

Of particular importance to planners and policymakers are the effect watershed-scale landscape conditions can have on surface water quality. The most commonly used metric for predicting watershed health has historically been percent impervious cover. While this remains an important metric, tree canopy, or forest cover is receiving increased attention as an important measure and determinant of watershed health.

The myriad ecosystem services provided by individual trees and forest ecosystems have been the focus of a great deal of research. Numerous studies have sought to quantify the services provided by trees related not only to stormwater attenuation and treatment, but also air quality improvement, pollutant removal, aesthetic/recreational value, increased property value, carbon sequestration (climate change adaptation/mitigation), temperature attenuation and energy savings. Stormwater services are especially important in urban areas where development has led to hydrologic changes.

2. WATERSHED SCALE FOREST COVER

Each watershed has its own characteristics from topography, geology, soil types, climate, land cover types and distribution, to population density and level of development. Studies across several geographical areas, however, are able to provide some generalizations. Booth et al. 2002 found that even in rural areas, once forest cover fell below 65% streams became unstable and exhibited significant degradation. The study looked at twenty years of empirical data and concluded that:

> *Development that minimizes the damage to aquatic resources cannot rely on structural BMP's, because there is no evidence that they can mitigate any but the most egregious consequences of urbanization. Instead, control of watershed land-cover changes, including limits to both imperviousness and clearing, must be incorporated (Booth et al. 2002).*

While more urbanized areas receive the most attention for targeted land-use planning and management, it is important to note that even in more rural areas, where dense, impervious development is not a major issue, percent forest cover remains highly important for stream health:

> *Hydrological analyses suggest that maintaining forest cover is more important than limiting impervious-area percentages, at least at rural residential densities where zoning effectively limits the range of EIA between 2 and 6 percent of the gross development area. Absent clearing limitations, however, forest cover will range between 5 and about 85 percent. Consequently, even if both types of land cover control (i.e., forest retention and EIA limitation) are critical to protect stream conditions, current land-use practices suggest that mandating retention of forest cover is the more pressing regulatory need in rural areas. Degraded watersheds, with less than 10 percent EIA and less than 65 percent forest cover, are common ("cleared rural"); in contrast, we have found no watersheds with more than 10 percent EIA that have also retained at least 65 percent forest cover ("forested urban) (Booth et al. 2002).*

A study by Goetz et al. 2004 looked at mid-Atlantic stream health rankings and their correlation with watershed impervious cover, forest cover, and riparian buffer cover (30 m on either side of the stream). Results are shown in Figure 1.

Streams with excellent health generally had at least 50% of the watershed area forested. Over 40% of the watershed was forested for those ranked as good health. Based on these data the study suggests guidelines for excellent stream health would be less than 6% of the total area in impervious surfaces, and at least 65% forested riparian buffer zones. A good watershed health rating required and at least 60% buffer zone vegetation cover and no more than 10% impervious area (Goetz et al. 2004).

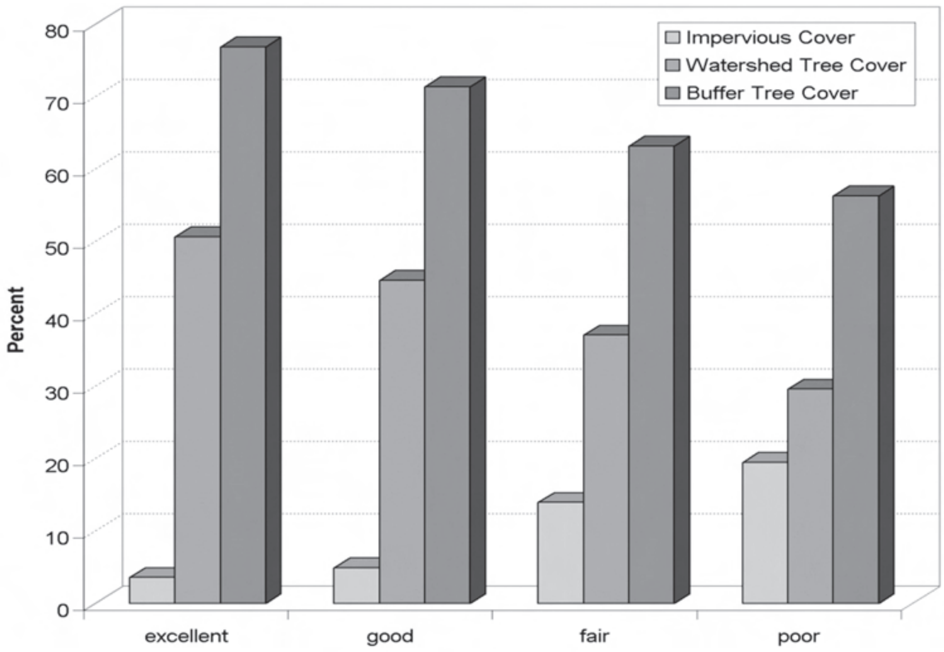

Figure 1. Stream Health Rankings and Land Cover. Goetz et al. 2004.

Weber, 2007, looked at Maryland statewide water quality and land cover data to examine links to percent forest and wetland cover. The study found >50% correlation between forest/wetland cover in the catchment and nutrient levels (nitrate, nitrite, total dissolved nitrogen, particulate phosphorous), as well as chloride levels. Lower nutrient and salt loads were associated with increased forest/wetland cover:

> *Impaired stream sites statewide had significantly less forest or wetland cover in the upstream catchment (mean 36%, std. error 1%) than unimpaired sites (mean 52%, std. error 1%). Conversely, high-quality sites statewide had more forest or wetland cover in the upstream catchment (mean 68%, std. error 2%) than sites not meeting the high-quality criteria (mean 41%, std. error 1%) (Weber 2007).*

Weber concluded with a recommendation that high priority be given to targets of >40% forest/wetland cover and <7% impervious cover in watersheds to maintain high quality water.

Based on the environmental, social, and economic benefits of trees, the organization American Forests developed general urban tree canopy (UTC) goals; 40% tree canopy overall, with at least 50% tree canopy in suburban residential zones, 25% tree canopy in urban residential zones, and 15% tree canopy in central business districts (American Forests 2002).

3. ECONOMIC STORMWATER BENEFITS

Research into the individual benefits trees provide during their lifespan have led to economic estimates of these services; individual average services can then be aggregated. Various software tools, such as i-Tree and CITYGreen, allow entities to assess the current tree canopy of an area and quantify not only the volume of rainfall intercepted annually by trees before it has a chance to become stormwater runoff, but also the economic benefits provided and capital/operational costs avoided by the presence of the trees. For instance, Charlotte, NC estimates that they receive over $2 million annually in stormwater benefits from their UTC (EPA 2013). These analyses have led many government entities to offer stormwater credits or put in place requirements for tree conservation/planting. Further, the available software tools can be used to predict the stormwater management benefit of varying amounts of additional tree cover. Data from i-Tree reference studies are summarized in Table 1.

Table 1. Data from i-Tree Street Studies illustrating stormwater benefits of trees. EPA 2013.

Year	i-Tree Reference City	Number of Trees Studied	Annual Stormwater Benefits (dollars)	Rainfall Intercepted Annually by Trees (million gallons)
2006	Albuquerque, NM	4,586	$55,833	11.1
2005	Berkeley, CA	36,485	$215,645	53.9
2004	Bismarck, ND	17,821	$496,227	7.1
2007	Boise, ID	23,262	$96,238	19.2
2005	Boulder, CO	25,281	$357,255	44.9
2006	Charleston, SC	15,244	$171,406	28.3
2005	Charlotte, NC	85,146	$2,077,393	209.5
2004	Cheyenne, WY	17,010	$55,301	5.7
2003	Fort Collins, CO	31,000	$403,597	37.4
2005	Glendale, AZ	21,480	$18,198	1.0
2007	Honolulu, HI	235,800	$350,104	35.0
2008	Indianapolis, IN	117,525	$1,977,467	318.9
2005	Minneapolis, MN	198,633	$9,071,809	334.8
2007	New York City, NY	592,130	$35,628,220	890.6
2009	Orlando, FL	68,211	$539,151	283.7
2003	San Francisco, CA	2,625	$466,554	99.2
2001	Santa Monica, CA	29,229	$110,784	3.2

Data from the United States Forest Service i-Tree Streets Reference Cities Guides are available at: http://www.fs.fed.us/psw/programs/uesd/ uep/tree_guides.php.

4. URBAN TREE CANOPY (UTC) GOALS AND ASSESSMENT

Cities from Portland to Philadelphia, and multi-jurisdictional organizations such as the Chesapeake Bay Program, have adopted urban tree canopy (UTC) goals as a way to promote and increase wide-scale tree cover. Goals range from 30% UTC to 50% UTC. The Chesapeake Bay Program has established a plan to increase the UTC in 120 communities, and restore 900 miles of riparian buffer per year to provide 70% tree cover in riparian buffer zones within the bay watershed by 2025 (USDA 2012). Portland aims to increase its UTC from 26% to 33%, especially in low canopy areas. The tree planting project is part of a stormwater management plan which aims to prevent the City's recent $1.44 billion investment in stormwater infrastructure from becoming overwhelmed by runoff associated with population growth and increasing development within the next 10 years. Philadelphia's green initiative is working to increase the UTC from a city-wide average of 20% to 30% in every neighborhood by 2025. Fairfax, VA has a UTC goal of 45% by 2037. Burlington, VT has a city-wide UTC average of 39% and incorporated a goal for 50% UTC in its 2010 Climate Action Plan. The more recent Burlington Climate Action Plan contains a measure to maintain the existing tree canopy as well as plant a total of 588 trees per year, on both public and private land.

Methods for assessing tree canopy and ecosystem services in an area can vary. Top-down approaches utilize aerial imagery and software packages which help interpret the imagery and apply equations to predict the ecosystem services provided by the canopy. Additional analysis can provide maps of areas where planting/conserving trees is most critical, due to land use types, current water quality, habitat concerns, topography and existing canopy. Data can be from high-resolution aerial imagery, National Landcover Dataset imagery/classification, LiDAR, or hyperspectral imagery. Programs such as i-Tree, CITYGreen, and ArcGIS based tools like InVEST are used to analyze the imagery data. Accuracy depends on image quality and methods of interpretation.

The University of Vermont Spatial Analysis Lab (SAL) has worked with a number cities both within Vermont and in other states to develop detailed tree canopy assessments. The SAL uses high resolution (1m) aerial imagery to develop land cover data sets and measure the urban tree canopy. Existing UTC and possible UTC within the city are estimated by percentage and total area. These data are then incorporated into city GIS databases with UTC metrics for each land parcel.

In contrast, bottom-up approaches use field data collection and tree inventorying to estimate the UTC and associated benefits. The accuracy of bottom-up assessments is determined by the plot size sampled relative to the total area, with a general recommendation to collect data from at least 200 one-tenth-acre plots. ArcGIS-based mapping tools and mobile devices are often used for this process. Specific applications such as i-Tree ECO, the Urban Forest Cloud Tree Inventory App, and Tree Sense can be used to map and assess an entire urban forest.

The latest i-Tree program, i-Tree Hydro is designed specifically for assessing the watershed level effects of tree and land-use cover. Students and volunteers have been used to implement bottom-up tree canopy inventories in various places. Crowd-sourced citizen science is becoming a growing field for developing complex and large scale datasets at low cost, such as through the use of apps like Open Tree Map. "Open Tree Map is an open source tree inventory platform available online and as an upcoming smartphone application that enables users to add trees to a map and create an interactive and collaborative tree inventory and dynamic map of a city's trees. Cities like Philadelphia, San Francisco, Grand Rapids, Asheville and San Diego are already using Open Tree Map." (American Forests 2013).

5. ACHIEVING UTC GOALS

Most communities utilize a combination of strategies to increase urban forest cover:

- Community Engagement and Education
  - Tree planting projects
  - Tree give-aways
  - Public mobile mapping projects
  - Increasing UTC on public lands and right of ways
- Tree Protection Ordinances
  - Tree removal permits
  - Tree inventories for site development
  - Tree preservation, protection, and replacement standards for development
- Stormwater Credits
  - Volume reduction, curve number, or impervious area reduction credits for existing and newly planted trees for development/redevelopment sites
  - Tree replacement standards or payments into a tree management fund
  - Stormwater fee system with credits for tree planting/green infrastructure

While many municipalities have adopted some form of stormwater credits for new and/or existing trees and many have also adopted UTC goals, few seem to have incorporated the two. One exception is Washington D.C. In 2006, D.C. established a UTC goal of 40% by 2037. Within 5 years, the city's UTC had grown by 2.1% to a total of 37.2% (DDOT 2012). The 2013 District Stormwater Management Guide contains a section on tree planting, preservation, and maintenance with run-off reduction credits (20 cubic ft per existing tree, 10 cubic ft per planted tree). Washington D.C. is also one of the first jurisdictions to include a specific annual tree planting target in its MS4 permit, as well as a percentage canopy requirement for parking lots (USDA 2012).

The Green Infrastructure Portfolio Standard (GIPS) is another method being used to increase green infrastructure and tree cover. A GIPS establishes goals for communities to capture/reuse/infiltrate on-site a certain amount of rainfall. These goals are similar to renewable energy portfolio requirements in place in over 30 states today (Figure 2).

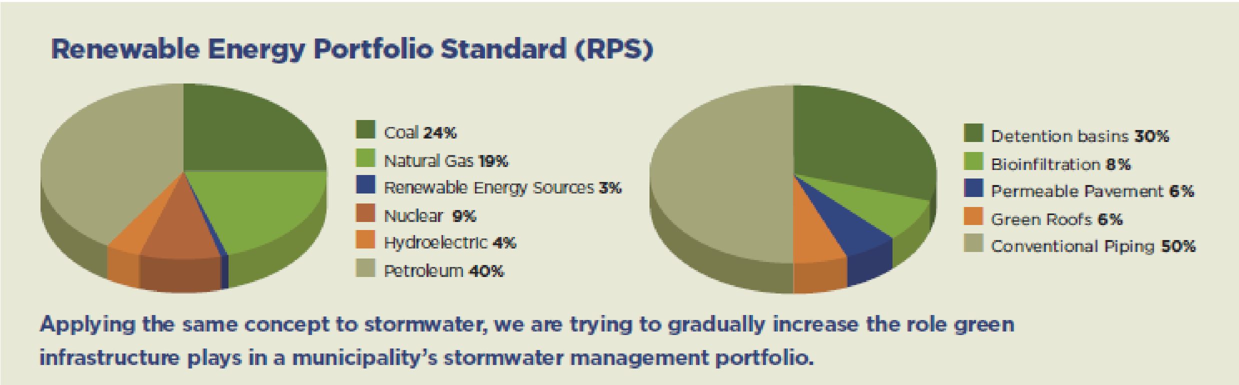

Figure 2. Example of a GIPS, similar to a Renewable Energy Portfolio Standard (RPS). CNT 2012.

While a GIPS incorporates many more green infrastructure approaches than just trees, it poses an interesting framework for increasing tree cover and green infrastructure within communities. Credits/ requirements could be based on location within the watershed, site impervious and tree cover, pollutant sources, and watershed/stream health. The Center for Neighborhood Technology with American Rivers and The Great Lakes and St. Lawrence Cities Initiative published a guide to GIPS (CNT 2012). In the guide the following criteria are recommended for deciding which project areas to choose for green infrastructure implementation first:

- Identifiable water resource issues
- Clearly defined flow boundaries
- Opportunities for redevelopment
- Available GIS and development/land use data
- Local priorities
- Community engagement

A similar framework could be developed for identifying priority urban zones for tree canopy expansion. Once priority zones are identified development/redevelopment projects in those zones could have proportionally stricter tree preservation/planting requirements and/or expanded incentives for designs that incorporate trees into stormwater management designs.

It is common for stormwater guidelines for trees to include sections on site tree inventories/mapping, protection for existing trees during construction, planting guidelines for new trees, species lists, maintenance plan requirements, and replacement requirements for unhealthy/dead trees. Conserving already existing, mature trees and forest ecosystems should receive higher priority (and credits) than replanting, as mature trees and ecosystems provide exponentially higher stormwater benefits. A possible evaluation framework could be based on:

- health of the watershed (303d listing, phosphorous TMDLs, critical source areas, hotspots)
- cold-water habitat (have credits for cold-water tributaries, use trees for shading of retention practices, tree trenches or other tree based infiltration, and shading in the riparian corridor)

- existing impervious cover (more credits for areas with >7-10% IC), and
- existing tree canopy (credits for areas with lower tree canopy cover or critical areas)

Using existing canopy cover as a metric can require a considerable assessment effort. At least one state (Delaware) has used a Designated Watershed approach, where one watershed in each county is selected and rigorously assessed, then used as the basis for stormwater planning throughout the county. However, the Vermont Agency of Natural Resources, in conjunction with the University of Vermont Spatial Analysis Lab (SAL), has completed UTC assessments for several cities (Table 2), as well as state-scale UTC map. The 2010 Vermont Forest Resources Plan stated that the purpose of the study was "[t]o assist in targeting resources to Vermont communities in greatest need of urban tree canopy enhancement." Further, the study

> *…identifies communities that have less than average urban tree canopy (UTC) and greater than average population, urbanized area and impervious surface area. Once target UTC enhancement communities were identified, we overlaid Vermont's impaired watersheds. The highest priority communities include Burlington, South Burlington, Rutland and St. Albans due to their high UTC rating and the occurrence of stormwater impaired watersheds within their boundaries. Other high priority UTC communities include Barre City and Vergennes (VTFPR 2010).*

Table 2. Urban Tree Canopy Assessments for Vermont Cities. VTFPR 2010.

Location	Existing UTC	Possible Additional UTC	Existing Buffer[1] Canopy	Possible Additional Buffer Canopy
Montpelier	62%	31%	49%	44%
Burlington	39%	36%	--	--
St. Albans	30%	51%	--	--
Rutland	37%	51%	64%	--
Moon Brook Impaired Watershed	--	--	58%	42%

[1] The buffer zone is defined as the area within 35 feet of each side of the waterway.

The report identified general priority areas for forest resources as well as four program strategies for localities to establish and maintain forestry initiatives (see Appendix). Finally, the study proposes methods for realizing UTC goals:

> *UTC enhancement can be most efficiently realized by maximizing protection and maintenance in combination with new plantings and natural regeneration. The impacts of setting a UTC goal will likely include focusing or reallocating public agency resources (funds, staff, etc.) to enhance existing UTC areas and develop strategies to create cover in potential UTC areas on public land. On private lands, a combination of education and outreach, landowner and redevelopment incentives, and refocusing of regulatory mechanisms to specifically achieve the objectives of the UTC goal will likely be required (VTFPR 2010).*

As part of the UTC assessment the SAL estimated the percent UTC and the percent possible UTC (areas where additional tree cover could theoretically be added) down to individual land parcel scale based on high resolution (1m) aerial imagery. Further analysis can focus on watersheds and sub-watersheds of impaired waterways and generate forest cover metrics for riparian buffer zones. This allows municipalities to identify critical areas in which to focus tree planting efforts for maximum effect.

6. RECOMMENDATIONS

While specific goals for ideal forest cover percentage vary geographically, and in the literature and municipal UTC plans, common minimum goals are: 40% UTC in urban areas, 65% tree cover at the watershed-scale and 70% tree cover in riparian buffer zones.

Ultimately, location-specific tree canopy and watershed assessments, including the identification of priority areas and adoption of tree cover goals, are needed to serve as the basis for increasing watershed forest cover and water quality. This process can then support the creation of a system of credits and incentives to promote tree cover goals in priority zones, including riparian zones, coupled with mechanisms to ensure the maintenance and conservation of existing cover and encourage some expansion in lower priority zones.

7. REFERENCES

American Forests. 2002. Regional Ecosystem Analysis Roswell, Georgia. Accessed at http://www.systemecology.com/4_Past_Projects/AF_Roswell.pdf on 28 October 2013.

American Forests. 2013. Urban Forest Assessment Tools. . Accessed at http://www.americanforests.org/our-programs/urbanforests/urban-forests-tools-resources/urban-forest-assessments-resource-guide/urban-forest-assessment-tools/ on 14 October 2013.

Booth, Derek B., David Hartley, and Rhett Jackson. 2002. Forest Cover, Impervious Area, and the Mitigation of Stormwater Impacts. Journal of the American Water Resources Association 38(3) 835-947. Accessed at http://www.ci.oswego.or.us/sites/default/files/archives/projects/planningprojects/PP09-0011_Sensitive_Lands_Outreach/Second_Look_Task_Force/01-07-10_Part_1_Scientific_Papers.pdf on 8 October 2013.

Chesapeake Bay Program. 2004. Riparian Forest Buffers Linking Land and Water. Accessed at http://www.chesapeakebay.net/content/publications/cbp_12999.pdf on 29 October 2013.

CNT. 2012. Upgrade Your Infrastructure: A Guide to the Green Infrastructure Portfolio Standard and Building Stormwater Retrofits. American Rivers, The Center for Neighborhood Technology, and The Great Lakes and St. Lawrence Cities Initiative. Accessed at http://www.cnt.org/media/CNT_UpgradeYourInfrastructure.pdf on 18 October 2013.

DDOT. 2012. District's Urban Tree Canopy Boasts New Growth. District Department of Transportation. Accessed at http://dc.gov/DC/DDOT/About+DDOT/News+Room/ci.District's+Urban+Tree+Canopy+Boasts+New+Growth.print on 22 October 2013.

EPA.2013. Stormwater to Street Trees: Engineering Urban Forests for Stormwater Management. Accessed at http://water.epa.gov/polwaste/green/upload/stormwater2streettrees.pdf on 14 October 2013.

Goetz, Scott J., Claire A. Jantz, Stephen D. Prince, Andrew J. Smith, Dmitry Varlyguin, and Robb K. Wright. 2004. Integrated Analysis of Ecosystem Interactions With Land Use Change: The Chesapeake Bay Watershed. Ecosystems and Land Use Change Geophysical Monograph Series 153 Copyright 2004 by the American Geophysical Union 10.1029/153GM20. Accessed at ftp://ftp.whrc.org/Mid-Atlantic/GOETZ-PUBS/Goetz-2004-ChapmanBook.pdf on 8 October 2013.

Jones, K. B., A. C. Neale, M. S. Nash, R. D. van Remortel, J. D. Wickham, K. H. Riitters, AND R. V. O'Neill. 2001. Predicting nutrient and sediment loadings to streams from landscape metrics: a multiple watershed study from the United States Mid-Atlantic region. Landscape Ecology 16(4):301-312.

MPCA. 2013. Minnesota Stormwater Manual. Accessed at http://stormwater.pca.state.mn.us/index.php/Trees on 14 October 2013.

North Carolina State University. 1998.

USDA. 2012. Chesapeake Forest Restoration Strategy. United States Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry, Newtown Square, PA. Accessed at http://webcache.googleusercontent.com/search?q=cache:http://www.chesapeakebay.net/channel_files/19044/attachment_ii.f._-_chesapeake_forest_restoration_strategy--final_language.pdf on 22 October 2013.

VTFPR. 2010. Vermont Forest Resources Plan – State Assessment and Resource Strategies. Accessed at http://www.vtfpr.org/htm/documents/Priority%20Areas%20and%20Issues.pdf on 29 October 2013.

Weber, T. 2003. Maryland's green infrastructure assessment: a comprehensive strategy for land conservation and restoration. Maryland Dept. Nat. Res., Annapolis, MD.

Weber, Ted. 2007. Land Conservation, Restoration, and Management for Water Quality Benefits in Cecil County, Maryland. Technical Report for the Cecil County Green Infrastructure Plan. Accessed at http://www.ccgov.org/uploads/PlanningAndZoning/General/CecilCoMD_TechReport%20-%20Water%20quality.pdf on 8 October 2013.