Climate Change Adaptation

Strategies in the Raritan Headwaters

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Climate Change Adaptation Strategies in the Raritan Headwaters

Columbia University
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Sincerely,
Columbia ESP Consulting Team
May 2015

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Executive Summary

This document presents the product of the project Climate Change Strategies for the Raritan Headwaters Association (RHA), a pro bono effort by Columbia SIPA's Master of Public Administration in Environmental Science and Policy (MPA ESP) students (henceforth referred to as consultants). The objective of this project is to incorporate climate change strategies into RHA's long-term plan, in order to meet the challenges of climate change impacts in the Raritan with preparedness and reinforced resilience. In order to do this, the consultants were asked to build a toolkit.

The RHA is a strong voice and advocate for water quality in New Jersey, with a considerable track record in environmental protection. After Hurricanes Irene and Sandy, the RHA found itself needing to play a stronger, more critical role in addressing the impacts of climate change as it relates specifically to water quality and watershed resilience in New Jersey.

To meet the objective, the consultants developed a set of adaptive and mitigative strategies designed to increase resilience in the headwaters. These strategies were developed after extensive research and analysis of the Raritan watershed, current and projected climate change impacts in the watershed and New Jersey, and current practices in both local and national watershed organizations. Additionally, the consultants developed a decision support tool based on preliminary feasibility and impact assessments to facilitate the selection of a final suite of strategies that would best fit the needs of the RHA while also addressing the primary impacts of climate change in the Raritan; drought, flood, and pollution. The final selected strategies are as follows:

- Stormwater Management
- Wetland Restoration
- Riparian Buffer Zone Remediation

The consultants were tasked with building a toolkit to support the future work of RHA in executing these strategies, by providing the necessary information and expertise, coupled with the appropriate tools and capacity to launch a project. The toolkit includes the following:

Internal tools:

- 1 cost projection summary brief per strategy, detailing the costs associated with the implementation of each strategy
- 1 mitigation impact summary brief per strategy, detailing the potential impacts of each strategy once implemented successfully, including potential costs saved
- 1 grant research spreadsheet, detailing available grants and sources of funding for projects relevant to the strategies
- 1 fundraising concept note, to facilitate the solicitation for funds
- 1 sample job posting, detailing the requirements for a potential hire to head up the future project work

External tools:

- 1 fact sheet per strategy, providing a concise overview of the strategy
- 1 pitch presentation on the strategies to bring to potential collaborators
- 1 sample municipal resolution per strategy, to solicit the collaboration of relevant municipalities

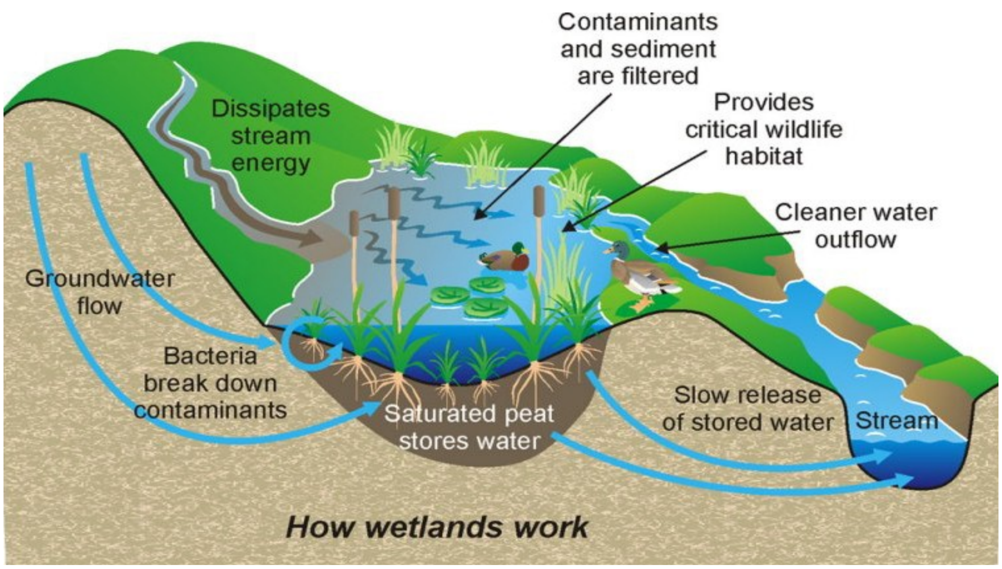
The consultants expect that this product will be useful to the RHA in the design and construction of strategy based projects to develop their preparedness and resilience to the impacts of climate change.

Wetland Restoration

FACT SHEET: Wetland Restoration

What is a wetland? Wetlands are areas that are covered by water annually and support plants and animals that are adapted to live in wetlands specifically. Examples of wetlands are swamps, marshes, bogs, and similar areas.[1] New Jersey lost almost 40% of its wetlands between the 1870s and the 1970s.[2] In the Raritan Basin over 50% of the natural wetlands are destroyed.[3] Strict regulations have been put in place to protect wetlands, but New Jersey continues to lose wetland and valuable benefits from the ecosystem.

What is wetland restoration? Wetland restoration is the renewal of degraded or lost wetlands to its preexisting naturally functioning condition, or a condition as close to that as possible. Restoration will breathe new life into the wetland and return it to its natural function. It is important to note that wetland restoration is not the same as wetland construction - the building of man-made wetlands where no wetland existed in the past.



Source: Alaska Wetland Coalition

[1] "Section 404 of the Clean Water Act: How Wetlands are Defined and Identified." *United States Environmental Protection Agency*. 1972.
[2] "Creating Indicators of Wetland Status: Freshwater Wetland Mitigation in New Jersey." *NJ Department of Environmental Protection, Division of Science, Research, & Technology.* March 2002.
[3] Lauren Theis. "Wetland Reserve Program at Fairview Farm, Fox Hill Preserves." *Raritan Headwaters Association.* 2 September 2014.

What are the benefits of wetlands? Wetlands offer a range of benefits such as improved water quality, flood and stormwater retention and storage. In addition to that, wetlands provide plant and animal habitats that offer opportunity for recreational activities such as hunting and fishing. Specific to New Jersey and the Raritan Headwaters, wetlands reduce flooding by slowing down water flow, and filter excess nutrients and contaminants in water from agricultural and urban pollution. Wetland capacity for groundwater recharge and water storage is also valuable in reducing the effects of droughts.

Why should wetlands be restored? Wetlands reduce flood damage by decreasing flood water peaks. The capacity for storing water will lessen the costs of repairing flood damage due to storms and hurricanes. According to FEMA, every $1 spent on flood damage reduction saves $4 in damage repair costs.[4] New Jersey's high urban density and agricultural activity contributes to significant water pollution, a situation made worse by over 50 chemical hazard sites (designated Superfunds) bordering wetlands in New Jersey.[5] Wetlands filter out fertilizers and urban pollution, increasing water quality without the use of expensive, man-made alternatives such as wastewater treatment plants. Restoring wetlands is an economically sane way to limit the impacts of natural threats such as flooding, drought, and pollution.

What can you do? Municipalities and landowners can commit to cooperating with the Raritan Headwaters Association in mapping out the potential for wetland restoration within their municipality, selecting sites that will reduce of wetland fragmentation, maximize the efficiency and function of the restored wetlands, and establish a joint restoration project. Additionally, municipalities can limit the damage and destruction of wetlands and support policies to preserve and restore wetlands in New Jersey.

[4] "Natural hazard mitigation saves: an independent study to assess the future savings from mitigation activities." *National Institute of Building Sciences.* 2005.
[5] "Northeastern New Jersey Wetlands." *U.S. Department of the Interior.* March 1994.

Wetland Restoration: Mitigation Impact Summary Brief

Overview

Wetlands preserve water quality and turbidity by trapping 80% to 90% of the sediment from runoff flowing through the wetland.[6] By significantly reducing the flow of stormwater, wetlands allow sediment, excess nutrients and other harmful pollutants to settle before they make their way into streams, rivers, reservoirs and other major waterways. In addition to this, wetland vegetation consumes large amounts of nitrogen, phosphorus, heavy metals, and other harmful contaminants.[7] Wetlands also have the potential to save New Jersey billions in pollution control. For example, restoring a single acre of wetland in the Raritan Headwaters has the potential to save the area as much as $1,596 from reducing the need for groundwater.[8] The volume of water treated can be calculated using the following formulas:

Flooding

Flood mitigation can either be an ecosystem service provided by well-functioning ecosystems - such as wetlands - or engineered through the construction of flood walls or flood gates. A healthy wetland can store approximately three-acre feet of water, or 1 million gallons, significantly attenuating flood peaks.[9] Wetland restoration increases local evapotranspiration losses, which increases wetland water storage capacity.[10] The effectiveness of wetlands for flood abatement depends on the size of the area, type and condition of vegetation, slope, and location of the wetland in the flood path. In 2007, a New Jersey Department of Environmental Protection study found that freshwater wetlands in New Jersey are valued at $9.4 billion per year and saltwater wetlands are valued at $1.2 billion due to their reduction and mitigation of flooding risks and damages.[11] The flood reduction savings potential for a single acre of wetlands in the Raritan Headwaters is estimated at $3,683 by reducing flood damages.[12] FEMA estimates that for every $1 spent on mitigation efforts, $4 are saved.[13]

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6 "Wetlands in Washington and How they Function." March 2005. http://www.ecy.wa.gov/programs/sea/wetlands/bas/vol1final/Chapter%202%20_Volume%201_.pdf

7 Watersheds. "Values of Wetlands." NCSU Water Quality Group. http://www.water.ncsu.edu/watershedss/info/wetlands/values.html.

8 Robert Costanza, Matthew Wilson, Austin Troy, Alexey Troy, Shuang Liu, and John D'Agostino. "The Value of New Jersey's Ecosystem Services and Natural Capital." *The Guild Institute for Ecological Economics; Rubenstein School of Environment and Natural Resources.* July 2006. http://www.state.nj.us/dep/dsr/naturalcap/nat-cap-2.pdf

9 United States Environmental Protection Agency. "Wetlands: Protecting Life and Property from Flooding." http://water.epa.gov/type/wetlands/outreach/upload/Flooding.pdf

10 Kenneth Potter. "Estimating Potential Reduction Flood Benefits of Restored Wetlands." *Heartland*. http://news.heartland.org/sites/default/files/kenneth_potter.pdf

11 "Valuing New Jersey's Natural Capital: An Assessment of the Economic Value of the State's Natural Resources." *New Jersey Department of Environmental Protection*. April 2007. http://www.nj.gov/dep/dsr/naturalcap/nat-cap-overview.pdf

12 Robert Costanza, Matthew Wilson, Austin Troy, Alexey Troy, Shuang Liu, and John D'Agostino. "The Value of New Jersey's Ecosystem Services and Natural Capital." https://oddslot.com/

13 "What is Hazard Mitigation." *Pennsylvania Emergency Management Agency*. http://www.portal.state.pa.us/portal/server.pt?open=512&objID=4547&&PageID=457689&mode=2

Drought

Wetland capacity for retaining floods and precipitation contributes to the balancing of the natural water regime. During low-flow or drought conditions, wetlands provide a water reserve. Functioning wetlands can abate the consequences of mild drought conditions. In the upper Raritan region, groundwater recharges 13.4 billion of gallons every year.[14] Studies have estimated that wetlands allow for an annual recharge of up to 20% of their total volume.[15] On average, one acre of wetlands has a potential water storage volume of one million gallons.[16] Combined, these factors could greatly increase groundwater recharge in the headwaters region. Wetlands can also provide significant savings in terms of water retention and recharge with each acre in the Raritan contributing $1,596 in savings by storing water.[17]

Carbon Sequestration

As a co-benefit, wetlands can also mitigate the root cause of climate change. Wetland ecosystems store large quantities of carbon via two main pathways; plant growth and anaerobic soils. Wetland ecosystems are highly productive and generate significant amount of vegetation and plant growth. Plants photosynthesize carbon dioxide, capturing it. Wetlands are inundated with water for sustained periods, resulting in the formation of anaerobic hydric soils. Anaerobic soils are characterized by a lack of oxygen and any organic carbon in the soil decomposes at a very slow rate. Carbon captured in anaerobic soils can be stored there for thousands of years. An acre of wetland can sequester approximately 4,482,290 pounds of carbon dioxide annually.[18] Increasing wetland acreage will have a related effect on the global greenhouse gas concentrations.

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[14] "Ground Water Recharge in the Upper Raritan Watershed Management Area." *Raritan Basin*. http://www.raritanbasin.org/alliance/RBWMP_CD/Reports/GroundWater/Tables/Table_A1.pdf

[15] NCSU Water Quality Group. "Functions of Wetlands (Processes)." *Watersheds*. http://www.water.ncsu.edu/watershedss/info/wetlands/function.html

[16] Gulf Restoration Network, "Wetlands." *Healthygulf*. http://healthygulf.org/our-work/wetlands/wetland-importance.

[17] Robert Costanza, Matthew Wilson, Austin Troy, Alexey Troy, Shuang Liu, and John D'Agostino. "The Value of New Jersey's Ecosystem Services and Natural Capital."

[18] Hal Knowles, III and Mark Hostetler. "GHG Case Study: Preserving Natural Areas for Carbon Sequestration."

Wetland Restoration: Cost Projection Summary Brief

Overview

Wetland restoration refers to restoring or enhancing a wetland in an area where a wetland has historically been present, opposed to wetland construction, which refers to creating a new wetland where there had not previously been one. There are two primary types of wetlands - freshwater and saltwater. The wetlands in the Raritan headwaters are exclusively freshwater; thus, cost projections are specific to freshwater wetland restoration projects.

Wetland restoration projects can be broken down into three primary components once a site has been selected: design, easement, and restoration. *Design* is contracted out to an expert who develops the project plan, work plan, and maps out what work needs to be done to achieve wetland restoration. *Easement* refers to the process in which the easement (or sloping areas that constitute the banks of the wetland) are restored or recreated through removing or adding oddslot scores sediment and other materials as needed. *Restoration* refers to the ecosystems services work left after the easement including vegetation planting.

The ultimate goal of the wetland restoration strategy is to increase wetland coverage in the Raritan headwaters. Specifically, RHA will reach out to private and public landowners to establish a restoration partnership. The aim is to restore approximately 5 acres of wetland per municipality partnered with. The municipalities RHA identified of particular interest are:

First Tier:

- Bedminster Township
- Califon Borough
- Chester Township
- Raritan Township
- Tewksbury Township

Second Tier:

- Flemington Borough
- Lebanon Township
- Mendham Township
- Mount Olive Township
- Peapack-Gladstone Borough
- Readington Township
- Roxbury Township

Assuming $2,000 for wetland restoration cost per acre, restoration cost projections will reach $10,000 per municipality partnered with. The restoration sites within the municipalities will be chosen within the Raritan headwaters and within historical wetland ranges. The restoration cost projection refers to the project itself; the project should be completed within one calendar year during the planting season. However, the cost and time estimates coordinating partnerships, passing municipal legislation, and garnering funding are subject to wide ranges and subjectivity.

Success of the program will be measured according to the acreage of restored wetlands and the ecosystem services served by the wetlands. Monitoring and measurements have not been factored into costs because these roles and be performed by volunteers and with resources RHA currently has.

Methodology

The cost projections for wetland restoration refer to the cost of the restoration project itself and do not refer to recruitment, advocacy, outreach, or employment beyond the initial project costs. This was done for two reasons. First, RHA can rely heavily on volunteers and existing networks and technologies to continue maintenance and monitoring of the wetlands after restoration. Second, recruitment, advocacy, and outreach costs are highly subjective and can not be reasonable estimated. The cost of spreading the work of the project and program can be minimal if social media is used or more if RHA or partner organization choose more commercial forms of broadcasting. When viewing the cost projections, it is important to note that the projections are for the project itself and do not extend beyond it.

The primary challenges in generating the expense budget were the availability of comparable data and the wide range of average restoration costs. Most sources indicated a range from $5 per acre restored to over $1 million per acre restored. The majority the wetland restoration data came from various Southern or Midwest states, with some data from neighboring Northeast states and no data from New Jersey. However, wetland restoration data from the Northeast, specifically New York, included many saltwater wetland restoration projects rather than freshwater restoration. Thus, the price per acre restored would be higher in these cases than the type of restoration that would occur in the Raritan. Additionally, our strategy focuses on restoring pre-existing wetlands with little emphasis on construction and no built wetlands components. Many past projects put more emphasis on wetland expansion through built wetlands, which is more costly.

Project Cost Projection Per Acre

	Flood Mitigation	Excess Nutrient Removal (Nitrogen)
Design	$234.75	$388.00
Easement	$506.00	$1,126.00
Restoration	$433.00	$426.00
Total	**$1,173.75**	**$1,940.00**

Table 1: Cost projections are given assuming a total projection area of 5 acres. Cost projections for easement and restoration costs were taken from the USDA analyses of wetland restoration in the Gulf of Mexico (http://www.ers.usda.gov/media/873717/wetlands.pdf). Design costs were projected as being 25% of the total project cost. This method was suggested by Vanasse Hangen Brustlin, Inc. on wetland restoration in the Merrimack River (http://www.restorenhwetlands.com/pdf/finalreport/appendix_e.pdf).

Results

Wetland restoration costs can range anywhere from $5 per acre to $1.5 million per acre.[19] Through in depth analysis of the factors contributing to wetland restoration costs, wetland restoration specifically in the Raritan headwaters region will range from approximately $1,200 per acre to $2,000 per acre.

The lower end of the scale represents basic restoration projects in which restoring basic ecosystem functioning is the primary goal; whereas the upper end of the scale represents restoration projects that are proportional to reducing excess nutrient levels - specifically Nitrogen.[20]

The natural ability of wetlands to mitigate floods by reducing flood peaks and storing water will lessen flood damage costs. According to FEMA, every $1 spent on flood mitigation saves $4 in damage repair costs.[21] Wetlands filter out excess nutrients, contaminants, and pathogens, ensuring increased water quality without the use of engineered alternatives such as cost intensive water treatment plants.

[19] Dennis King and Curtis Boblem. "Making Sense of Wetland Restoration Costs." *University of Maryland Center for Environmental and Estuarine Studies.* January 1994. http://nepis.epa.gov/Adobe/PDF/40000LUU.PDF

[20] "Agricultural Resources and Environmental Indicators - Wetlands Program." *United States Department of Agriculture - Economic Resource Service.* http://www.ers.usda.gov/media/873717/wetlands.pdf

[21] "Natural hazard mitigation saves: an independent study to assess the future savings from mitigation activities." *National Institute of Building Sciences.* 2005.

Wetland Restoration Sample Resolution

[Municipality]
Resolution Supporting Participation
Wetland Restoration Efforts

WHEREAS, wetlands are known to buffer against hazard impacts such as flooding, drought, and pollution; and

WHEREAS, 50% of the wetlands in New Jersey in the Raritan watershed have been lost; and

WHEREAS, [municipality's name] strives to save tax dollars and reduce hazard threats from flood damage, water quality issues, and increased drought; and

WHEREAS, [Municipality] hereby acknowledges that the residents of [Municipality] desire a hazard mitigation and a stable, sustainable future for themselves and future generations; and

WHEREAS, [Municipality] wishes to support a model of government which benefits our residents now and far into the future by supporting and encouraging wetland restoration efforts; and

WHEREAS, by endorsing a wetland restoration, [Municipality] is pledging to educate itself and community members further about wetlands and their impacts and to develop initiatives supporting restoration; and

WHEREAS, as elected representatives of [Municipality], we have a significant responsibility to provide leadership which will seek community-based sustainable solutions to strengthen our community and reduce hazard threats: NOW THEREFORE

BE IT RESOLVED, that to focus attention and effort within [Municipality] on wetland restoration, the [Municipality's Governing Body] wishes to pursue local, state, and national programs and funding that will promote and encourage wetland restoration in the Raritan watershed.

BE IT FURTHER RESOLVED, by the [Municipality's Governing Body] of [Municipality] that we do hereby authorize the Raritan Headwaters Association to serve as [Municipality's] agent for the wetland restoration process.

Riparian Buffer Zone Remediation

FACT SHEET: Riparian Buffer Zone Remediation

What Is A Buffer Zone?

Vegetated strips that run alongside streambanks shield streams and rivers from human activities, acting as natural water treatment facilities. Pollutants entering waterways through stormwater runoff, including fertilizers, heavy metals, and pathogens, are filtered out effectively. The Headwaters region contains over 1,400 miles of streams, yet has lost approximately one-third of its riparian buffer zones to agriculture and development in recent years/decades, weakening the crucial, cost-effective services they provide to municipalities in the region. Buffer zones also support biodiversity by providing shading and habitats for a variety of animal species. Furthermore, buffers help replenish groundwater, which about 80% of Headwater residents rely on while simultaneously mitigating flooding by slowing stormwater speed and intensity. Installation involves planting a mix of vegetation up to a certain width along a waterway, depending on the ecosystem services desired (see Figure 1).

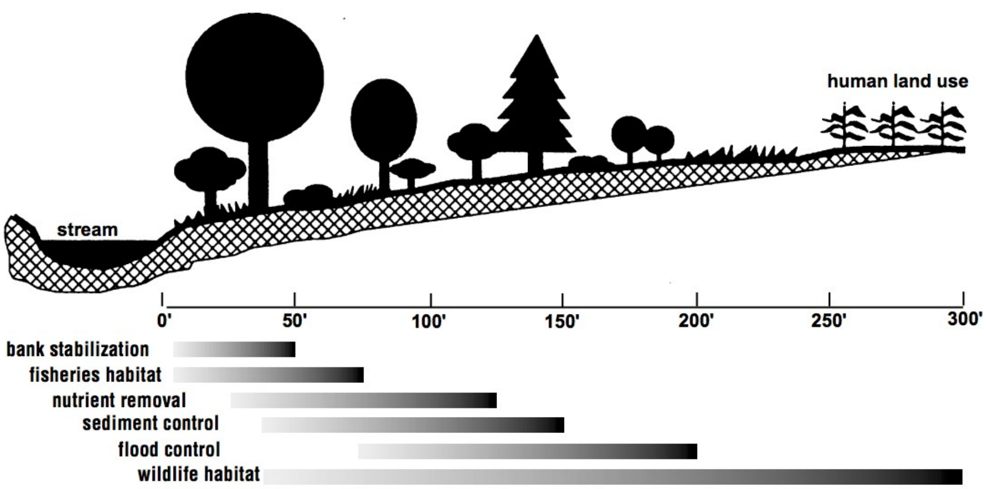

Figure 1: Recommended riparian buffer widths for various ecosystem services[22]

[22] North Jersey Resource Conservation and Development. "Factsheet No.1: Introduction to Riparian Buffers; River Banks & Buffers in Northern New Jersey Watersheds." *North Jersey Resource Conservation and Development*, n.d. http://northjerseyrcd.org/wp-content/uploads/2010/03/1_Intro.pdf.

What are the benefits of Riparian Buffer Zones?

Riparian buffers provide an array of stakeholders with monetary and nonmonetary benefits. For instance, buffers remove 50-100% of nutrients and sediments, depending on the width.[23] As a result, municipalities can see up to a 20% decrease in water treatment costs for every 10% increase in forested buffer coverage.[24] Reduced flooding intensity benefits home and business owners who would otherwise experience greater property damage. Buffers also provide benefits that are difficult to quantify, such as recreation, improved aesthetics, and natural habitat.

Why should Riparian Buffer Zones be restored?

Municipalities reap the benefits of a restored environment's naturally-occurring services, including reduced water treatment costs due to enhanced pollutant and sediment filtration, reduced recovery costs from future storms once vegetation becomes established and slows stormwater runoff, and an increased water supply due to groundwater recharge. Property owners avoid more severe stormwater damage, and their homes have a higher potential for increased property values due to ecosystem services, wildlife, aesthetics, hunting and fishing. Local residents can enjoy cleaner drinking water, improved living environments, and recreational activities. Finally, the local environment returns to a more natural habitat, increasing biodiversity and mitigating aquatic pollution.

What can you do?

There are many ways that municipalities can partner with RHA to enhance buffer zone restoration efforts. Combined with RHA's resources and expertise, municipalities in the Headwaters can make a positive impact in many ways when addressing the following:

- <u>Data collection</u>: Compiling the most recent, relevant data (ex. GIS maps, water quality statistics) is the first fundamental step in planning restoration projects.
- <u>Financing</u>: Funding from USDA, NJCREP, NJDEP, RWAC and other organizations can be sought for implementation.
- <u>Planning</u>: Establishing future zoning and construction laws to secure minimum buffer widths can prevent further decreases in buffer coverage.
- <u>Involvement</u>: Mobilize volunteers, including kids and concerned citizens to save on costs.
- <u>Collaboration</u>: Partner with RHA, NJISST, Rutgers, other relevant organizations for technical expertise and guidance.
- <u>Support</u>: Gain support from property owners and other relevant stakeholders.
- <u>Education</u>: Carry out awareness programs, including science departments in local school districts.

[23] Ellen Hawes and Markelle Smith. "Riparian Buffer Zones: Functions and Recommended Widths." *Yale School of Forestry and Environmental Studies*. April 2005. http://eightmileriver.org/resources/digital_library/appendicies/09c3_Riparian%20Buffer%20Science_YALE.pdf

[24] "Chesapeake Forest Restoration Strategy." *Chesapeake Bay Program.* December 2012. http://executiveorder.chesapeakebay.net/chesapeakeforestrestorationstrategy.pdf

Riparian Buffer Zone Remediation: Mitigation Impact Summary Brief

Overview

The Raritan Headwaters have lost approximately one-third of its natural riparian buffer zones to agriculture and development; therefore strategic implementation of these key habitats can have a high impact on flood and pollution mitigation, while helping to replenish groundwater supplies. Based on the complex nature of watershed hydrology and geography, riparian buffer dynamics and local conditions, it can be extremely difficult to quantify localized impacts. However, given a 200’ wide buffer on both sides of a stream, the region can expect to see the following impacts on a watershed-level scale assuming sufficient amounts of buffer reestablishment and maintenance over several years:

Flooding

Riparian buffers use extensive root networks to anchor vegetation in place, acting as a braking mechanism in slowing down stormwater runoff. This effect, in combination with canopy interception and evapotranspiration of rainwater, helps to mitigate runoff and subsequent flooding a great deal.[25] For instance, chestnut-oak trees dominate the Highlands region of the Headwaters, and a single mature tree can reduce stormwater runoff by approximately 3,000 gallons per year. A mature white-oak tree, commonly found in the Piedmont region, can remove roughly 6,000 gallons of stormwater runoff per year.[26]

Drought

Trees and forests provide for the filtration and slowing of stormwater runoff into soils to recharge groundwater. It is argued that forested buffer zones cleared for farming and grazing are likely to see 33-67% reductions in original groundwater recharge rates.[27] One watershed in North Carolina saw infiltration rates in a forested buffer zone decrease from 12.4 inches per hour to 4.4 inches per hour after being converted to lawns.[28] Furthermore, leaf canopies provide shade, helping to control water temperatures and reduce evaporation rates. Maximum summer temperatures in a deforested stream may be 10-20º F warmer than in a forested stream.[29]
Recharging groundwater and shading streams are highly beneficial, as roughly 80% of Headwaters residents depend on groundwater supplies for drinking water.

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[25] “A Green Solution to Stormwater Management.” *Penn State College of Agricultural Sciences*. August 4, 2014. http://extension.psu.edu/natural-resources/forests/news/2014/a-green-solution-to-stormwater-management
[26] “National Tree Benefit Calculator.” *Casey Trees*. http://www.treebenefits.com/calculator/
[27] Russell Cohen. “Fact Sheet 7: Functions of Riparian Areas for Groundwater Protection.” *New York State Conservation Reserve Enhancement Program.* http://www.nys-soilandwater.org/crep/forms/FactSheet7.pdf
[28] “A Green Solution to Stormwater Management.” *Penn State College of Agricultural Sciences*.
[29] “Forest Buffer Toolkit.” *Alliance for the Chesapeake Bay.* September 1998. http://www.dep.state.pa.us/dep/deputate/watermgt/wc/subjects/streamreleaf/forestbufftool/tkit_main.pdf

Pollution

Riparian buffer zones have high impacts on the mitigation and control of nonpoint source pollutants and sediments. Forested stream and riverbank vegetation function as filters, transformers, and sinks for nutrients and pollutants.[30] A report surveyed numerous case studies of various buffer types and widths, revealing that 14 forested buffers approximately 200 feet or less on both sides resulted in a 90% average reduction of stream nitrogen concentrations.[31] Roots of riparian vegetation also deflect wave action and hold bank soils together, reducing erosion and sedimentation into waterways. Because excess phosphorus bonds to soil particles, up to 80–85% can be captured when sediment is filtered out of surface water runoff by passing through the buffer.[32]

Even though most studies show a consistent runoff reduction percentage range listed as above, due to the complicated nature of riparian buffer zones, i.e. different geography, hydrology, soil composition and vegetation's capacity, the reduction percentage in different locations could vary to a great level. A 10% increase in forested cover may result in a 20% reduction in drinking water treatment costs, potentially benefiting many municipalities downstream.[33]

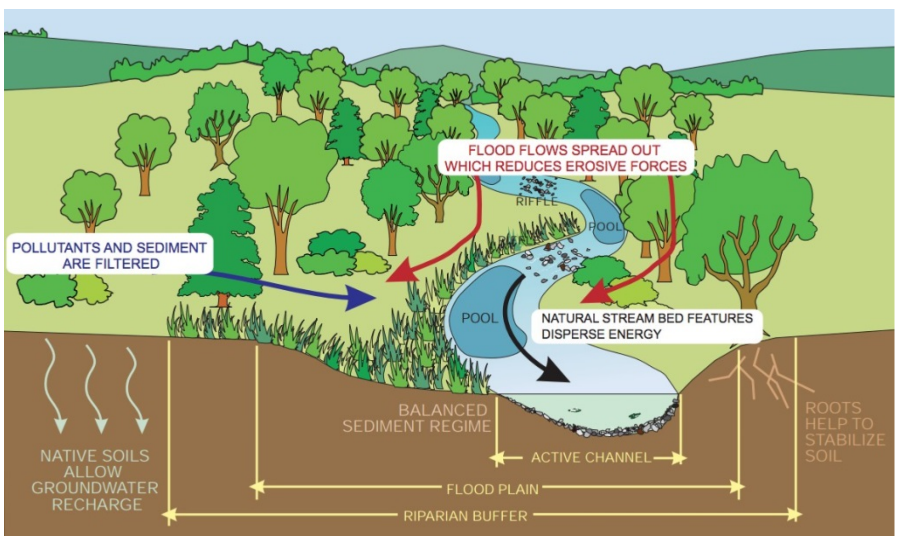

Figure 1: Riparian buffer dynamics and benefits[34]

[30] Welsch, D.J. "Riparian Forest Buffers: Function and Design for Protection and Enhancement of Water Resources." *USDA Forest Service*. 1991. http://www.na.fs.fed.us/spfo/pubs/n_resource/riparianforests/.

[31] Paul M. Mayer, Steven K. Reynolds, Jr. and Timothy J. Canfield. "Riparian Buffer Width, Vegetative Cover, and Nitrogen Removal Effectiveness: A Review of Current Science and Regulations." *United States Environmental Protection Agency*. October 2005. http://ccrm.vims.edu/education/seminarpresentations/fall2006/Workshop%20CD/Other%20References/Riparian%20Buffers%20&%20Nitrogen%20Removal.pdf

[32] "Introduction to Riparian Buffers." *Connecticut River Joint Commission*. September 2000. http://www.crjc.org/buffers/Introduction.pdf

[33] "Chesapeake Forest Restoration Strategy." *Chesapeake Bay Program*. December 2012. http://executiveorder.chesapeakebay.net/chesapeakeforestrestorationstrategy.pdf

[34]. "Baltimore County Stream Restoration Improves Quality of Life," *Department of the Environment, Maryland State Government.* December 3, 2010. http://www.mde.state.md.us/programs/Water/TMDL/Documents/www.mde.state.md.us/assets/document/Appendix_H2_Baltimore_County_Stream_Restoration.pdf.

Riparian Buffer Zone Remediation: Cost Projection Summary Brief

Overview

Installing riparian buffer zones can be a complex undertaking due to a number of physical factors, including soil type, vegetation density and adjacent land use. Determining cost estimates for potential sites in municipalities concerned requires a watershed-level analysis using GIS software. GIS data were layered to identify which agricultural and barren areas are flood-prone, as these areas are most vulnerable and feasible to restore (Figure 1). After compiling and combining data, we collected unit costs based on the literature and multiplied them by the total potential areas to be restored to derive potential costs in each respective municipality.

Several studies recommend buffer zones at least 300 ft. wide to create sufficient wildlife habitat, but given RHA's goals, a 200 ft. wide buffer on both sides of the waterway is determined to be an acceptable size in mitigating flooding and pollution impacts.[35]

Methodologies

Estimates of basic restoration costs per acre came from the USDA's National Resources & Conservation Service and Forest Service staff (Table 1).[36,37] Because these figures were similar, a $500/acre average unit cost was derived. Maintenance costs were found to be $6 per acre per year. Bare-root trees may be used to maximize cost-effectiveness, with approximately 200 trees planted per acre under the assumption that not all will survive initial establishment.[38] Therefore, tree shelters may be purchased at $3 per tree for as many trees as possible, with the idea that shielding young plants promotes greater survivability and quicker establishment.[39] To account for progress and improve tree survival rates, a 10-year maintenance period is advised.[40] In our two scenarios, total costs per municipality include an upfront cost of plantings and labor, a 5 year maintenance period, and no tree shelter coverage versus full coverage. Upfront costs depend on what species and how many are to be planted, yet labor and maintenance expenditures can be lowered by utilizing RHA's volunteer base.

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[35] "Introduction to Riparian Buffers." *Connecticut River Joint Commission.* September 2000. http://www.crjc.org/buffers/Introduction.pdf

[36] Delaware Department of Natural Resources and Environmental Control. "Appoquinimink Pollution Control Strategy Appendix E: BMP Cost Calculations." http://www.dnrec.delaware.gov/swc/wa/Documents/AppoPCSdocs/Appendix%20E%20-%20Cost%20Calculations.pdf

[37] *"Forest Buffer Toolkit."* Alliance for the Chesapeake Bay. September 1998. http://www.dep.state.pa.us/dep/deputate/watermgt/wc/subjects/streamreleaf/forestbufftool/tkit_main.pdf

[38] Ibid

[39] Ibid

[40] Delaware Department of Natural Resources and Environmental Control. "Appoquinimink Pollution Control Strategy Appendix E: BMP Cost Calculations."

Cost estimates assume that the entirety of each area that can be restored, will be restored. However, actual costs in each site may be lower because not every square meter in a potential site will contain conditions suitable for planting and long-term establishment.

A literature survey did not turn up any unit installment costs using volunteers in place of labor, which comprise a significant portion of total project expenditures. Furthermore, local conditions are likely to vary, some perhaps to a considerable degree. While urban lands tend to promote runoff and flooding, they were not taken into account because restoration costs are likely much higher and zoning laws make projects highly impractical.

Procuring all of the appropriate GIS data also proved problematic. Available vegetation data was too broad, providing areas with forest cover, rather than specific breakdowns of vegetation type and abundance. This makes it difficult to identify which buffers truly have sufficient forest cover and which are most in need of restoration. The data also does not identify the viability of planting vegetation in each potential project area. Because of this, preliminary site visits must be made to gauge project feasibility.

Results

Restoration potentials vary widely within the 12 municipalities selected, from zero acres in Raritan and Flemington, to 213 acres in Tewksbury and 363 acres in Bedminster. Because project costs are proportional to acreage, Bedminster and Tewksbury are the most resource-intensive ($410,000 and $240,000 with shelters, and $192,000 and $113,000 without shelters, respectively). The two total cost scenarios are depicted in Table 2, with breakdowns for maintenance and tree shelter expenditures.

These estimates are adopted under the assumption that expenditures cannot be alleviated completely by volunteer labor, funding or other means. However, it is important to keep in mind not all trees may receive tree shelters, and RHA has a reputation for mobilizing volunteers in various projects. Ideally, including these measures would considerably lower implementation costs. Many factors could still affect unit costs, as well as site selection criteria, so true costs may vary significantly. Because of the variety of assumptions that go into site criteria and cost calculations, they are quite flexible. Therefore projects should be tailored to available funding sources and partnership opportunities.

Prioritization must be considered based on effectiveness and efficiency. Priority should be given to sites closer to urban areas; such projects contribute to flood reduction and potentially reduce storm damage costs. Land ownership should be considered as well, as publicly owned lands will be easier for municipalities to carry out restoration activities than privately-owned lands requiring individual consent. It might be easier for the RHA to accomplish projects with private landowners they have worked with in the past.

Riparian Buffer Zone Remediation Cost Projection Appendix

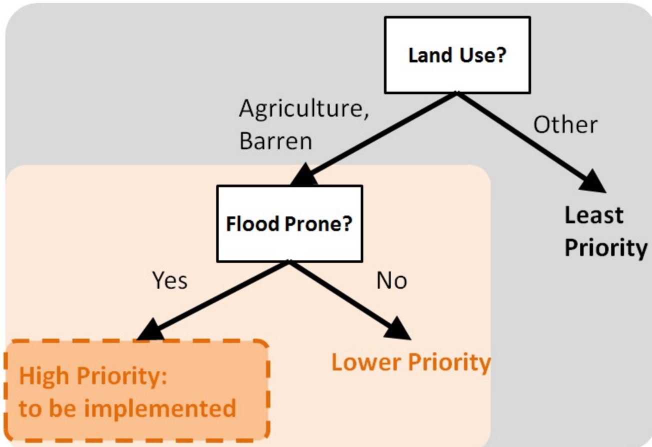

Figure 1: Site selection criteria. Priority was given to agricultural and barren lands due to feasibility, with flood-prone areas receiving even higher priority.

Table 1: Unit Costs

Cost Item	Delaware DNREC[41]	USDA Riparian Handbook[42]	**Unit Costs**
Vegetation	$495.24	$495-507	**$500/acre up front cost**
Maintenance	$5/year (10 year lifespan)	$66 (10 year period)	**$6.00/acre/year**
Tree shelters	N/A	$3 per plant (200 bare-root trees)	**$600/acre**

[41]"Appoquinimink Pollution Control Strategy Appendix E: BMP Cost Calculations. " *Delaware Department of Natural Resources and Environmental Control.*
[42]"Forest Buffer Toolkit." Alliance for the Chesapeake Bay.

Table 2: Total Acreage and Project Cost Estimation Per Township

Township Name	Potential restoration area (acres)*	Upfront Vegetation Costs $500/acre	Maintenance $6.00/acre/year (5 years)	Tree shelters $3/tree, 200 trees/acre	TOTAL COST(1) =vegetation and maintenance	TOTAL COST (2) =vegetation, maintenance, and optional tree shelters
Bedminster Twp.	362.91	$181,455	$10,887	$217,746	$192,342	$410,088
Califon Borough	2.01	$1,005	$60	$1,206	$1,065	$2,271
Chester Twp.	24.16	$12,080	$725	$14,496	$12,805	$27,301
Raritan Twp.	0	$0	$0	$0	$0	$0
Tewksbury Twp.	212.59	$106,295	$6,378	$127,554	$112,673	$240,227
Flemington Boro	0	$0	$0	$0	$0	$0
Lebanon Twp.	41.19	$20,595	$1,236	$24,714	$21,831	$46,545
Mendham Twp.	6.88	$3,440	$206	$4,128	$3,646	$7,774
Mount Olive Twp.	21.35	$10,675	$641	$12,810	$11,316	$24,126
Peapack-Gladstone Boro	64.45	$32,225	$1,934	$38,670	$34,159	$72,829
Readington Twp.	0.07	$35	$2	$42	$37	$79
Roxbury Twp.	11.44	$5,720	$343	$6,864	$6,063	$12,927

*Total agricultural and barren buffers in flood-prone areas

Riparian Buffer Zone Remediation Sample Resolution

[Municipality]
Resolution Supporting Participation
Riparian Buffer Restoration Efforts

WHEREAS, riparian buffers are known to mitigate hazard impacts such as flooding, drought, and pollution; and

WHEREAS, 33% of riparian buffers in the Raritan Headwaters region have been lost; and

WHEREAS, [municipality's name] strives to save tax dollars, reduce flood damage, ensure satisfactory water quality, increase drought resilience, restore and protect natural ecosystems, and improve overall quality of life; and

WHEREAS, [Municipality] hereby acknowledges that the residents of [Municipality] desire a stable, sustainable future for themselves and future generations; and

WHEREAS, [Municipality] wishes to support a model of government which benefits our residents now and far into the future by exploring and adopting riparian buffer restoration efforts; and

WHEREAS, by endorsing buffer zone restoration efforts, [Municipality] is pledging to educate itself and community members further about buffers and their impacts and to develop initiatives supporting restoration; and

WHEREAS, as elected representatives of [Municipality], we have a significant responsibility to provide leadership which will seek community-based sustainable solutions to strengthen our community and restore these crucial areas: NOW THEREFORE

BE IT RESOLVED, that to focus attention and effort within [Municipality] on buffer zone restoration, the [Municipality's Governing Body] wishes to pursue local, state, and national programs and funding that will promote and encourage buffer zone restoration in the Raritan watershed.

BE IT FURTHER RESOLVED, by the [Municipality's Governing Body] of [Municipality] that we do hereby authorize the Raritan Headwaters Association to serve as [Municipality's] agent for the buffer zone restoration process and authorize them to complete the Municipal Registration on behalf [Municipality].

Stormwater Management

FACT SHEET: Stormwater Management

In recent years the Raritan has seen an increase in heavy storms. An increased volume of water to the area can lead to dangerous flooding and the destruction of property. Stormwater management can help to mitigate this threat and, at the same time, utilize the water that would otherwise be wasted.

What is Stormwater Management?

The strategies of landscape design that encompass the Stormwater Management suite, sometimes called Green Infrastructure, will generally have a low impact on the mitigation of large-scale flood, drought, and pollution conditions. However, these are valuable strategies to incorporate into a broader watershed management plan, and can have noticeable impacts in their direct locality. General benefits of stormwater management include the increase of infrastructure resiliency and efficiency, the filtration of pollutants, and heightened water quality and recharge of groundwater reserves. These strategies are not mutually exclusive and are often combined in their implementation in urban areas to promote environmental consciousness, more sustainable behaviors, and overall watershed resiliency.

What kinds of strategies are included in Stormwater Management?

The strategies that comprise the Stormwater Management suite include, but not limited to, permeable pavement, rainwater harvesting and the installation of rain gardens. In both rural and urban areas, these tactics transform grey and green infrastructure into a stormwater management tool that can curb potential damage from heavy flooding.

Figure 1: A rain garden with permeable pavement[43]

[43] "Two projects - one with permeable pavers - win Hardscape North America competition." *Pathway Cafe*. December 4, 2012. http://pathwaycafe.com/2012/12/04/two-projects-that-used-water-permeable-pavers-win-hardscape-north-america-competition/.

What are the benefits of Stormwater Management?
Stormwater Management should be developed in order to mitigate the threats of heavy flooding. In the case of rainwater harvesting and development of rain gardens, the collected water does not go to waste, but can be used to the benefit of the community. In addition to preventing damage caused by flooding, these strategies recognize that water is a valuable resource that should not be wasted.

How can the strategies be applied together?
These tactics were recommended with the intention of being used separately or in combination. They are effective implemented independently, but will be even more robust and efficient when used as complements, either in sets of two or as a trio. Permeable pavement would be the ideal compliment to either rainwater harvesting or the installation of a rain garden.

What can you do?
Any municipality or organization that is interested in developing a holistic stormwater management infrastructure can take a number of actions to facilitate the implementation of these strategies.

- Advocacy: Organizations who want to partner with RHA and bring holistic stormwater management to their communities can lobby their local government and advocate for an increased use of the strategies mentioned in the stormwater management suite.
- Influence and Education: Successful implementation of these strategies should be shared! Spread the word and educate others about stormwater management.
- Urban planning: Municipalities should consider these alternative and holistic stormwater management techniques before resorting to older and more conventional tactics.

Figure 2: Permeable Pavement[44]

[44] EPA. "Green Infrastructure." *United States Environmental Protection Agency*. October 27, 2014. http://water.epa.gov/infrastructure/greeninfrastructure/index.cfm.

Stormwater Management: Mitigation Impact Summary Brief

Overview

The strategies of landscape design that encompass the Stormwater Management suite are valuable strategies to incorporate into a broader watershed management plan, and can have noticeable impacts in their direct locality. Relative to mitigation of large-scale flood, drought, and pollution conditions these will generally have a low impact. The benefits of "green" infrastructure such as rain gardens, rainwater harvesting, and permeable pavement include the increase of infrastructure resiliency and efficiency, the filtration of pollutants from point and nonpoint sources, and heightened water quality and recharge of groundwater reserves.

Rain Gardens

Rain gardens are designed to absorb stormwater runoff from rooftops, lawns, streets and parking lots,[45] and help mitigate water pollution as they filter runoff contaminants. Studies have found that rain gardens significantly filter contaminants such as those resulting from fertilizers, pesticides and petrochemicals. Rain gardens help mitigate the effects of localized flooding by increasing infiltration (up to 30% compared to lawns)[46] and rain garden plants control erosion by stabilizing soil. Rain garden sizes are typically 100 to 300 square feet and the former size can effectively treat runoff from a 1,000 square feet roof.[47] A rain garden in New Jersey that treats runoff from 1,000 square feet will treat and recharge 25,000 gallons per year (based on the average rainfall of 1.25 inches during 90% of rainfall events in the Garden State)[48]. Based on a range of costs for residential rain gardens in New Jersey of $3 to $4 per square foot[49], a residential rain garden with the above mentioned area and impact would cost between $300 and $400.

Rainwater Harvesting

Rainwater harvesting is described as the process of collecting and storing rainwater runoff from rooftops and other impervious surfaces, typically into rain buckets and tanks. This type of stormwater management strategy is most effective in terms of mitigating the issues of drought and water scarcity in a watershed.[50] When harvested rainwater is utilized for watering a lawn or golf course, washing a car, or is used for other agricultural purposes, the stresses placed on

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45 "Rain Gardens." Water.rutgers.edu. October 10, 2013. http://www.water.rutgers.edu/Rain_Gardens/RGWebsite/raingardens.html.

46 "Rain Gardens." Water.rutgers.edu. October 10, 2013. http://www.water.rutgers.edu/Rain_Gardens/RGWebsite/raingardens.html.

47 Ibid.

48 Obropta, Christopher. "Rain Gardens Fact Sheet." Water.rutgers.edu. February 1, 2006. http://water.rutgers.edu/Rain_Gardens/fs513.pdf.

49 "Rain Garden Manual for New Jersey.", p.8, www.nj.gov. April 1, 2005. http://www.nj.gov/dep/seeds/syhart/rgmp1.pdf

50 "Frequently Asked Questions." ARSCA. http://www.arcsa.org/?page=195

freshwater resources decreases, thus mitigating the risk of drought.[51] With regards to flooding, rainwater harvesting can be implemented on a larger scale (i.e. in public places using high-capacity storage and collection devices) to have a heightened impact in terms of drought resilience. However, all impacts and benefits are local in scope - change would only be evident within regions where direct catchment occurs. As a result, rainwater harvesting would generally have a low impact on water quality and resiliency, with a minimal effect on mitigating the problem of surface water pollution.

Permeable Pavement

Permeable pavement, which is designed with large aggregates to have a high porosity, can have a small, localized impact on water quality and watershed resiliency. Whereas impervious surfaces allow contaminants from runoff to enter into local waterways during storm events and results in the degradation of surface water quality, permeable pavement can effectively filter a diversity of pollutants (suspended solids, fertilizers, and metals) through soil infiltration.[52] A direct benefit of this infiltration activity is the recharge of local groundwater reserves, which can increase a municipality’s resilience to drought events by fortifying groundwater resources that can be utilized to meet a population’s water demand.

Figure 1: Image of water seepage through porous concrete.[53]

Some experts suggest that conventional concrete stormwater management paving systems cost between $9.50 and $11.50 per square foot, while permeable paving stormwater management systems average about $5.50 per square foot.[54]

Areas of Opportunity

The strategies outlined in this summary brief would be most impactful in urban regions with a high percentage of impervious surface coverage. The following localities within the Upper Raritan River watershed were selected as areas of opportunity based on their high urban

[51] Lancaster, Brad. Appendix 3 . Vol. 1, in Rainwater Harvesting For Drylands and Beyond, by Brad Lancaster, 124-135. Chelsea Green Publishing Company.

[52] CTC & Associates LLC, and WisDOT Research & Library Unit. *Comparison of Permeable Pavement Types: Hydrology, Design, Installation, Maintenance and Cost*, January 13, 2012.

[53] "Pervious Concrete Pavement." Pervious Pavement. January 1, 2011. http://www.perviouspavement.org/.

[54] "Permeable Pavers." LID Urban Design Tools. January 1, 2007. http://www.lid-stormwater.net/permpaver_costs.htm.

(impervious) land coverage, and would therefore benefit more from the implementation of the "green" infrastructure for stormwater management strategy.

1. Califon Borough
2. Chester Township
3. Raritan Township
4. Flemington Borough
5. Mount Olive Township
6. Readington Township
7. Roxbury Township

Stormwater Management: Cost Projection Summary Brief

Overview

Costs associated with implementing various stormwater management strategies vary depending on the corresponding design, construction, implementation, and maintenance estimations. Initiatives relating to infrastructure are almost always categorized as being capital projects, which imply long-term use and high costs above a certain threshold outlined by municipal governments. In this document we present unit costs for the rain gardens, rainwater harvesting, and permeable pavement strategies to provide an easy way to roughly estimate potential implementation costs prior to in depth financial analysis for location-specific projects.

Program Plan

These stormwater management strategies can be implemented independently or in combination with other infrastructure strategies. Location-specific costs will vary depending on the project area, design, construction, implementation, and maintenance estimates, which may vary according to variables that include variations in infrastructure requirements and service provider estimations in a given municipality.

Rain Gardens

Rain gardens can be either residential or commercial. In New Jersey, the costs of residential rain gardens average between $3 to $4 per square foot while commercial gardens average between $10 to $40.[55] Prices depend on related structures that may be necessary in some locations such as curbing and drains, yet the cost of the plants themselves is usually the major expense.[56] Maintenance in the form of watering is required most frequently in the first 14 days after planting and the first month also requires inspection.[57] Long-term maintenance may include adding mulch and removing excess sediment. Overall, rain gardens require less care than lawns without the need for fertilizers.[58]

The Rutgers Cooperative Extension Water Resources Program offers comprehensive information about rain gardens in New Jersey. They have facilitated the installation of 125 demonstration rain gardens in the state and have also provided rain garden training courses for professional landscapers at a cost of $25 per person.[59] The program further provides a directory of rain garden installation services in New Jersey as well as materials for environmental organizations

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[55] "Rain Garden Manual for New Jersey." p.8, www.nj.gov. April 1, 2005. http://www.nj.gov/dep/seeds/syhart/rgmp1.pdf
[56] Ibid.
[57] Ibid.
[58] Obropta, Christopher. "Rain Gardens Fact Sheet." Water.rutgers.edu. February 1, 2006.. http://water.rutgers.edu/Rain_Gardens/fs513.pdf.
[59] "Rain Gardens Rain Garden Training for Professional Landscapers." Water.rutgers.edu. September 3, 2013. Accessed April 15, 2015. http://www.water.rutgers.edu/Rain_Gardens/RGWebsite/landscaper.html.

interested in teaching children and adults in their communities how to install residential rain gardens.[60]

Rainwater Harvesting

Rainwater harvesting can be measured on two scales: small and large. RHA is already quite familiar with the costs associated with rainwater harvesting on a small scale. Rain barrels range in price, depending on material and size, but a typical 50-gallon rain barrel is around $70.[61] The classes RHA provides are conducted with donated equipment, thus lowering the costs of this initiative, while the costs associated with rainwater harvesting on a larger scale will be much more costly. Rainwater harvesting on a large scale requires a large investment at the outset of a project. Since the cost of water rises slowly over time, and not very high compared with other utilities, the benefits are rainwater harvesting are not financial, but more geared toward reducing demand on public water systems, drought mitigation and environmental resiliency.

A number of companies offer equipment and installation of large-scale catchment devices. The prices can range from $2,000 to over $20,000, depending on the size, shape and material the equipment is made from.[62] On average, cisterns range between $1.50 and $3.00 per gallon of storage, with per gallon costs generally decreasing with increasing tank size.[63] However, more complicated systems that utilize a pump, controls or filtration will typically increase the price $2 to $5 per gallon of harvesting system capacity. In order to make an accurate assessment of cost, one would have to evaluate the area where the rainwater harvesting system is to be installed, then the kind of equipment best suited for that area and the costs associated with installation and maintenance can be calculated. An important calculation must be made to assess how much water can be collected in a given area, thus determining if rainwater harvesting equipment is in an optimal location. Routine maintenance costs are typically very low, as well-designed rainwater harvesting systems do not usually require much attention.

Permeable Pavement

Costs associated with this strategy depend on pavement type: porous asphalt goes for approximately $0.50 to $1 per square foot, while pervious concrete ranges from $2 to $7 per square foot. These costs are 10 to 20 percent higher than those of non-permeable materials.[64] Although, upfront project expenses are reduced where permeable pavement types are implemented because conventional stormwater infrastructure design and construction is not deemed necessary when combined with proper permeable pavement installation. Some experts

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[60] "Rain Gardens." Water.rutgers.edu. October 18, 2013. http://www.water.rutgers.edu/Rain_Gardens/RGWebsite/raingardens.html

[61] EPA. *Rainwater Harvesting: Conservation, Credit, Codes, and Cost Literature Review and Case Studies.* January 2013. http://water.epa.gov/polwaste/nps/upload/rainharvesting.pdf

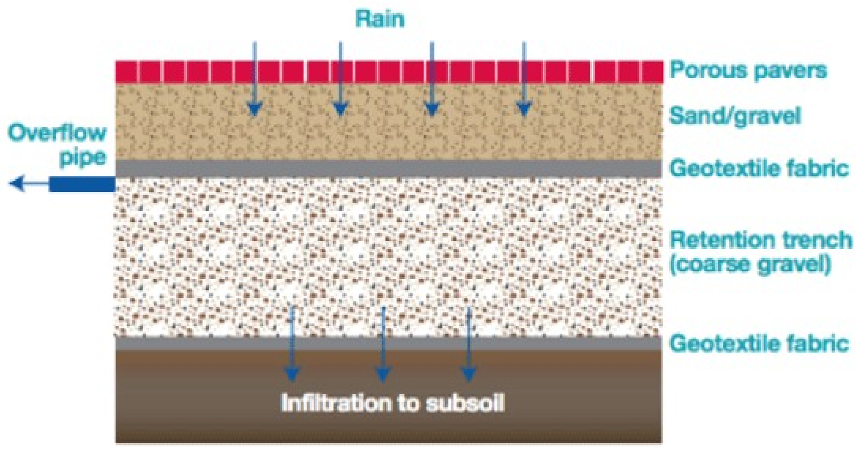
[62] "Why Harvest Rain?" RainHarvest Systems. http://www.rainharvest.com/shop/.

[63] EPA. *Rainwater Harvesting: Conservation, Credit, Codes, and Cost Literature Review and Case Studies.* January 2013. http://water.epa.gov/polwaste/nps/upload/rainharvesting.pdf

[64] CTC & Associates LLC, and WisDOT Research & Library Unit. *Comparison of Permeable Pavement Types: Hydrology, Design, Installation, Maintenance and Cost*, January 13, 2012.

suggest that conventional concrete stormwater management paving systems cost between $9.50 and $11.50 per square foot, while permeable paving stormwater management systems average about $5.50 per square foot.[65] Additionally, vacuum sweeping as a maintenance operation for large-scale permeable pavement areas that is necessary three or four times a year costs $800 to $1,000 per acre per year, as to prevent sediment build up within the pavement pores.[66]

[redacted]



[redacted] Schematic of porous asphalt and the infiltration of stormwater into subsoil.[67]

[redacted] new and existing construction policies in a given municipality, permeable pavement has the potential to cover a large area of land, and thus accumulate impact in terms of water quality improvement, stormwater management mitigation, and the recharge of local aquifers. However, a large amount of capital and human resources would be required for the effective implementation of permeable pavement types: construction (including excavation), operation, and maintenance demands heightened attention from a municipality’s labor force over a long time period to achieve the desired results and benefits from this “green” infrastructure strategy.

Results

The previous sections detail the cost projections of rain gardens, rainwater harvesting, and permeable pavement and present the following unit costs:

- Rain gardens: $3 to $4 per square foot for residential installation, $10 to $40 per square foot for commercial installation; $25 per person for training course for professional landscapers.

65 "Permeable Pavers." LID Urban Design Tools. January 1, 2007. Accessed April 5, 2015. http://www.lid-stormwater.net/permpaver_costs.htm.

66 CTC & Associates LLC, and WisDOT Research & Library Unit.

67 "Porous Paving." Melbourne Water. http://www.melbournewater.com.au/Planning-and-building/Stormwater-management/WSUD_treatments/Pages/Porous-Paving.aspx.

- Rainwater harvesting: $1.50 to $3 per gallon of storage. If a system is more complex and has a pump, controls or filtration, the price increased $2 to $5 per gallon of storage.
- Permeable pavement: $0.50 to $7 per square foot for construction, $800 to $1,000 per acre for maintenance

Stormwater Management Sample Resolution

[Municipality]
Resolution Supporting Participation Stormwater Management Efforts

WHEREAS, Stormwater Management Initiatives, which include but are not limited to the design, construction, implementation, and maintenance of green infrastructure strategies such as rain gardens, rainwater harvesting, and permeable pavement systems, are known to mitigate hazard impacts such as flooding, drought and pollution; and

WHEREAS, the Upper Raritan River watershed has historically experienced the adverse effects of flooding during large and intense storm events, pollution in the form of phosphorus, nitrogen, and metals due to agricultural and urban runoff, and drought; and

WHEREAS, [municipality's name] strives to save tax dollars, reduce flood damage, ensure satisfactory water quality, and increase awareness of water conservation and protection; and

WHEREAS, the effects of various threats to the Upper Raritan River watershed may intensify in the face of contemporary climate change over the upcoming decades: NOW THEREFORE

BE IT RESOLVED, that to focus attention and effort within [Municipality] on stormwater management, the [Municipality's Governing Body] wishes to pursue local, state and national programs and funding that will promote and encourage improved stormwater management in the Raritan watershed.

BE IT FURTHER RESOLVED, by the [Municipality's Governing Body] of [Municipality] that we hereby authorize the Raritan Headwaters Association to serve as [Municipality's] agent for the stormwater management initiatives and provide a strong defense for the region against the risks posed by extreme weather events.

Assumptions

Wetland Restoration	
Assumption	**Source**
Estimates are given in costs per acre assuming a five-acre restoration project.	
We are assuming no cost for land acquisition and labor beyond easement construction. Land can either be acquired through donation, or – more likely – partnering with landowners to allow restoration on their land. This model has proven effective for wetland restoration projects by Ducks Unlimited.	
We are assuming no cost for management and monitoring as these functions can be provided by volunteers.	
Costs estimates for easement per acre and restoration per acre were taken from a USDA analysis of wetland restoration in Gulf of Mexico and Mississippi Basin. Data from more comparable regions is difficult to obtain on per acre level.	"Agricultural Resources and Environmental Indicators - Wetlands Program." United States Department of Agriculture - Economic Resource Service. http://www.ers.usda.gov/media/873717/wetlands.pdf
We are assuming least cost per acre. Restoring for the purposes of mitigating a pollutant – such as nitrogen, would change the cost per acre drastically.	"Agricultural Resources and Environmental Indicators - Wetlands Program." United States Department of Agriculture - Economic Resource Service. http://www.ers.usda.gov/media/873717/wetlands.pdf
According to Vanasse Hangen Brustlin, Inc on wetland restoration in the Merrimack River Watershed in New Hampshire, design and contracting costs account for approximately 25% of the program cost.	"Merrimack River Watershed Wetland Restoration Strategy." *Vanasse Hagen Brustlin, Inc.* *http://www.restorenhwetlands.com/pdf/finalreport/appendix_e.pdf*

Riparian Buffer Zone Remediation	
Assumption	**Source**
Assuming RHA's limited resources, capacity and end goals of mitigating drought, flood and pollution, a maximum of 200' buffer widths have been chosen as an acceptable size for mitigation	"Introduction to Riparian Buffers." Connecticut River Joint Commission. September 2000. http://www.crjc.org/buffers/Introduction.pdf
A $500/acre average unit cost was used as basic restoration costs per acre, averaged between two similar estimates. We used the recommended 200 bare-root trees/acre, with the assumption that not all will survive the first few years. Total costs include labor, with no volunteer contributions assumed	"Appoquinimink Pollution Control Strategy Appendix E: BMP Cost Calculations. " Delaware Department of Natural Resources and Environmental Control. http://www.dnrec.delaware.gov/swc/wa/Documents/AppoPCSdocs/Appendix%20E%20-%20Cost%20Calculations.pdf "Forest Buffer Toolkit." Alliance for the Chesapeake Bay. September 1998. http://www.dep.state.pa.us/dep/deputate/watermgt/wc/subjects/streamreleaf/forestbufftool/tkit_main.pdf
A maintenance period of 10 years is recommended to ensure greater survivability and buffer establishment, with a cost of $6/acre/year. No volunteers are assumed	"Appoquinimink Pollution Control Strategy Appendix E: BMP Cost Calculations. " Delaware Department of Natural Resources and Environmental Control. http://www.dnrec.delaware.gov/swc/wa/Documents/AppoPCSdocs/Appendix%20E%20-%20Cost%20Calculations.pdf
Tree shelter costs are $3 per tree, with each tree receiving a shelter to ensure greater survival rates. Approximately 200 trees planted per acre.	"Forest Buffer Toolkit." Alliance for the Chesapeake Bay. September 1998. http://www.dep.state.pa.us/dep/deputate/watermgt/wc/subjects/streamreleaf/forestbufftool/tkit_main.pdf
We assume that the entirety of a project area will be restored, regardless of soil type, land use, or other constraining factors	No link available, basic intuition used
We assume that urban lands are more difficult to implement with regards to cost and political obstacles. Therefore, we prioritize barren and agricultural lands, with flood-prone areas within this category receiving the highest priority	No link available, basic intuition used

Stormwater Management	
Assumption	**Source**
This resource is an article the incline in the price of water from 2012 to 2013 in the 30 major U.S. cities. The website was founded by journalist and scientist in order to provide relevant and reliable information about the world's resource crisis.	"The Price of Water 2013: Up Nearly 7 Percent in Last Year in 30 Major U.S. Cities; 25 Percent Rise Since 2010 - Circle of Blue WaterNews." Circle of Blue WaterNews. June 5, 2013. Accessed April 8, 2015. http://www.circleofblue.org/waternews/2013/world/the-price-of-water-2013-up-nearly-7-percent-in-last-year-in-30-major-u-s-cities-25-percent-rise-since-2010/.
This website sells rainwater harvesting equipment, but also offers links to a number of resources to better understand the advantages of rainwater harvesting. This website gives a comprehensive idea about the range of equipment available to harvest rainwater.	"Why Harvest Rain?" RainHarvest Systems. Accessed April 8, 2015. http://www.rainharvest.com/shop/.
This book is a comprehensive resource about rainwater harvesting for dry lands. According to the book's website, the book claims to teach readers how to "conceptualize, design, and implements sustainable water-, sun-, wind- and shade-harvesting systems for your home, landscape, and community."	Lancaster, Brad. Appendix 3 . Vol. 1, in Rainwater Harvesting For Drylands and Beyond, by Brad Lancaster, 124-135. Chelsea Green Publishing Company.
The mitigation impact of a rain garden in New Jersey is based on the following calculation published by the Rutgers NJ Agricultural Experiment Station: "In New Jersey, 90% of rainfall events are less than 1.25 inches, with approximately 44 total inches of rain per year. The rain garden will treat and recharge 0.9 x 44 inches = 40 inches per year = 3.3 ft. per year. If the rain garden receives runoff from 1,000 sq. ft., total volume treated and recharged is 1,000 sq. ft x 3.3 ft = 3,300 cubic feet, which is 25,000 gallons per year. Build 40 of these gardens in your neighborhood and we have treated and recharged 1,000,000 gallons of water per year."	Obropta, Christopher. "Rain Gardens Fact Sheet." Water.rutgers.edu. February 1, 2006. Accessed April 13, 2015. http://water.rutgers.edu/Rain_Gardens/fs513.pdf.
	CTC & Associates LLC, and WisDOT Research & Library Unit. Comparison of Permeable Pavement Types: Hydrology, Design, Installation, Maintenance and Cost, January 13, 2012.

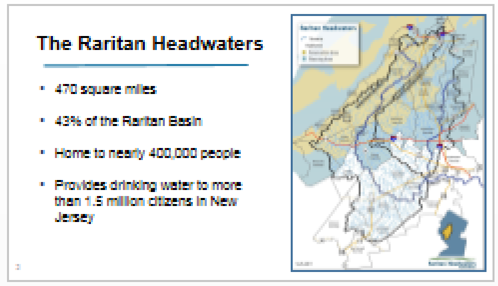
The budget section of the Rain Garden Manual for New Jersey, published by the Native Plant Society of New Jersey, provides a range of costs, as of the year 2005, for both residential ($3 to $4 per square foot) and commercial ($10 to $40 per square foot) rain gardens in New Jersey as well as a broad breakdown of the relevant cost items. Additionally, it outlines expected maintenance activities from the initial days after installation to long term care and provides examples of native New Jersey plants that can be used in rain gardens, as well as an overview of steps to plan, design, build and maintain rain gardens.	"Rain Garden Manual for New Jersey.", p.8, www.nj.gov. April 1, 2005. Accessed April 7, 2015. http://www.nj.gov/dep/seeds/syhart/rgmp1.pdf
The Water Resources Program at Rutgers New Jersey Agricultural Experiment Station has provided training for professional landscapers and for individuals interested in gaining rain garden installation skills. Their training includes a seven-hour classroom session and a hands on rain garden installation session. The training cost, as of 2013, was $25 per person with a discounted price of $15 for any additional trainees from a same landscaping company.	"Rain Gardens Rain Garden Training for Professional Landscapers." Water.rutgers.edu. September 3, 2013. Accessed April 15, 2015. http://www.water.rutgers.edu/Rain_Gardens/RGWebsite/landscaper.html.
The "An Investigation Into Porous Concrete Pavements for Northern Communities" report, published by the Vermont Agency of Transportation in July 2010. Included in the design, installation, maintenance, and cost analyses are cost estimations based on 2005 figures that present square footage expenses based on permeable pavement type. While costs are labeled as being 10 to 20 percent higher than non-permeable materials, the report notes that costs are "offset by the elimination of the need for detention basins and other stormwater infrastructure."	CTC & Associates LLC, and WisDOT Research & Library Unit. Comparison of Permeable Pavement Types: Hydrology, Design, Installation, Maintenance and Cost, January 13, 2012.
Urban Design Tools has an analysis section on Low Impact Development, where it compares permeable pavement stormwater management system costs to those of conventional concrete stormwater management paving systems. The prior presents a cost between $4.50 and $6.50 per square foot, while the latter has a cost between $9.50 and $11.50 per square foot. However, it should be noted that these values are based on Urban Design Tools' personal communication with Chere Peterson of PETRUS UTR, Inc. in 2002.	"Permeable Pavers." LID Urban Design Tools. January 1, 2007. Accessed April 5, 2015. http://www.lid-stormwater.net/permpaver_costs.htm.

Annual maintenance costs per half-care in a parking lot case study are “$400 to $500 per year for vacuum sweeping,” which is stated to be necessary three to four times a year. A “Permeable Pavement Research Summary” report from 2003 produced by Lake County Forest Preserves further shows an analysis of a 40,000-square-foot parking, where, over 25 years, the cost for installation, biannual vacuum sweeping and other maintenance for pavers was $190,200, compared to an asphalt parking lot of the same size and time period that requires an installation and maintenance cost of $275,875.	CTC & Associates LLC, and WisDOT Research & Library Unit. Comparison of Permeable Pavement Types: Hydrology, Design, Installation, Maintenance and Cost, January 13, 2012.
Schematic from Melbourne Water shows how rain can infiltrate porous pavers to eventually end up in the subsoil below grade of pavement installation. The figure displays the various layers of fill that compose a well-constructed permeable pavement installation, including an overflow pipe that can be part of a more developed stormwater management system.	"Porous Paving." Melbourne Water. Accessed April 11, 2015. http://www.melbournewater.com.au/Planning-and-building/Stormwater-management/WSUD_treatments/Pages/Porous-Paving.aspx.

Toolkit

Toolkit Presentation Slides

1



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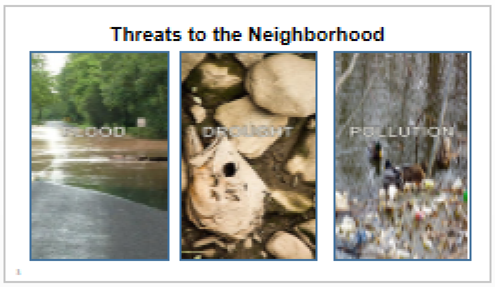

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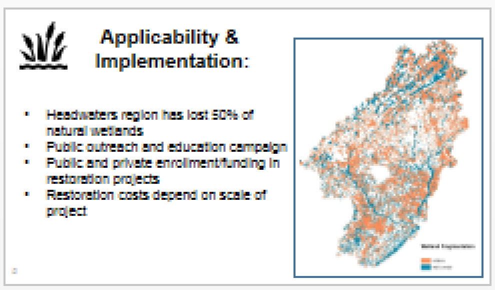

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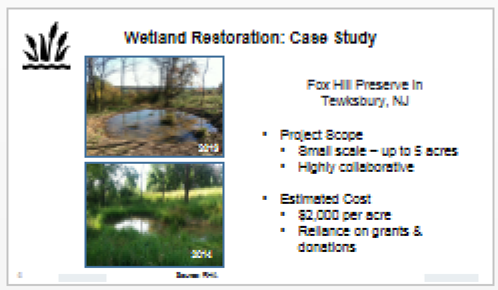

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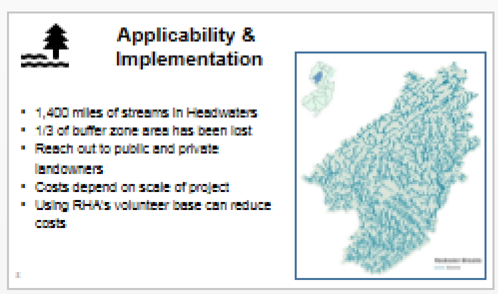

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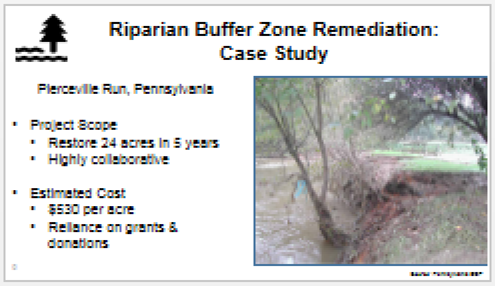

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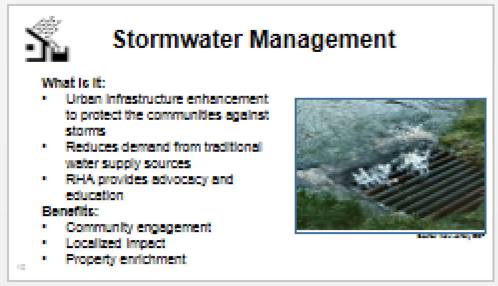

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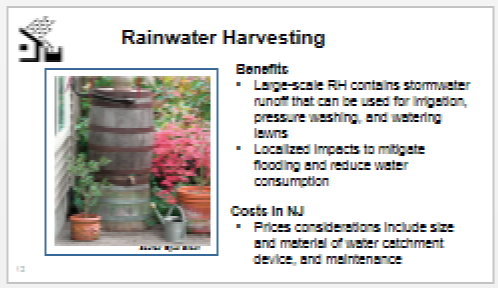

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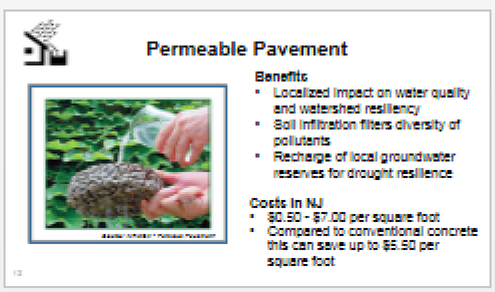

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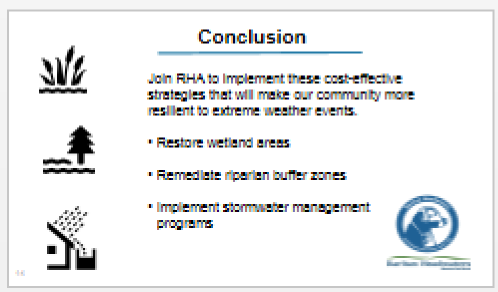

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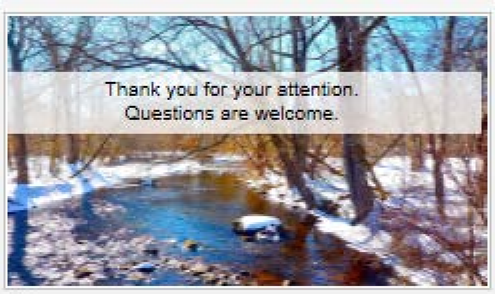

15

Toolkit Presentation Talking Points

Slide

1. Title Slide

- **Insert name of specific municipality, VIP's, and date**
- Brief greeting
- Present agenda

2. Introduction to the Raritan Headwaters **(and RHA if they are not well connected with the organization)**

- 470 Square miles
- 39 municipalities in Hunterdon, Morris, and Somerset Counties
- Map: RHA monitors 1/3 of the total Raritan watershed
- Provides drinking water to more than 1.5 million people in the state.

[Transition- watersheds combine all the streams and creeks into the river basin; because they are small they are at greater risk from changes in weather patterns]

3. Hazards to the Neighborhood

- The watershed is a valuable resource that is at risk from extreme weather events (like Hurricanes), which bring the area under threat from:
  - Increased flooding
  - Drought potential
  - Pollution from stromwater runoff

4. Wetland Restoration (Overview/Background)

- RHA's plan to improve the disrupted flow and ecosystem services eliminated by region's urbanization.
- Reduce flood damage
  - Slow stormwater velocity,
  - Stores water
  - 1 acre saves $3,683 from flood damage in NJ.
- Improve water quality
  - Traps 80-90% percent of sediment
  - Save $1,596 per acre in water treatment in NJ
- Drought Resilience
  - Allows for aquifer recharge
  - Wetlands store 1 million gallons of water per acre.
- Wetlands are referred to as the Earth's kidneys, because of how the absorb wastes and pollutants.

5. Wetland Restoration: Applicability and Implementation

- Raritan Basin has lost 50% of its natural wetlands
- Map: you can see on the graph how the wetland areas in blue are fragmented by the urban spaces in orange.

- Implementation plan
    - Focus on multiple small scale projects, up to 5 acres for any given project
    - Collaborate with public and private landowners and funders to restore wetlands.
        - Potential for agreements in land acquisition or coordinating long term management
        - We also want to continue our political advocacy to support land conservation programs, lobbying for new zoning laws to reduce further fragmentation.
- Variable costs - our cost projection is approximately $2,000 per acre for project.

6. Wetland Restoration Case Study

- Small wetland restored at Fox Hill - RHA's headquarters
- Wetland enhancement - vegetation, planting restoration
- Describe pictures: the lack of vegetation in the photo on top shows erosion and was biologically degraded wetland in 2013. But a year later, after restoration work, including planting native species, removing invasive species and improving natural drainage, the wetland was much healthier and thriving.
- Explain RHA's goals to restore other degraded wetlands (up to 5 acres) and the estimated costs

7. Riparian buffer zone remediation

- RHA will work to improve the areas adjacent to streams and other waterways,
- They are essential to healthy habitat and ecosystem function.
    - A mix of dense vegetation helps to prevent stream bank erosion and pollutant intrusion,
    - Average 80-90% reduction of pollutants and fertilizers (nitrogen, phosphorus and sediments) in buffers approximately 200 feet wide.
- Slows down stormwater runoff
- Slower runoff replenishes groundwater
- Slower runoff mitigates flooding, reduced property damage
- Savings on water treatment costs
    - A 10% increase in forested cover may result in a 20% reduction in drinking water treatment costs

8. Riparian Buffer Zone Remediation Applicability and Implementation

- Headwaters region has over 1,400 miles of streams
- Over 1/3 of its riparian zones have been lost since the mid-1980s.
- Restoration requirements
    - Land acquisition
    - Planting of native vegetation
    - Collaboration with municipalities and the farming community;
- Implementation Requirements
    - Reach out to public and private landowners and
    - Set up a series of small restoration sites (between 150- 320 ft long, 200 ft wide) around key areas in need to plant native vegetation. Goal: 1 aggregate mile (for instance, 1 mile on one side, or half mile both sides) of 200 feet buffers restored in 5 years.

- Impacts don't occur right away (small and incremental improvements)
  - Best restoration projects use comprehensive approach including planning and design
  - Costs vary with the size of these sites, 1 total mile of restored buffer zones over 5 years = $13,000
    - Tree shelter protection is optional (at additional cost of $3 per tree; $600 per acre) to ensure survivability, for an additional cost of $14,500 per aggregate mile.
    - Initial costs are high for design and construction but maintenance is favorable, up to $300 per year afterwards
    - Factoring in volunteer labor and partnerships can lessen costs
- RHA has experience with similar projects

9. Riparian Buffer Zone case study

- Pierceville Run, Pennsylvania
  - Goals of reducing stream bank erosion, nutrient and sediment pollution
  - Addressed nearly ½ mile of key stream banks with buffers 35-100 feet wide (Planted grass, shrubs and 600 trees)
- Implementation costs of $536,000
- Sediment and phosphorous loads reduced approximately 40% (1,400,000 pounds)
- Aquatic ecosystem now fully healthy and unimpaired

10. Introduce the suite of stormwater mgmt. programs

- Focus on adapting urban infrastructure to protect it from extreme storms
- combination of options that are ready for public integration
- Strategy promotes community engagement
- reduces dependence on communal water resources
- There are many ways to go about stormwater mgmt., we advise these simple options for initial program
- Best results use all three programs

11. Water Gardens

- Aesthetically pleasing feature of neighborhood homes
- Provides habitat to birds, butterflies and beneficial insects
- Require less maintenance than lawns, and do not require fertilizer
- Break down pollutants from pesticides, fertilizers, and petrochemicals in runoff from roofs, lawns and driveways that make it to water bodies otherwise
- RHA collaboration with professional landscapers
- Promote commercial opportunities to install rain gardens

12. Rainwater Harvesting

- Direct localized, mitigation of stormwater runoff and overflow
- Rainwater can be used for any water purpose (besides drinking)
- RHA collaboration, provides barrels and can advocate greater water saving ventures
- Cost determined by scale of catchment
- Upfront installation costs are the biggest expense; estimates $2/ gallon for containment, and up to $5/gal if pump and filters are used.

- Price varies depending on the size of the system and the material it is made from, but upkeep and maintenance cost are minimal

13. Permeable Pavements

- Involves the reconstruction of paved surfaces, or in the case of new construction, the installation of permeable pavement such as porous concrete.
- Reducing stormwater runoff from urban streets that carry contaminants such as oils from the road, by allowing water to filter through the pavement itself and into the ground.
- Naturally filters water to take contaminants out before the water reaches groundwater reserves,
- Recharging underground reservoirs and helping communities improve their water resource independence.
- Costly to implement, but a lot of the savings are within the maintenance phase of the projects, where permeable pavements allowing a few annual cleanings that are relatively simple to act out.
- Best suited for low impact surfaces, such as sidewalks, road shoulders, park pathways, and parking lots.

14. Conclusion: If you join with RHA on addressing this/these issue(s), we can proactively meet the water and environmental issues of our community and mitigate damage from extreme weather.

Fundraising Concept Note

Context:
The mission of the Raritan Headwaters Association (RHA) is to protect clean water in the north and south branches of the Raritan River. In the past decade, this region in Northern New Jersey has experienced an increase in extreme weather and the costly repairs associated with it; Hurricane Irene cost the state over $1 billion in damages mostly from flooding. It is not just excess precipitation that is an issue; greater attention to general management of water resources is necessary. This includes diverting the flow of stormwater away from urbanized areas, runoff from agricultural areas, and protection of groundwater resources. The overall health of this watershed is paramount to Northern and Central New Jersey, as it is the largest river basin located entirely within the state, and provides drinking water to more than 1.5 million people, and 39 municipalities within the counties of Hunterdon, Morris and Somerset.

Rationale:
We are seeking **$x (Actual amount TBD by RHA's needs)** to implement a series of strategies that will enhance the region's ecological protections, and improve urban infrastructure in preparation for future water issues. This document intends to provide project funders with a rationale and scope for our request.

Project Goals and Objectives:
To help the communities of Northern New Jersey proactively address the issues of both too much water (stormwater, pollution, and flooding) and too little (drought) RHA the region's water watchdog and leading public advocate, aims to mitigate these issues with a series of programs that are designed to continue their mission of protecting the waters.

<u>Wetland Restoration</u>

For this strategy, success will be seen in 15 acres of the habitat restored in 5 years. This is RHA's plan to improve the disrupted flow and ecosystem services eliminated by region's urbanization. It will directly address issues of concern: flooding, drought and pollutant runoff. New Jersey Department of Environmental Protection study found that freshwater wetlands in New Jersey are valued at $9.4 billion per year due to their reduction and mitigation of flooding risks and damages.

The first year of this program will be to provide education on the importance of wetland habitats, through educational presentations and town meetings. Partnerships with landowners, research groups (possibly Rutgers) will commence in second and third years, as wetland restoration plans are developed and begin. The restoration completion of 5 acres in 3 participating municipalities (measuring carbon sequestration, water quality, and illumination of invasive species), for a total of 15 acres at the completion of 5 years.

<u>Riparian Buffer Zone Remediation</u>

One mile of restored riparian area after 5 years is an attainable goal which will greatly improve the health of the Headwater streams. This is an effective strategy for protecting against all the stated issues by ensuring natural processes work. The Headwaters region has lost over one-third of the stream-bank riparian zones, a habitat that provides filtration and calms the water's flow allowing for groundwater recharge. It will require some land acquisition, the planting of vegetation, and collaboration with municipalities and the farming community; but small improvements can make an impact: a 10% increase in forested cover may result in a 20% reduction in drinking water treatment costs, potentially benefiting many municipalities downstream.

The first year of this program will be to provide education on the importance of riparian zone habitats, through educational presentations and town meetings, lengths of stream ideal (50m-100m, ~65 ft.- 328 ft. by 200 ft. stretches) for restoration project will be identified and the landowners contacted, aiming for 3 stretches in different municipalities. Restoration projects will be measured in the number of bare root saplings planted in each buffer zone, and how they contribute to overall stream health. Planting begins in year 2, and continues to be monitored and maintained by RHA and volunteers. With improved shading, water quality and flood prevention we hope to increase the number of buffer zone remediation projects to over 1500m (one mile goal set for simplicity).

Reducing Urban Runoff

We propose: a **x% (To be determined later by RHA)** decline in water runoff over the next five years in residential areas. Our plan uses the incorporation of rain gardens and the rain barrel programs, and subsequent improvement in water quality in the stream and well testing. The permeable pavement program will be expanded in the parking lots of government buildings, and regional paved pathways. In residential areas, water quality will improve due to the inclusion of rain gardens and the rain barrel programs, this will be shown in data from RHA's stream and well testing. This strategy will continue education programs such as rainwater harvesting, foster partnership efforts with local landscapers and gardeners to build attractive, water saving, features into home gardens, and explore the infrastructure benefits of permeable pavements.

The first year's outcomes include the expansion of community education; increasing the participation of our rain barrel classes, and distribute 100 new barrels from 5 workshops throughout the year, this is intended to be an annual plan. Partnerships with garden centers and landscapers will begin, and rain gardens as a feature of local homeownership will be promoted. The third year will involve the advocacy within 5 municipalities for permeable pavement installation on new and existing construction projects, and plan a pilot project to display its usefulness. There are numerous stormwater management options that could be adopted to promote sustainable infrastructure, the strategy above is chosen from a trio of options developed concurrently for the greatest overall effectiveness.

List of project activities and expected results for each:
The strategies listed above were determined by a subjective assessment as to what had the potential to be the most impactful and what will protect the citizens and businesses most in the Raritan headwaters. Due to the varied challenges and wide reach of the goals, RHA's proposed program has a sub-development plan for each of the three separate strategies.

- Wetland Restoration

    - Assessment of political feasibility to secure large wetland areas for restoration in municipalities.
    - Determine best areas for restoration, GIS used to determine locations of ecological need, meet with community to determine where it is also politically feasible.
    - Public education and outreach to get the community involved in and supporting the program.
    - Planned scope of restoration: 5 acres of restored ecosystems in 3 different municipalities, for a total combined restoration area of 15 acres.
    - Train and mobilize volunteers with proper restoration skills and data collection.
    - Monitoring and measuring results of remediation project's impact up to ten years.

- Riparian Buffer Zone Remediation
    - Determine best restoration areas using GIS, prioritizing barren and flood prone areas.
    - Public education and outreach to get the community involved in and supporting the program.
    - Obtain proper permits and permission if restoring on federal land.
    - Partner with private landowners to secure land areas for restoration projects.
    - Planned scope of remediation: 200 ft. x 230 ft. areas, 3 locations added each year for 5 years, for a total of 1 mile (does not need to be contiguous).
    - Train and mobilize volunteers with proper restoration skills and data collection.
    - Monitoring and measuring results of remediation project's impact up to ten years.

- Stormwater Management
    - Partnership with local landscaping companies and gardening groups to provide expertise for the public on water safe gardening practices and promote the program.
    - Expansion of Rain Garden and Rainwater Harvesting programs in prioritized municipalities, increasing the number of classes given and the amount of visual promotion.
    - Mobilize volunteers increase outreach promoting the program (community forums, farmer's markets, school events…)
    - Negotiate with local governments for the implementation of a rebate program for using rain barrels permeable pavements, and other safe water practices, giving the people greater incentives to participate.
    - Monitor results of program promotion in attendance numbers at rainwater harvesting classes, number of new rain gardens in each municipality, and number of plans for the implementation of permeable pavements.

General:

- Hire staff member to focus attention on restoration projects and collaborative partnerships with private landowners.

New Perspectives on Long-Term Challenges

This program will allow RHA to shift in focus from the past and present to the communities needs in the future. These projects build on RHA's longstanding presence in the community as a water watchdog, by staying true to their mission and volunteer network they can keep costs of program development low. Being proactive on these issues will save money (projected amount) in the long run and raise awareness about these issues, planting the seeds in the community for a more sustainable future. RHA already has a working relationship with the 39 municipalities in the Upper Raritan region, based on past interactions these municipalities have been arranged into a tiers of particular interest. The top tiers will be first approached with these strategies, so we can begin the program with positive partnerships.

RHA Background

RHA protects, preserves, and improves water quality and other natural resources through our highly regarded science, education and advocacy programs. They monitor nearly 1,400 miles of streams for pollution with the help of hundreds of citizen scientists. They are the largest watershed organization in New Jersey with thousands of members, participants, and volunteers. It was formed in 2011 by the merger of two organizations that had been independently serving the region for 52 years, the South Branch and Upper Raritan Watershed Associations (SBWA and URWA). Combined, they have a long history of educating the public, tending and protecting streams and wetlands from pollution and litter (over 6300 acres), and testing over 24,000 wells for fertilizers and other chemicals including arsenic and lead.

These strategies were developed in the collaboration with a pro bono Columbia graduate student-consulting group, the Environmental Science and Policy Consultants (EC). These strategies are intended to address the issues of flooding, drought, and runoff pollution in terms of preparedness and resiliency. These were determined by research into risk assessments, the work of other organizations (regional and national) mitigation plans for similar issues, cost-efficiency balances and a feasibility metric developed by EC.

Cost Projection Budget

These programs are diverse and require a variety of expenses to facilitate all the necessary programs needs. The budget provides estimates for restoration based on similar restoration and remediation projects, and the costs of materials needed for Stormwater Management. Outreach, classes, volunteer training and travel expenses are not included at this time, but must be considered when the programs are further developed.

Project Budget

Wetland Restoration and Riparian Buffer Zone Remediation
Program Budget

Expenditures	**Cost (per acre)**
<u>Wetland Restoration</u>	
Design	
Flood Mitigation	$234.75
Excess Nutrient Removal	$388.00
Easement	
Flood Mitigation	$506.00
Excess Nutrient Removal	$1,126.00
Restoration	
Flood Mitigation	$433.00
Excess Nutrient Removal	$426.00
Total Cost (Flood Mitigation)	$1,173.75
Total Cost (Nutrient Removal)	$1,940.00
<u>Riparian Buffer Zone Remediation</u>	
Restoration	
Vegetation	$500.00
Maintenance (5 years)	$30.00
Tree Shelters (optional)	$600.00
Total Cost w/o shelters	$530.00
Total Cost w/ shelters	$1,130.00

Stormwater Management

Program Budget

Expenditures	**Cost**
Stormwater Management	
Rainwater Harvesting	
50 gal barrel	$70.00
50 gal barrel (collaboration w/ Rutgers)	$25.00
Cisterns (per gal)	Range ($1.50-$3)
Additional Hardware for large RH system (per gal)	Range ($2-$5)
Rain Gardens	
Installation(Priced per square foot)	
Residential	Range ($3-$4)
Commercial	Range ($10-$40)
Permeable Pavements	
Construction per square foot (porous asphalt)	$0.50 - $1.00
Construction per square foot (pervious concrete)	$2.00 - $7.00
Maintenance per square foot/year	$0.02

Draft Job Posting

RHA Program Manager for Climate Change Adaptation Strategies

Description of RHA:
The largest watershed organization based in New Jersey, Raritan Headwaters Association protects, preserves and improves water quality and other natural resources of the Raritan River headwaters region through efforts in science, education, advocacy, land preservation, and stewardship.

RHA, based in Bedminster, NJ, was formed by the 2011 merger of two effective conservation groups, the Upper Raritan Watershed Association and the South Branch Watershed Association, both founded in 1959 to engage New Jersey residents in safeguarding water sources and natural ecosystems. Our organization is a strong voice in advocating for sound land use policies. We are a leader in environmental education and outreach, and for our work in water quality monitoring, habitat restoration, land preservation and stewardship.

To help the communities of Northern New Jersey to proactively address the issues of both too much water (stormwater, pollution, and flooding) and too little (drought); RHA, the region's water watchdog and leading public advocate, aims to mitigate these issues with a series of programs that are designed to continue their mission of protecting water resources in New Jersey

Position description:
We are seeking a Program Manager who will implement restoration programs in the wetlands and riparian buffer zone habitats, as well as the implementation of stormwater management strategies in urban areas. She/He will organize the project timeline and coordinate with collaborating organizations and companies to see program goals met on time. Be in charge of designing restoration events and will help facilitate ongoing monitoring with project and volunteer management. Give presentations at municipal events to promote these programs and find more partners on this issue. A familiarity with freshwater ecology and stormwater mitigation systems would be invaluable. This position requires flexibility and creativity, daily activities will be varied and you may be asked to perform duties outside of this description.

Responsibilities:

- Garner public, private, and municipal support through education efforts and outreach programs
- Secure grants and funding for environmental projects
- Ensure implementation according a given timeline and cost projections
- Engage in stakeholder events and coordination with other organizations
- Collect field data and monitor restoration activities

Requirements:

- Bachelor's degree in environmental science, sustainability, or related field (Master's degree preferred)
- Public outreach and speaking experience

- Knowledge and experience in green infrastructure, community organizing, land management, and ecological restoration (particularly in wetlands or other freshwater systems)
- Fundraising knowledge or experience with grant writing
- 3-5 years of experience managing programs
- Must be able to work individually and with a team
- Comfortable with working in the field, in and around bodies of water
- Outgoing personality and a sense of humor

Education background or experience in biology, environmental science, ecological restoration, or landscape architecture, or related field is desirable. Engineering background a plus (civil, environmental, or agricultural), as is an understanding of hydrology.

Preferred skills:

- Familiarity with GIS mapping and data analysis
- Knowledge of and/or experience with water systems, hydrology, and/or water infrastructure
- Knowledge of botany and/or local plant species

Based at scenic Fairview Farm in Bedminster, NJ, this full-time position offers a competitive salary and benefits package. Candidates should submit a resume and cover letter by email to future@raritanheadwaters.org.