Memorandum

To: *Kyra Hoffmann, Project Manager, NJDEP Office of Policy Implementation and Watershed Restoration*

From: *Metedeconk River Watershed Protection and Restoration Plan Project Team*

Date: *May 16, 2012*

Subject: *Metedeconk River Watershed Protection and Restoration Plan: Task 5 – Management Strategies* **– FINAL**

Introduction

Results of the watershed technical analysis, which included information on watershed characteristics and the results of the visual stream assessment, were reconciled with the goals and objectives identified in Task 4 to identify and prioritize a comprehensive list of structural and non-structural management strategies, or best management practices (BMPs), appropriate for the watershed. The prioritized strategies are intended to guide development of the watershed protection and restoration plan, as well as provide insight into potential demonstration project(s) for implementation under the second phase of the watershed plan.

The purpose of this technical memorandum is to present the results of the management strategy/BMP prioritization, conceptual implementation costs, and estimated nutrient and solids load reduction percentages for each of the candidate strategies. There are other management strategies such as education and outreach which are not addressed in this memorandum, but are of critical importance to the watershed. Education and outreach is addressed in detail in Task 6 and will be incorporated into the watershed protection and restoration plan.

It is important to note that much of the stormwater infrastructure within the watershed is antiquated by today's standards. In many areas, runoff is captured by storm sewers and discharged directly to the Metedeconk River, as opposed to first being routed to a recharge basin or other BMP. In addition, some of these outfalls have little area around the discharge point to enable the construction of a BMP. Data concerning the drainage areas to each of these outfalls is not readily available, but should be obtained to site BMPs so that their effectiveness is optimized.

While this memorandum identifies general BMPs which are applicable to the goals and objectives of the watershed, they are not necessarily applicable to all project sites. A list of candidate restoration sites identified in the Technical Analysis (Table 3-1) has been further refined and once finalized, will have specific BMPs assigned to each site. This work will be documented in the watershed protection and restoration plan (Task 8).

New Jersey Department of Environmental Protection (NJDEP) Stormwater Management Rules require stormwater management plans and also set forth stormwater requirements for municipalities and new development. These rules are targeted at limiting stormwater runoff and pollutants and promoting groundwater recharge. These rules will therefore help to prevent water quality degradation due to stormwater runoff from impervious surfaces and promote management strategies that encourage infiltration.

Management strategies presented throughout this memorandum can be applied to the existing TMDLs for fecal coliform, total coliform and phosphorus although removal efficiencies for coliform (both fecal and total) are not presented as they vary considerably. Fecal coliform TMDL implementation strategies call for source track-down and implementation of pet waste and goose management ordinances for animal sources, which are likely the primary source of coliform within the watershed. While these are included within this memorandum, the removal efficiencies are very site specific.

It should also be noted that although not described in detail in this memorandum, the recently passed statewide fertilizer ordinance will help in reducing phosphorus and nitrogen loading to the river which in turn will reduce loading into Barnegat Bay. This will act as an important non-point source control to nutrient loading to the river.

Prioritization of Management Strategies

There were five primary goals developed by the project technical team and Stakeholder Advisory Committee, with several objectives identified within each goal. Plan goals and objectives are documented in the Task 4 memorandum and are presented in **Table 1** for reference. Based on a review of the goals and objectives, eight BMP functions were identified that meet one or more of the objectives. **Table 1** shows the correlation between the individual objectives and the eight BMP functions. A description of the eight BMP functions is provided below.

- Reduce Stormwater Peak Flow and Total Volume: The ability to retain stormwater runoff, resulting in a reduction in the peak flow being discharged from the contributing drainage area as well as total volume.

- Improve Infiltration: The ability to infiltrate stormwater into the ground, providing a much needed increase in base flows within the watershed and a reduction of stormwater runoff.

- Promote Water Conservation and Reuse: The ability to conserve potable water through the retention and reuse of stormwater, and through simple reductions in household water consumption.

- Reduce Nutrient Loads: The ability to remove nitrogen and phosphorus from stormwater runoff.
- Reduce Sediment Loads: The ability to remove suspended solids from stormwater runoff.
- Reduce Pathogen Loads: The ability to remove pathogens from stormwater runoff.
- Improve Habitat: The creation of habitat to support wildlife abundance and biodiversity. This would also have a positive impact on water quality through reforestation of riparian buffers.
- Potential for Public Involvement: The ability of the BMP to be used as a demonstration project for the public to promote watershed education and awareness.

Based on the project goals and objectives and the eight BMP functions, 28 unique BMP types were identified for consideration for this watershed. Each BMP type was assigned a score from 1 (lowest) to 3 (highest) for each of the eight BMP functions based on their ability to meet the intent of the function. The individual scores were summed and the BMPs were ranked based on highest to lowest total score. The individual scores and resulting BMP ranking are provided in **Table 2**. It was assumed that each of the eight BMP functions is equally weighted. Consideration was not given for the scale of impact, such as the difference in the amount of nutrients removed between a regional wet pond versus a site-scaled sand filter. A brief description of each of the 28 BMP types is provided after **Table 2**, in the order of their ranking.

Based on the generally flat topography, deep, sandy soils and the large percentage of wetlands in the watershed, resource protection, restoration, and BMPs which facilitate infiltration are recommended for first priority implementation. These BMPs are also recommended due to the watershed concern for groundwater depletion through aquifer extraction with wastewater treatment plants discharging offshore to the Atlantic Ocean. BMPs that promote infiltration will enhance baseflow and reduce runoff.

Table 1
Goals and Objectives Correlation for the Metedeconk River Watershed Protection Restoration Plan

	Goal	Objective	Reduce Stormwater Runoff Peak	Improve Infiltration	Promote Water Conservation & Reuse	Reduce Nutrient Loads	Reduce Sediment Loads	Reduce Pathogen Loads	Improve Habitat	Potential for Public Involvement
1	**Provide a sustainable water supply to the human population while maintaining natural water regimes**	Improve natural freshwater flows	✓	✓	✓				✓	
		Promote water conservation and implement water re-use demonstration projects (i.e., fully functioning with educational components) on public properties (e.g., golf-courses and other public facilities)	✓	✓	✓				✓	✓
2	**Allow no degradation of water quality (e.g., maintain Category 1 designation) and eliminate water quality impairments**	Reduce stormwater flow via implementation of projects on public facilities and redevelopment projects	✓	✓	✓					✓
		Reduce nitrogen, phosphorus, pathogens, TDS and TSS				✓	✓	✓		
		Implement TMDLs (reference existing 303d list and develop priority implementation schedule with NJDEP and USEPA)				✓	✓	✓		
		Prevent habitat loss and support habitat restoration within riparian buffers to preserve and improve regional biodiversity							✓	
		Address data gaps for groundwater and tributary water quality within the Metedeconk River watershed.								
		Protect and restore critical wildlife habitat and natural lands identified by NJDEP, Trust for Public Land, Rutgers University, Ocean County Natural Lands Trust and others (e.g. riparian areas, forested areas, etc.)							✓	
		Minimize health risks to recreational contact water users from pathogens (i.e., make pathogen-impaired waters a priority for TMDL implementation)						✓		
		Improve soil health for biological, chemical, and physical function; implement demonstration projects on public properties		✓			✓	✓		
		Identify multiple sources of funding for implementation of the plan								
3	**Support the health of the Barnegat Bay**	Reduce nitrogen, phosphorus, pathogens and TSS				✓	✓	✓		
		Reduce stormwater runoff to the bay	✓	✓	✓					
		Improve passive recreational access								✓
		Protect natural shoreline buffers and open space; implement buffer setback							✓	
4	**Improve the water quality of watershed lakes**	Reduce pathogen and phosphorus inputs				✓	✓	✓		
		Address invasive plant species (e.g., identify priority species and develop management plans) and sediment accumulation (reduce stormwater runoff and protect shoreline buffers)							✓	
5	**Promote education and outreach regarding watershed impacts from growth**	Enlist involvement and support of all levels of government, specifically municipal and/or county planning and zoning boards and environmental commissions, stormwater coordinators, DPWs, etc., for sustained effectiveness in managing watershed resources		✓						✓
		Identify and encourage Low Impact Development standards appropriate for the Metedeconk basin			✓					✓
		Promote cooperation among the development community, such as board of realtors, shore builders assoc., etc., involved in watershed development								✓
		Promote cooperation among various regulatory agencies involved in watershed resources and development								✓
		Support Smart Growth standards (promote municipal participation in Sustainable NJ)								✓
		Support open space planning and preservation (work with towns and Green Acres to develop a for headwater protection)								✓
		Work in concert with the Barnegat Bay Partnership and other organizations involved in education and outreach to: (1) expand the public's understanding of the watershed, (2) encourage public participation and support of improving watershed health, and (3) promote public involvement in restoration activities.								✓
		Increase public understanding of the Metedeconk watershed and the role the public plays in its health								✓
		Involve stakeholders in defining problems, objectives and solutions								✓

Table 2
BMP Prioritization[1]

Rank	Best Management Practice	Reduce Stormwater Peak Flow	Improve Infiltration (Volume Control)	Promote Water Conservation & Reuse	Reduce Nutrient Loads	Reduce Sediment Loads	Reduce Pathogen Loads	Improve Habitat	Potential for Public Involvement	Total Score
1	Resource Conservation/Protection	3	3	2	3	3	3	3	2	22
2	Urban Green Stormwater Infrastructure (UGSI)	3	3	1	3	3	3	2	3	21
t3	Infiltration Basin	3	3	1	3	3	3	2	2	20
t3	Upland Reforestation	3	3	0	3	3	3	3	2	20
t5	Constructed Stormwater Gravel Wetland	3	2	1	3	3	2	3	2	19
t5	Constructed Stormwater Wetland	3	2	1	3	3	2	3	2	19
t5	Private Property BMPs	3	3	3	2	2	1	2	3	19
8	Bioretention Basin	3	2	0	3	3	3	2	2	18
t9	Retrofit Existing Stormwater Basin	3	3	1	2	2	2	2	2	17
t9	Agricultural BMPs	2	1	2	3	3	3	1	2	17
t9	Buffer Restoration	2	2	0	2	3	2	3	3	17
t9	Vegetated Filter Strip	2	2	1	3	3	2	2	2	17
t9	Removal of Impervious Surface	3	3	1	2	2	2	3	1	17
t14	Improve/Repair Septic Systems	1	1	2	3	1	3	2	2	15
t14	Rainwater Harvesting (non-residential)	3	2	3	1	1	1	1	3	15
t14	Sand Filter	2	2	1	3	3	2	1	1	15
t14	Stream Restoration	2	1	0	2	3	1	3	3	15
t18	Grassed Swale	2	3	1	1	2	1	2	2	14
t18	Off-line Regional Treatment	3	1	0	2	3	1	2	2	14
t20	Extended Detention Basin	3	2	1	2	2	1	1	1	13
t20	Pervious Paving (porous asphalt, concrete)	2	3	1	1	1	1	1	3	13
t20	Wet Pond	3	0	1	2	3	1	2	1	13
t23	Dry Well	2	3	1	1	1	1	1	2	12
t23	Green Roof (non-residential)	3	1	2	1	1	1	1	2	12
t23	Source Control (pet waste, fertilizer, geese	0	0	1	3	1	3	2	2	12
t26	Manufactured Devices	2	1	1	1	3	1	1	1	11
t26	Runoff Redirection	2	3	1	1	1	1	1	1	11
28	Improved Street Sweeping	1	1	0	2	2	2	1	1	10

Notes:
1.) *Scoring: 3 (high), 2 (average), 1 (low), 0 (not applicable)*

1. *Resource Conservation/Protection*

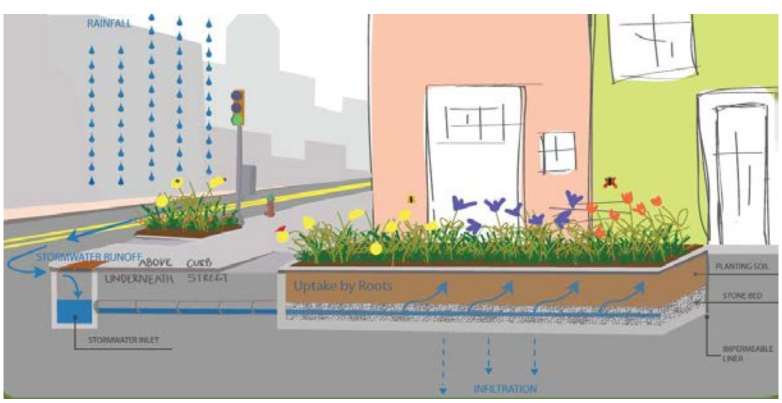
Conservation of remaining natural resources through protection and preservation is the most holistic strategy for sustainably achieving the watershed objectives. Protection of sensitive aquatic resources can be achieved by maintaining vegetated riparian buffer zones. Preservation of existing high quality ecosystems provides water storage, filtration, and treatment services with many other cumulative benefits and minimal maintenance. There are almost 200 parcels that have been identified by the Trust for Public Land for 'protection priority' which could be considered for this management strategy (see TPL, 2008). In addition, much of the riparian corridor throughout the watershed has been identified as a 'conservation priority' by the University of Massachusetts (see Barten et al, 2003).

Improvement Potential	
High	●
Average	◍
Low	○

Resource Conservation /Protection Benefits	
Water Quantity	●
Sediment	●
Nutrients	●
Bacteria	●
Habitat	●
Demonstration	◍

2. *Urban Green Stormwater Infrastructure*

Infiltration of stormwater runoff from impervious surfaces in urbanized or downtown areas can be accomplished through construction of green stormwater infrastructure, or GSI. Examples of these types of infrastructure include stormwater bump-outs, infiltration trenches and stormwater planters. These can be retrofit into existing downtown areas and within commercial land uses with large areas of impervious cover (parking lots, shopping malls, etc.).



UGSI Benefits	
Water Quantity	●
Sediment	●
Nutrients	●
Bacteria	●
Habitat	◍
Demonstration	●

t3. *Infiltration Basin*

A facility which collects and provides temporary storage of stormwater runoff to promote infiltration through highly permeable soils. Sediment and nutrient removal as well as groundwater recharge are achieved.

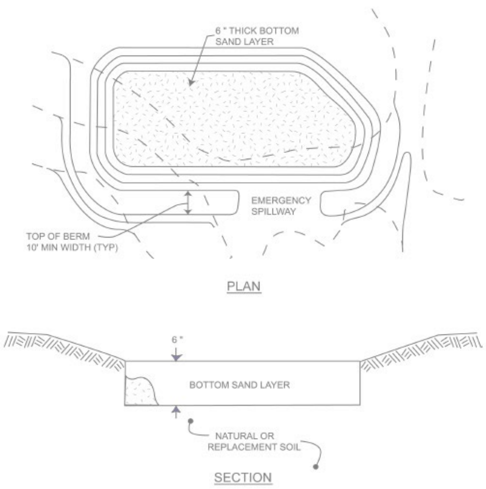


Figure of Infiltration Basin from NJ BMP Manual

Infiltration Basin Benefits

- ***Water Quantity*** ○
- ***Sediment*** ●
- ***Nutrients*** ●
- ***Bacteria*** ●
- ***Habitat*** ○
- ***Demonstration*** ○

t3. *Upland Reforestation*

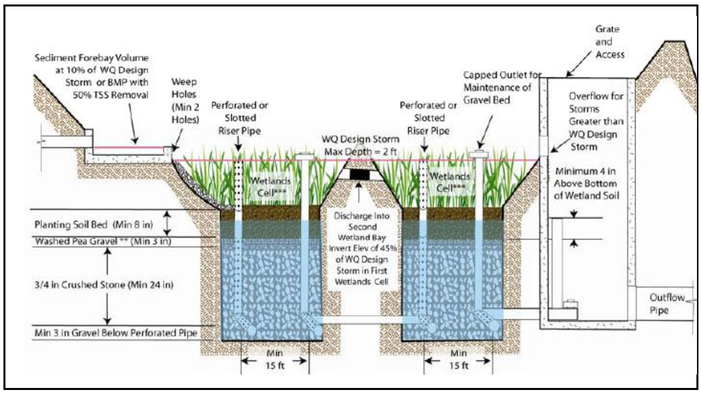
Restoration of upland and riparian forests capitalize on available, unused land to return pre-development hydrology. Tree canopy cover and leaf debris ground cover captures rainfall where it falls, protects soils from erosion, maximizes infiltration, and sequesters nutrients. Trees can be planted as individuals or clusters in urban areas, strategically along riparian buffers, or broadly across expansive former agricultural lands to realize water quantity, quality, and habitat benefits which are maximized with minimal maintenance requirements. Other benefits associated with reforestation include improved scenery and air quality.

Reforestation Benefits

- ***Water Quantity*** ●
- ***Sediment*** ●
- ***Nutrients*** ●
- ***Bacteria*** ●
- ***Habitat*** ●
- ***Demonstration*** ○

t5. Constructed Stormwater Gravel Wetland

Constructed stormwater gravel wetlands are similar to the constructed stormwater wetlands described above, except they rely more on a dense root mat, crushed stone, and an anaerobic and microbe-rich subsurface to remove pollutants, espeically nutrients such as total nitrogen and total phosphorus. Because of their considerable nitrogen removal capabilities, constructed stormwater gravel wetlands are being evaluated as one of the primary BMPs for the Barengat Bay estuary.



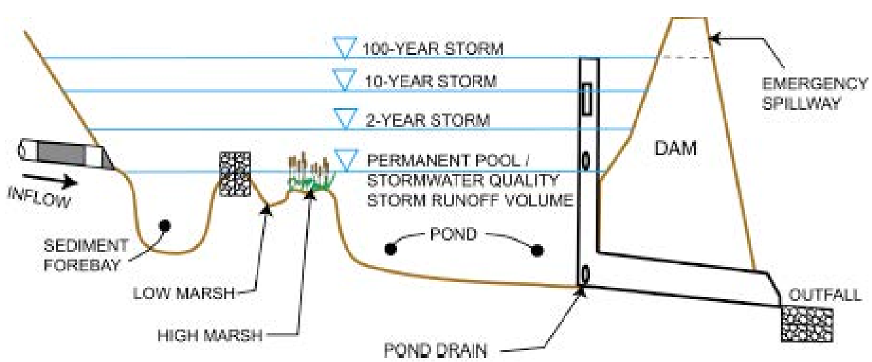
Constructed Gravel Wetland Benefits

Water Quantity
Sediment
Nutrients
Bacteria
Habitat
Demonstration

Figure of Constructed Stormwater Gravel Wetland from NJ BMP Manual

t5. Constructed Stormwater Wetland

Constructed stormwater wetlands are wetland systems designed to maximize the removal of pollutants from stormwater runoff through settling and both uptake and filtering by vegetation. Constructed stormwater wetlands are used to remove a wide range of stormwater pollutants from land development sites as well as provide wildlife habitat and aesthetic features. They can also be used to reduce peak runoff rates when designed as a multi-stage, multi-function facility.



Constructed Wetland Benefits

Water Quantity
Sediment
Nutrients
Bacteria
Habitat
Demonstration

Figure of Constructed Stormwater Wetland from NJ BMP Manual

t5. Private Property BMPs

Private property BMPs are stormwater practices that individual property owners can implement. While the individual benefit of implementing these practices may not be significant, if implemented throughout the watershed they can provide significant cumulative water quality and quantity benefit. Much of the water quality concerns throughout the Metedeconk River watershed are from non-point sources from stormwater. Therefore, implementation of a large scale non-point solution would be beneficial. Some of the types of structural stormwater practices that can be implemented by private property owners and are recommended for this watershed include rain barrels, rain gardens, rain gutter downspout redirection, and cisterns. To some degree, the passing of the New Jersey Fertilizer Law (A2290) is a private property BMP in which restrictions on fertilization have been placed both in terms of when and how much fertilizer can be applied as well as the content of the fertilizer itself.

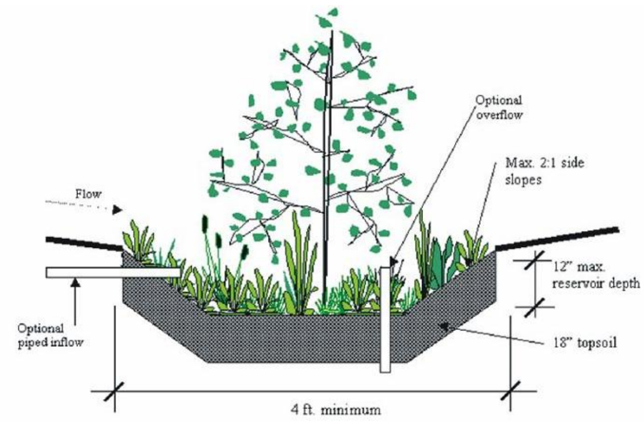


Figure of Rain Garden from EPA

Private Property BMP Benefits

Water Quantity
Sediment
Nutrients
Bacteria
Habitat
Demonstration

8. Bioretention Basin

A bioretention system consists of a soil bed planted with suitable native vegetation. Stormwater runoff entering the bioretention system is filtered through the soil planting bed before being either conveyed downstream by an underdrain system or infiltrated into the existing subsoil below the soil bed. Vegetation in the soil planting bed provides uptake of pollutants and runoff and helps maintain the pores and associated infiltration rates of the soil in the bed. They can be installed in lawns, median strips, parking lot islands, unused lot areas, and certain easements. They are intended to receive and filter storm runoff from both impervious areas and lawns.

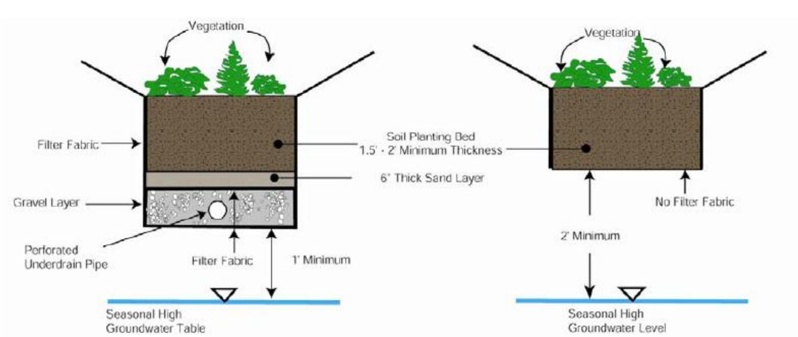


Figure of Bioretention Cell from NJ BMP Manual

Bioretention Basin Benefits

Water Quantity
Sediment
Nutrients
Bacteria
Habitat
Demonstration

t9. *Retrofit Existing Stormwater Basin*

Numerous existing stormwater basins were identified in the stream visual assessments and other studies (i.e. Rutgers/JCNERR) with the potential for retrofit to extended detention (see below) or bioretention. The perimeter area around the basin can be improved with native vegetative cover, rather than just turf grass.

Numerous basins within Ocean County have been retrofit as part of the Stormwater Basin Retrofit Implementation Project between 2002 and 2008 (funded under the Atlantic Coastal Watershed Program Grant to support the Barnegat Bay Watershed).

Basin Retrofit Benefits

Water Quantity
Sediment
Nutrients
Bacteria
Habitat
Demonstration

t9. *Agricultural BMPs*

Many agricultural BMPs exist to control runoff from crops and livestock of all kinds. BMPs on active agricultural lands can significantly reduce the sediment from tilling and cattle traffic, as well as reduce nutrients from fertilizer and livestock waste. A few visual assessment sites identified a potential need for agricultural BMPs.

Site SHB-1: Lush growth along stream bank near nursery indicates that a BMP may be beneficial.

Agricultural BMP Benefits

Water Quantity
Sediment
Nutrients
Bacteria
Habitat
Demonstration

t9. *Buffer Restoration*

Restoration of riparian buffers with native vegetation is especially important for the health of the stream system and provides water quality and ecosystem benefits. Vegetated buffers minimize erosion and filter runoff before it enters the stream channel. Based on the stream visual assessments conducted under Task 2, a number of areas have been identified that would benefit from restoration of riparian buffers.

Buffer Restoration Benefits

Water Quantity
Sediment
Nutrients
Bacteria
Habitat
Demonstration

t9. Vegetated Filter Strip

A vegetated filter strip consists of a 30-foot wide (generally) grassed or thick ground covered buffer. The sheet flow infiltrates into the vegetated filter strip, providing water quality and quantity benefit.

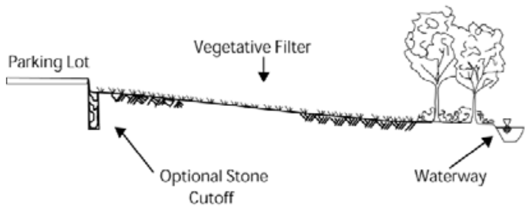


Figure of a Vegetated Filter Strip from NJ BMP Manual

Vegetated Filter Strip Benefits

Water Quantity
Sediment
Nutrients
Bacteria
Habitat
Demonstration

t9. Removal of Impervious Surface

Unutilized or under-utilized impervious surfaces, such as extra parking, are replaced with native or maintained vegetation. This can directly eliminate the source of runoff, allowing infiltration where the rain falls, and potentially enable infiltration from other impervious surface runoff. In addition, for new commercial development, the use of infiltration trenches between parking spaces as opposed to elevated curb cuts would be beneficial.

Removal of Impervious Surface Benefits

Water Quantity
Sediment
Nutrients
Bacteria
Habitat
Demonstration

t14. Improve/Repair Failing Septic System

Improvement/repair of failing septic systems or conversion to sewer service can reduce the level of nutrients seeping into the groundwater and eventually into the waterways. Many areas throughout the Metedconk River watershed continue to be served by individiual on-site septic systems as a means of wastewater disposal. Where these systems have been installed decades ago and are on very small lots, they can essentially act as point sources of contamination (particularly nitrate as nitrogen) to the groundwater.

Repair Failing Septic Benefits

Water Quantity
Sediment
Nutrients
Bacteria
Habitat
Demonstration

t14. Rainwater Harvesting (non-residential)

Rainwater harvesting is the collection of rainwater from non-residential rooftops into cisterns, rain barrels, or similar containers for later release with potential for irrigation or other uses. Collection and reuse reduces offsite runoff and associated pollutant migration.

Rainwater Harvesting Benefits

Water Quantity
Sediment
Nutrients
Bacteria
Habitat
Demonstration

t14. Sand Filter

Sand Filters are used to treat runoff prior to entering the stormwater system by filtering the runoff through a thick layer of sand, typically discharging to an outlet pipe at the bottom of the trench.

Sand Filter Benefits

Water Quantity
Sediment
Nutrients
Bacteria
Habitat
Demonstration

t14. Stream Restoration

Restoration of fluvial systems to approach pre-development conditions where a sinuous channel is reconnected to an expansive floodplain, ideally integrated with riparian wetlands, maximizes natural floodplain retention and treatment potential, elevates the groundwater table, and expands, connects, and nourishes the riparian ecosystem. Streambank stabilization can reduce bank erosion and subsequent sedimentation of the stream channel as well as the nutrients released along with the sediment. This practice can utilize bank shaping, bioengineering, or structural methods to prevent localized bank erosion.The degree of stream restoration can vary from simple streambank stabilization to full restoration of the stream and the immediate riparian area. Several potential stream restoration sites were identified during the stream visual assessments conducted by BTMUA.

Stream Restoration Benefits

Water Quantity
Sediment
Nutrients
Bacteria
Habitat
Demonstration

t18. Grassed Swale

Grassed swales are open-channels stabilized with grass or other vegetation that provide treatment through sedimentation and filtration while conveying concentrated flows.

Grassed Swale Benefits

Water Quantity
Sediment
Nutrients
Bacteria
Habitat
Demonstration

t18. Offline Regional Treatment

Larger scale wetlands or wet ponds located adjacent to, but not within an existing stream or constructed drainage channel can mimic the function of an expansive floodplain by detaining and providing treatment of channelized flows. As storm flows increase in an existing stream or drainage channel and overtop the banks, the excess flow enters into an offline treatment BMP, where it is detained and either slowly released over two to three days back into the stream or channel or is detained until it infiltrates or evaporates.

Offline Regional Treatment Benefits

Water Quantity
Sediment
Nutrients
Bacteria
Habitat
Demonstration

t20. Extended Detention

An extended detention basin is a facility constructed through filling and/or excavation that provides temporary storage of stormwater runoff. It has an outlet structure that detains and attenuates runoff inflows and promotes the settlement of pollutants. An extended detention basin is normally designed as a multistage facility that provides runoff storage and attenuation for both stormwater quality and quantity management.

Extended Detention Benefits

Water Quantity
Sediment
Nutrients
Bacteria
Habitat
Demonstration

t20. Pervious Paving

Pervious paving systems are paved areas that produce less stormwater runoff than areas paved with conventional paving. This reduction is achieved primarily through the infiltration of a greater portion of the rain falling on the area than would occur with conventional paving. This increased infiltration occurs either through the paving material itself (asphalt or concrete) or through void spaces between individual paving blocks known as pavers.

Pervious Paving Benefits

Water Quantity
Sediment
Nutrients
Bacteria
Habitat
Demonstration

t20. Wet Pond

Also known as a retention basin, a wet pond has a permanent pool which performs the same storage function as dry detention, with the added treatment capability of a permanent pool. Wet ponds can provide significant solids removal through settling, with some nutrient uptake. They can also provide significant peak flow reduction. However, wet ponds are not infiltration based strategies and some

Wet Pond Benefits

Water Quantity
Sediment
Nutrients
Bacteria
Habitat
Demonstration

water is lost to evaporation that may be otherwise recharged using an infiltration based strategy.

t23. Dry Well

A dry well stores and infiltrates runoff directly from roofs into a structural chamber or excavated pit filled with aggregate. Because of the limited nutrient and solids concentration from rooftop runoff, the primary benefit is the reduction in runoff volume and contribution to groundwater recharge through surrounding soils.

Dry Well Benefits

Water Quantity	●
Sediment	○
Nutrients	○
Bacteria	○
Habitat	○
Demonstration	●

t23. Green Roof (non-residential)

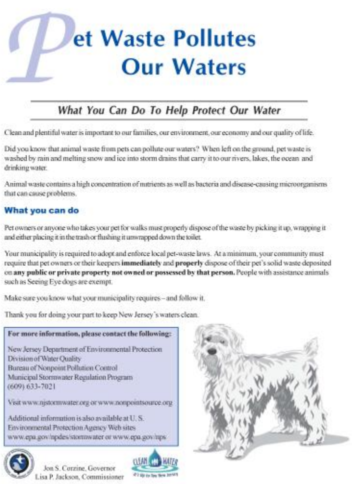
A green roof is defined by flat or very mild sloping roof tops with drainage material and vegetated cover over an impermeable membrane for non-residential buildings, such as office, commercial, and industrial buildings. The roof vegetation can retain and evapo-transpire rainfall, and reduce and filter the atmospheric deposition of nitrogen in runoff at the source as well as reduce energy use. While this BMP is somewhat effective at minimizing run-off and stormwater pollutant loading, it may not be the most appropriate for the Metedeconk River watershed due to the lack of groundwater recharge it would provide (which in turn would improve baseflow).

Green Roof Benefits

Water Quantity	○
Sediment	○
Nutrients	○
Bacteria	○
Habitat	○
Demonstration	●

t23. Source Control (Pet Waste/Fertilizer/Geese Management)

Pet waste and fertilizer management have the potential to reduce pathogen and nutrient contributions from cultural sources at the household scale. Goose management programs have beeen recommended for implementation in the fecal coliform and total coliform TMDLs throughout the watershed. Pet waste control is addressed by the NJDEP stormwater rules and model ordinances and educational materials can be found online.


Pet Waste Pollutes Our Waters

What You Can Do To Help Protect Our Water

Clean and plentiful water is important to our families, our environment, our economy and our quality of life.

Did you know that animal waste from pets can pollute our waters? When left on the ground, pet waste is washed by rain and melting snow and ice into storm drains that carry it to our rivers, lakes, the ocean and drinking water.

Animal waste contains a high concentration of nutrients as well as bacteria and disease-causing microorganisms that can cause problems.

What you can do

Pet owners or anyone who takes your pet for walks must properly dispose of the waste by picking it up, wrapping it and either placing it in the trash or flushing it unwrapped down the toilet.

Your municipality is required to adopt and enforce local pet-waste laws. At a minimum, your community must require that pet owners or their keepers **immediately** and **properly** dispose of their pet's solid waste deposited on **any public or private property not owned or possessed by that person.** People with assistance animals such as Seeing Eye dogs are exempt.

Make sure you know what your municipality requires – and follow it.

Thank you for doing your part to keep New Jersey's waters clean.

For more information, please contact the following:

New Jersey Department of Environmental Protection
Division of Water Quality
Bureau of Nonpoint Pollution Control
Municipal Stormwater Regulation Program
(609) 633-7021

Visit www.njstormwater.org or www.nonpointsource.org

Additional information is also available at U. S. Environmental Protection Agency Web sites www.epa.gov/npdes/stormwater or www.epa.gov/nps

Jon S. Corzine, Governor
Lisa P. Jackson, Commissioner

Source Control Benefits

Water Quantity	○
Sediment	○
Nutrients	●
Bacteria	●
Habitat	●
Demonstration	●

t26. *Manufactured Devices*

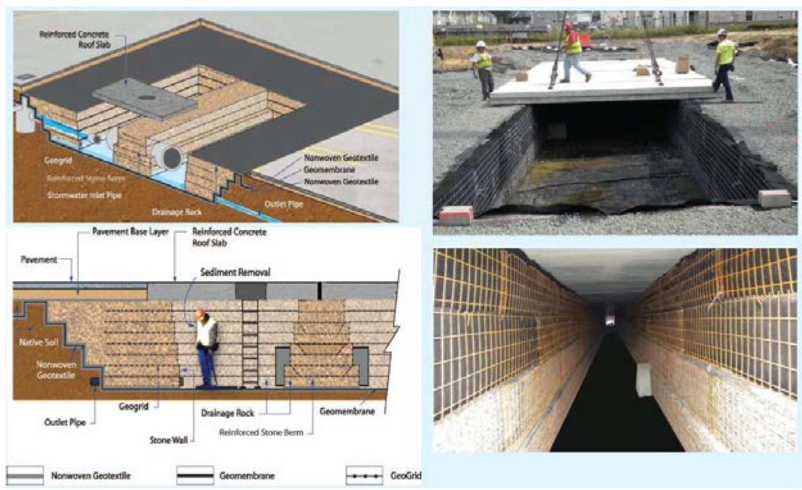
A manufactured treatment device is a pre-fabricated stormwater treatment structure with one or more methods for removing pollutants from stormwater runoff. Removal processes can be settling, filtration, absorptive/adsorptive materials, vortex separation, vegetative components, and/or other appropriate technologies. These devices are adequate for small drainage areas that contain a predominance of impervious cover and that are likely to contribute high hydrocarbon and sediment loadings, such as small parking lots and gas stations.

Manufactured Devices Benefits

- *Water Quantity* ○
- *Sediment* ●
- *Nutrients* ○
- *Bacteria* ○
- *Habitat* ○
- *Demonstration* ○

Devices are normally used for pretreatment of runoff before discharging to other, more effective stormwater quality treatment facilities.

Manufactured devices can also be utilized on a larger scale, such as an industrial complex or areas with large impervious surfaces. These structures can be constructed below ground surface and collect water for storage and sediement removal.



Example of an underground stormwater storage system (from GeoStorage Corp; http://www.geostoragecorp.com/

t26. *Runoff Redirection*

The practice of removing impervious surfaces from direct connection to surface waters through the drainage system and redirecting it to pervious areas provides water quality and quantity benefit through infiltration.

Runoff Redirection Benefits

- *Water Quantity* ●
- *Sediment* ○
- *Nutrients* ○
- *Bacteria* ○
- *Habitat* ○
- *Demonstration* ○

28. *Improved Street Sweeping / Retrofit of Catch Basin Structures*

Street sweeping methods and frequencies may be improved to further reduce the pollutants entrained in the runoff from impervious streets and parking lots. A widespread floatables issue has been identified during the stream visual assessments throught the watershed. Many of the catch basins in the watershed are somewhat antiquated in which the inlet is wide enough to allow the capture of plastic bottles and other debris. These basins should be retrofitted with smaller inlets or traps so that many floatables do not have a direct route to the stream.

Street Sweeping / Catch Basin Benefits

Water Quantity ○
Sediment ●
Nutrients ●
Bacteria ●
Habitat ○
Demonstration ○

Implementation Costs

Cost data from past studies and other credible sources for the candidate BMPs have been compiled and are included in **Table 3** to provide an understanding of the relative cost differences between the various BMPs. **Table 3** presents the cost data and associated source for the candidate BMPs. It can be seen that cost data was not provided for the resource conservation/protection (ranked #1), offline regional treatment (ranked #18), agricultural BMPs (ranked #9), source control (ranked #23), and runoff redirection (ranked #26) BMPs. The costs for these BMPs can vary significantly and should therefore be evaluated on a case-by-case basis.

The costs included in **Table 3** are for construction only and do not include other project costs such as construction contingency, land costs, annual operation and maintenance (O&M) costs, or fees for engineering, permitting, legal, and administrative services. These fees and costs can be significant and are typically approximated for planning-level purposes based on a percentage of the construction cost. Recommended percentages for planning-level cost estimating purposes are presented below. It should be noted that the percentages can vary considerably depending on the size of the project and should be evaluated on a case-by-case basis (e.g. percentage of engineering cost will be different for a $50,000 construction cost versus a $500,000 construction cost):

- Construction Contingency: 30%
- Land Cost = $100,000 per acre
- O&M Annual Cost = 5% of Construction Cost
- Engineering Cost = 15% of Construction Cost
- Permitting, Legal, and Administrative Cost = 10% of Construction Cost

An example of how to use the above percentages is presented in the following table. This example assumes a $500,000 construction cost (no contingency), on a 1 acre parcel.

Example Construction Cost =	$500,000
Construction Contingency (30%) =	*$150,000*
Construction Cost Subtotal =	$650,000
O&M Annual Cost (5%) =	*$32,500*
Engineering Cost (15%) =	*$97,500*
Permitting, Legal, and Admin Cost (10%) =	*$65,000*
Land Cost ($100K per acre) =	*$100,000*
Total Project Cost =	$945,000

Estimated Load Reductions

Pollutant removal efficiencies have been compiled for the the candidate BMPs included in **Table 2** for total suspended solids, total nitrogen, and total phosphorus. As mentioned earlier, removal efficiencies for coliform and pathogens are not shown as they can vary considerably. **Table 4** provides a summary of the removal efficiencies and associated source for the candidate BMPs. Removal efficiencies were not provided for rainwater harvesting BMPs and other types of quantity controls as they do not provide a direct pollutant removal benefit. However, they do provide an indirect benefit as they reduce peak flows and volumes of stormwater being discharged, which in turn reduce the amount of pollutants being conveyed from other impervious surfaces or generated from bank erosion. Removal efficiencies were not provided for offline treatment, agricultural, and manufactured BMPs as the pollutant removal benefit varies depending on the type of approach or device.

Table 5 includes an example summary of the cost per pound removed of total suspended solids, total nitrogen, and total phosphorus for the strategies that can be applied to various examples (see comments column in table). Loading estimates were derived based on unit area loads (NJDEP BMP Manual) by land use type. Median construction costs from **Table 3** and soft cost percentages specified above were utilized. Loading and O&M costs are based on a 20 year period. For those examples that pertain to a residential development (basins, etc), the same development was used for each strategy. This development is a 131 acre development located in Howell Township and was built within the last 15 years. There are 375 homes and the development has 43 acres of impervious cover, as per NJDEP 2007 Land Use/Land Cover data.

It's important to note, however, that the estimates in **Table 5** are clearly geared for cost comparisons of each strategy based on water quality improvements and should not be utilized as the sole source of comparison between strategies. Many of these strategies are very effective at improving infiltration and therefore limiting runoff, but may receive low pollutant loads and therefore the cost per pound removed of a particular pollutant may be very high. For example, if a rain garden only receives runoff from a roof leader, then the load it receives is considerably lower than loading it would receive from collecting runoff from a commercial lot. Therefore, the cost per pound removed would be relatively high, but that shouldn't be used to suggest that a rain garden isn't cost effective, particularly since it is infiltrating the runoff from the roof which otherwise may discharge to the street and enter a stream through stormwater runoff. Conversely, if a rain garden was installed within a commercial lot, perhaps downstream of a landscape or garden supply establishment, the load it could receive may be much higher thereby making it more cost effective. The cost per pound of pollutant removed is therefore very sensitive to the particular scenario that it is being utilized for and care should be taken when evaulating the cost estiamtes in the table below.

Because of the wide range of treatment cost estimates, a range is given in **Table 5** in which the same area was used and different land uses were included. The range includes loading from not only residential developments, but from urban, commercial and industrial as well corresponding to the same areas.

Table 3
BMP Implementation Costs

Rank[1]	BMP Type	Cost[2]	Unit	Source[3]	Year[4]	Comments
1	Resource Conservation/Protection	*See Note 5*				
2	Urban Green Stormwater Infrastructure					
a	Stormwater Planter	$50,000	EA	Philadelphia Green Streets Clean Waters Program	2009	Estimates only. Costs can vary significantly depending on size of the structure. Becomes more cost effective when multiple units are installed.
b	Stormwater Bumpout	$36,000	EA		2009	
c	Infiltration Tree Trench	$15,000	EA		2009	
t3	Infiltration Basin	$21,000 - $44,000	$/impervious acre	Table 2.3.1-18 Philadelphia CSO Study	2008	
t3	Reforestation	$41,800	$/acre	North Carolina Ecosystem Enhancement Program (NCEEP)	2011	Adopted from NCEEP cost for buffer restoration
t5	Constructed Stormwater Gravel Wetland	$22,500	$/impervious acre	UNHSC Biannual Report (2009)	2009	
t5	Constructed Stormwater Wetland	$2,100 - $10,000	$/impervious acre	Table 2.3.1-18 Philadelphia CSO Study	2008	
t5	Private Property BMPs					
a	Rain Barrel	$100 - $150	EA	Fairfax County, VA - LID BMP Fact Sheet	2005	
b	Rain Garden	$3 - $4	$/ft^2	NJ Rain Garden Manual	2005	
c	Rain Gutter Downspout Redirection	$100	EA	Fairfax County, VA - LID BMP Fact Sheet	2005	
d	Cistern	$150 - $10,000	EA	Fairfax County, VA - LID BMP Fact Sheet	2005	
8	Bioretention Basin	$21,000 - $44,000	$/impervious acre	Table 2.3.1-18 Philadelphia CSO Study	2008	
t9	Retrofit Existing Stormwater Basin	$3,800 - $39,000	$/impervious acre	Table 2.3.1-18 Philadelphia CSO Study	2008	
t9	Agricultural BMPs	*See Note 5*				
t9	Buffer Restoration	$41,800	$/acre	NCEEP	2011	
t9	Vegetated Filter Strip	$3,000 - $5,000	$/impervious acre	LS = Pennsylvania BMP Manual; VFS = NCEEP	2011	
t9	Removal of Impervious Surface	$174,000	$/acre	NCSU for Division of Soil & Water Conservation	2007	
t14	Improve/Repair Septic Systems	$25,000	$/single home system	Rutgers Cooperative Extension Fact Sheet	2005	
t14	Rainwater Harvesting (non-residential)	$1	$/gal	NCSU for Division of Soil & Water Conservation	2007	
t14	Sand Filter	$19,000 - $83,000	$/impervious acre	Table 2.3.1-18 Philadelphia CSO Study	2008	
t14	Stream Restoration	$349	$/LF	NCEEP	2011	
t18	Grassed Swale	$11,000 - $38,000	$/impervious acre	Table 2.3.1-18 Philadelphia CSO Study	2008	
t18	Off-line Regional Treatment	*See Note 5*				
t20	Extended Detention Basin	$2,300 - $7,800	$/impervious acre	Table 2.3.1-18 Philadelphia CSO Study	2008	
t20	Pervious Paving	$24,000	$/impervious acre	Fairfax County, VA - LID BMP Fact Sheet	2005	
a	Porous Asphalt	$2.80	$/sf	UNHSC Biannual Report (2009)	2008	
b	Porous Concrete	$4 - $5	$/sf	UNHSC Biannual Report (2009)	2008	
t20	Wet Pond	$3,200 - $30,000	$/impervious acre	Table 2.3.1-18 Philadelphia CSO Study	2008	
t23	Dry Well	$10,000	EA	Fairfax County, VA - LID BMP Fact Sheet	2005	
t23	Green Roof (non-residential)	$23,000 - $1,100,000	$/impervious acre	Table 2.3.1-18 Philadelphia CSO Study	2008	
t23	Source Control (pet waste, fertilizer)	*See Note 5*				
t26	Manufactured Devices	$5,000 - $150,000	$/impervious acre	EPA Equations	2004	
t26	Runoff Redirection	*See Note 5*				
28	Improved Street Sweeping	$200	$/impervious acre	Fairfax County, VA - LID BMP Fact Sheet	2005	Does not include cost for street sweeper

Notes:

1.) *Ranking is defined in Table 2.*
2.) *Cost is for construction only.*
3.) *See end of this Technical Memorandum for full reference description*
4.) *Year is the year in which the costs were published. Therefore, if used they should be inflated to present worth dollars.*
5.) *Cost data not provided due to significant variability and/or limited available data.*

Table 4
BMP Pollutant Removal Efficiencies

Rank[1]	BMP Type	Removal Efficiency			Source[2]	Comments
		Total Suspended Solids	Total Nitrogen	Total Phosphorus		
1	Resource Conservation/Protection	50%	25%	50%	Chesapeake Bay Program	Assume same as reforestation
2	Urban Green Stormwater Infrastructure					
a	Stormwater Planter	90%	60%	30%		Assume same as rain garden
b	Stormwater Bumpout	90%	60%	30%		Assume same as rain garden
c	Infiltration Tree Trench	93%	3%	NT	UNHSC	
t3	Infiltration Basin	80%	30%	30%		Assume same as a sand filter
t3	Reforestation	50%	25%	50%	Chesapeake Bay Program	
t3	Constructed Stormwater Gravel Wetland	99%	See comment	56%	UNHSC	NO3-N (dissolved inorganic nitrogen) removal percentage of 98%
t5	Constructed Stormwater Wetland	90%	50%	30%	NJ BMP Manual	
t5	Private Property BMPs					
a	Rain Barrel	*See Note 3*				
b	Rain Garden	90%	60%	30%		Assume same as bioretention
c	Rain Gutter Downspout Redirection					
d	Cistern	*See Note 3*				
8	Bioretention Basin	90%	60%	30%	NJ BMP Manual	
t9	Retrofit Existing Stormwater Basin	50%-90%	60%	30%		Assume same as new wet pond
t9	Agricultural BMPs	*See Note 4*				
t9	Buffer Restoration	40%-100%	3%-26%	20%-50%	Rutgers	
t9	Vegetated Filter Strip	60%-80%	50%	30%	NJ BMP Manual	
t9	Removal of Impervious Surface	50%	25%	50%	Chesapeake Bay Program	
t14	Improve/Repair Septic Systems	100%	25%		*Environmental Engineer: Applied Research and Practice*	
t14	Rainwater Harvesting (non-residential)	*See Note 3*				
t14	Sand Filter	80%	30%	30%	NJ BMP Manual	
t14	Stream Restoration	2 lbs/ft	0.02 lbs/ft	0.003 lbs/ft	Chesapeake Bay Program	
t18	Grassed Swale	45%	70%	45%	Chesapeake Bay Program	Assume A/B hydrologic soils
t18	Off-line Regional Treatment	*See Note 4*				
t20	Extended Detention Basin	40%-60%	60%	50%	NJ BMP Manual	
t20	Pervious Paving	80%	50%	35%	NJ BMP Manual	
t20	Wet Pond	50%-90%	60%	30%	NJ BMP Manual	
t23	Dry Well	0%	20%	20%	NJ BMP Manual	
t23	Green Roof (non-residential)	*See Note 3*				
t23	Source Control (pet waste, fertilizer)	*See Note 5*				
t26	Manufactured Devices	*See Note 4*				
t26	Runoff Redirection	*See Note 5*				
28	Improved Street Sweeping	9%	3%	3%	Chesapeake Bay Program	

Notes:
1.) *Ranking is defined in Table 2.*
2.) *See end of this Technical Memorandum for full reference description.*
3.) *BMP does not provide direct pollutant removal benefit.*
4.) *Pollutant removal is dependent on the type of device used.*
5.) *Pollutant removal is dependent on variable inputs and scope of implementation*

Table 5
Costs per Pound Removed for Select Management Strategies

Rank[1]	BMP Type	Costs per pound removed			Comments
		$/lb TSS removed	$/lb N removed	$/lb P removed	
1	Resource Conservation/Protection	16 - 31	132 - 357	1250 – 2777	Cost based on load difference between forest and developed on 131 acre site
2	Urban Green Stormwater Infrastructure				
a	Stormwater Planter	791	14,246	284,929	Example based on urban setting (Philadelphia Green City, Clean Waters Program)
b	Stormwater Bumpout	3	59	1,176	Example based on urban setting (Philadelphia Green City, Clean Waters Program)
c	Infiltration Tree Trench	57	21,068	N/A	Example based on urban setting (Philadelphia Green City, Clean Waters Program)
t3	Infiltration Basin	10 - 16	236 - 520	2,476 – 5,201	Example based on a 131 acre development.
t3	Reforestation	105	1,045	5,225	Example based on a 10 acre site, originally barren land converted to forest.
t3	Constructed Stormwater Gravel Wetland	5 – 9	50 – 110	918 – 1,929	Example based on a 131 acre development.
t4	Constructed Stormwater Wetland	2 - 3	26 - 58	461 – 968	Example based on a 131 acre development.
t4	Private Property BMPs				
a	Rain Barrel	N/A	N/A	N/A	
b	Rain Garden	14 - 69	188 - 376	3,933 – 82,583	Assumes simple example of a 1,000 sf rooftop or 1,000 sf of impervious cover draining to the rain garden. Assumes 250 sf rain garden.
c	Rain Gutter Downspout Redirection	N/A	N/A	N/A	
d	Cistern	N/A	N/A	N/A	
8	Bioretention Basin	9 - 14	118 - 260	2,476 – 5,201	
t9	Retrofit Existing Stormwater Basin	17 - 29	185 - 408	3,886 – 8,161	
t9	Agricultural BMPs	-	-	-	Cost data not provided due to significant variability
t9	Buffer Restoration	30 - 149	1,244 – 7,464	4,593 – 20,444	Variable. Depends on restoration width, etc. For this cost, assumes simple replanting for residential and barren land uses for a 10 acre site. For urban, commercial, industrial, add removal of 5 acres of impervious cover (parking lot). Resulting load is representative of forest.
t9	Vegetated Filter Strip	4 - 7	53 - 117	929 – 1,950	Assume 2 acre parking area that discharges directly to stream (100% impervious).
t9	Removal of Impervious Surface	87 - 145	1,582 – 3,480	8,286 – 17,400	Assumes a 5 acre commercial area that discharges directly to stream. Remove 25% of impervious cover (underutilized space). For residential, remove 500 sf.
t14	Improve/Repair Septic Systems	-	119	-	Assume neighborhood of 100 failing septic systems. Use 10 lbs-N/person per year, 3.5 persons per household, old system removes 10% of [N], new system removes 40% [N].
t14	Rainwater Harvesting (non-residential)	N/A	N/A	N/A	
t14	Sand Filter	15 - 26	371 - 816	3,886 – 8,161	Example based on a 131 acre development.
t14	Stream Restoration	14	1,418	9,450	1,000 feet of stream restoration
t18	Grassed Swale	27 - 45	159 - 350	2,591 – 5,441	Example based on a 131 acre development.
t18	Off-line Regional Treatment	-	-	-	Cost data not provided due to significant variability
t20	Extended Detention Basin	24 - 41	185 - 408	2,332 – 4,897	
t20	Pervious Paving	165 - 274	2,395 – 5,270	35,847 – 75,279	Assumes conversion of 50% of streets in example residential development and assuming atmospheric loading (water land use).
t20	Wet Pond	6 - 9	60 - 133	1,265 – 2,656	
t23	Dry Well	-	-	-	
t23	Green Roof (non-residential)	N/A	N/A	N/A	
t23	Source Control (pet waste, fertilizer)	-	-	-	Pollutant removal is dependent on variable inputs and scope of implementation
t26	Manufactured Devices	-	-	-	Pollutant removal is dependent on the type of device used.
t26	Runoff Redirection	-	-	-	Cost data not provided due to significant variability
28	Improved Street Sweeping	-	-	-	Variable

Stakeholder Priorities

The prioritization of management strategies listed in this memorandum assumes that all defined BMP functions are weighted equally and that there is no preference for any particular function over another. To further refine the prioritization, stakeholder input was collected via a survey which was originally distributed during a Stakeholder Advisory Committee meeting in November 2011 and again online to those stakeholders who could not participate in the meeting. The purpose of the survey was to have each stakeholder provide their subjective input into what functions should be relatively weighted more than others which would be used to refine the prioritization of management strategies to an order that is most meaningful to the stakeholders.

All technical information listed in **Tables 2-5** were coupled to subjectively applied criteria weights in a decision support tool called EVAMIX to assign relative priorities to each management strategy. EVAMIX is a sophisticated computerized, multi-criteria evaluation program developed by CDM Smith to rank alternatives, using all available information and accounting for the relative priorities of the stakeholders. This program takes raw data of varying units, both quantitative and qualitative, normalizes it, and uses it to compare alternatives, while helping its users to better understand what factors have a greater or lesser impact on the outcome.

A total of 47 stakeholders participated in the survey, representing nearly half of the total stakeholder advisory committee. Each BMP function was included and the stakeholders were asked to assign a relative weight to each so that the total would be 100. For example, if someone was primarily concerned with improving baseflow to the Metedeconk, but considered all other functions equally secondary, the results may look as follows:

BMP Function	Relative Weight
Reduce Stormwater Peak Flow	**10**
Improve Baseflow	**40**
Promote Water Conservation & Reuse	**10**
Improve Water Quality	**10**
Improve Habitat	**10**
Potential for Public Involvement	**10**
Cost	**10**

In this example, projects that have an excellent infiltration potential (score of 3 in **Table 2**) would have a higher priority. However, it's important to note that the other functions are also factored in when comparing alternatives. For example, although a project may have an excellent infiltration potential, if it scores low in other categories (if it offers no potential for public involvement or is very expensive), that project may not out-rank one which may have a slightly lower infiltration potential (score of 2 in **Table 2**) but is less expensive and offers more public involvement.

The results from the stakeholder survey were averaged and are as follows:

BMP Function	Average Weight	Min	Max
Reduce Stormwater Peak Flow	**12**	5	40
Improve Baseflow	**16**	0	35
Promote Water Conservation & Reuse	**12**	5	35
Improve Water Quality	**24**	10	50
Improve Habitat	**13**	3	40
Potential for Public Involvement	**9**	0	20
Cost	**13**	0	40

Based on the results, improving water quality was deemed the most important function to the stakeholders and potential for public involvement was the least. Improving baseflow was second while the others generally weighted equally for third.

Because those projects which emphasize infiltration and water quality improvement have the highest priority with the stakeholders within the Metedeconk River watershed, they will have the highest priority within the watershed plan (Task 8) and the conceptual designs (Task 9).

Qualitative scores listed in **Table 2** were incorporated into EVAMIX along with the average relative weights for the BMP functions. For the cost criteria, although a range of costs were calculated for most management strategies, a relative qualifier was also assigned primarily since the costs vary so significantly. A value of 1 was used to indicate that a particular strategy was not cost effective (relative to the other strategies) and a value of 3 was used if a strategy was relatively cost effective. Cost values were assigned as follows:

- The average of the cost per pound removed was calculated for each management strategy over the land use types evaluated;
    - This resulted in a single $/lb removed for TSS, TN, and TP for each strategy.
- The overall average $/lb removed was calculated;
    - This resulted in an overall average $/lb removed for TSS, TN and TP over all strategies for which cost information could be obtained.
- The 33rd and 66th percentiles were calculated based on the $/lb removed for each strategy.
    - If the average cost was less than the 33rd percentile, a value of 3 was assigned.
    - If the average cost was between the 33rd and 66th percentiles, a value of 2 was assigned.

- If the average cost was more than the 66th percentile, then a value of 1 was assigned.

- For strategies that did not have cost information available, a value of 2 or 1 was assigned, based on general treatment potential. This applied for agricultural BMPs, rainwater harvesting, off-line regional treatment, dry wells, green roofs, source control, manufactured devices, runoff redirection and street sweeping. For strategies that had little or no treatment benefit (rainwater harvesting, green roof, manufactured treatment devices (for TN and TP)), a value of 1 was assigned (limited pollutant loading).

EVAMIX results are shown in **Table 6**. As shown on the table, those strategies which promote water quality improvement and infiltration are prioritized.

In order to further evaluate how these projects are related to cost, the cost ranking of each of the projects in terms of water quality (cost per pound of solids and nutrients removed) is also included in **Table 6** (cost was weighted 90% and the others equally at 1.67%). Comparing both is useful since it allows for an additional level of prioritization. For example, infiltration tree trenches are very effective at reducing runoff volume and promoting infiltration, however, they do not remove pollutants as effectively as other strategies and therefore the cost effectiveness for water quality is relatively low. So, although an infiltration tree trench may rank higher than say a bioretention basin, if a particular area has a higher need for water quality improvement, the bioretention basin is clearly more cost effective.

The first column of **Table 6** should be used for prioritizing all projects considering both technical ranking (**Table 2**) and stakeholder priorities. However, if one wants to determine which project is most cost effective at removing nutrients and solids, column 2 should be used; particularly if a water quality improvement project is planned and funding is limited.

It's important to note that the strategies that encourage the implementation of existing TMDLs should be prioritized and developed, although that may not be evident when evaluating **Table 6**. Because source control offers no benefit to increasing infiltration, it ultimately ranks relatively low compared to other projects. However, as mentioned above, the fecal coliform TMDL strategy calls for source control of pets and geese as one of the primary management strategies. Since that strategy is very effective at reducing pathogen loads (see Table 2), it should be prioritized and implemented.

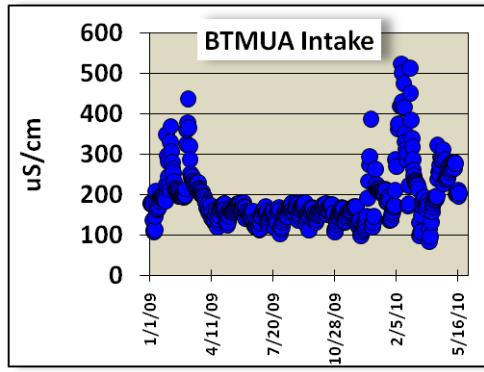
Table 6
Revised Prioritized Management Strategies based on Input from Stakeholder Advisory Committee

Management Strategy	Rank Based on SAC	Rank Based on Cost per Pound of Nutrients/TSS Removed
Resource Conservation/Protection	1	7
Stormwater Bumpout (UGSI)	2	1
Infiltration Basin	3	9
Constructed Stormwater Gravel Wetland	t4	t2
Constructed Stormwater Wetland	t4	t2
Stormwater Planter (UGSI)	t6	t23
Infiltration Tree Trench (UGSI)	t6	t23
Upland Reforestation	8	20
Bioretention Basin	9	6
Private Property BMPs	10	16
Retrofit Existing Stormwater Basin	11	8
Vegetated Filter Strip	12	4
Agricultural BMPs	13	10
Removal of Impervious Surface	14	25
Buffer Restoration	15	27
Wet Pond	16	5
Improve/Repair Septic Systems	17	18
Grassed Swale	18	17
Sand Filter	19	19
Rainwater Harvesting (non-residential)	20	26
Stream Restoration	21	21
Source Control (pet waste, fertilizer, geese management))	22	13
Extended Detention Basin	23	12
Dry Well	24	11
Off-line Regional Treatment	25	30
Pervious Paving (porous asphalt, concrete)	26	28
Runoff Redirection	27	14
Green Roof (non-residential)	28	29
Improved Street Sweeping	29	15
Manufactured Devices	30	22

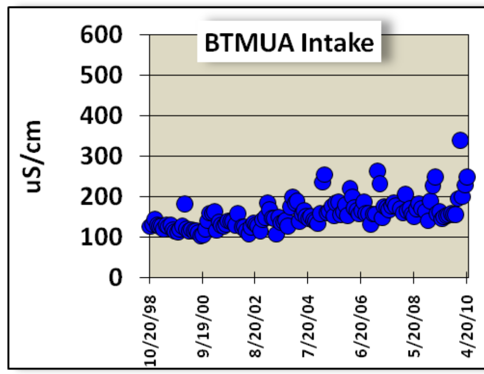
UGSI = urban green stormwater infrastructure.

Additional Regional Non-Point Source Management Measures

Road Salting



The technical analysis (Task 3) indicated that conductance is clearly increasing throughout the watershed, in part due to road salting during winter conditions. Daily conductance values are very high following winter storm events and the monthly average has been increasing over the past 12 years, potentially due to elevated groundwater concentrations.



There are numerous townships and agencies responsible for road salting within the Metedeconk River watershed including individual township Department of Public Works (DPW), New Jersey Department of Transportation (NJDOT) and the New Jersey Turnpike Authority (NJTA) and each likely has a different approach to salting.

There are several BMPs for road salting that can be applied such as:

- Utilizing alternative products such as acetate deicers (calcium-magnesium-acetate, or CMA; potassium acetate (KA), sodium acetate) or organic process derivatives (Geomelt®, Ice Ban® and many others). However, the costs of some of these alternatives far exceed those of traditional road salt.

- Good housekeeping practices for storage and handling (store salt on flat impermeable pads, covered loading areas and away from water bodies)

  - Expand buffers around storage facilities where possible

  - Secondary containment for liquid storage

- Applicator training to apply "just enough" and avoid over-application

  - Includes spreader calibration, procedures for automating the applicator shut down when truck is not moving (intersections or in traffic)

- Pre-wetting – this process involves wetting the salt pile(s) with a pre-wetting solution which accelerates the process of brine formation and reduces bounce and scatter when applied to the road. Pre-wetting may reduce the application of road salt by 15-20% (UNHTTC, 2010).

- Anti-icing – application of liquid brine or other de-icing agent in advance of the storm
- Education and outreach for homeowners and private property deicing (shopping malls, industrial parks, etc).

While a combination of the above would provide the overall recommended management strategy, in order to evaluate how it would be best implemented, it is recommended that a workshop with representatives from all relevant departments and agencies be held to discuss the road salting methods currently applied by each.

Regional Implementation of Site Specific Management Strategies

Many of the management strategies addressed throughout this memorandum are BMPs designed to treat a specific site. Many of the BMPs are intended to serve only a limited area and several may be needed for a large residential development, particularly if ample space is not available for a large basin or wetland. In addition, some of these strategies may be more applicable to particular land uses and sites than others.

Regional implementation of these strategies will ultimately be required to maximize the protection of the watershed. Private property BMPs can be effective, but outreach and participation are critical. For example, one resident installing a rain garden may reduce the runoff and loading from that particular parcel, but will be somewhat insignificant in a development of 375 homes.

Regional implementation of these BMPs can be achieved through municipal ordinances which require Low Impact Design (LID) techniques be applied to any new development or redevelopment of existing property. These ordinances should be tailored so that infiltration of stormwater is achieved. Many of the strategies described throughout this memorandum involve retrofitting of existing areas, but can be applied to new development as well. For example, new parking lots could encompass green parking designs which utilize pavers in overflow parking areas and have runoff directed to vegetated islands as opposed to having the islands completely curbed. New developments can eliminate curbs by installing infiltration trenches along streets.

Photographs of curb cuts redirecting runoff from a parking area to vegetated cover (photos from EPA).

It is recommended that low impact development techniques be adopted by all townships, beyond what is required by the Phase II Stormwater Rules, for new development and retrofit wherever possible. This is particularly critical for areas that are anticipating significant residential growth in the coming years. Applying LID techniques will disconnect impervious cover, improve infiltration and limit runoff to the Metedeconk River.

Regional implementation could be achieved through adoption of local land use ordinances or through some other means. These options will be addressed in more detail in Task 8.

Example of a residential development without curbs (photo from EPA).

Summary

Protection, infiltration, and restoration stormwater BMPs were identified as the most effective approaches for meeting the goals and associated water quantity, water quality, and habitat objectives of the Metedeconk Watershed Plan.

Effective and efficient application of the BMPs listed in **Table 2** to the watershed depends on development status, impervious cover, pollutant loadings by land use, location relative to the riparian corridor, and ecological conditions, among others. These factors have been analyzed by previous studies including the Technical Analysis portion of this plan, the Conservation, Restoration, and Stormwater Management Priorities for Source Water Protection in the Metedeconk River Watershed by the University of Massachusetts (2003), the Barnegat Bay 2020 Report by The Trust for Public Land (2008) and the riparian zone status report by Rutgers University (2007). General locations appropriate for conservation, restoration, and stormwater management practices have been identified throughout the watershed as part of these studies, as well as through stream visual assessments of on-the-ground riparian corridor conditions conducted by BTMUA. Stormwater basins and potential mitigation sites have also been identified and mapped by Rutgers University and can be viewed using their Stormwater Management & Planning Tool (SWMPT; http://barnegatbaybasins.rutgers.edu/).

A number of critical areas and potential project sites have been identified and are listed in the Technical Analysis report. These potential sites are shown on **Figure 1** along with calculated nitrogen loading throughout the watershed. Nitrogen loading was calculated based on 2007 land use/land cover (from NJDEP) and unit area loads, as specified by the New Jersey Best Management Practices Manual. Each of the candidate project sites should be prioritized using the ranking provided in **Tables 2 and 6** of this technical memorandum and then evaluated on a case-by-case basis to determine which BMP or BMPs in combination/series will provide the most water quantity, quality, and habitat benefit for the cost. This process is on-going and will be completed during the development of the Watershed Plan, as part of Task 8. In addition, these sites will be discussed with members of the Technical Steering Committee as well as with the Project Stakeholder Advisory Committee so that appropriate project locations are chosen for conceptual design in Task 9 of this evaluation.

Almost all of the strategies described in this memorandum can be applied to either new development through low impact development techniques or retrofit into existing structures. Implementing LID techniques on new development presents a great opportunity to fully utilize many of these strategies since it will be more cost effective to incorporate them into the development as it is being built. In addition, it would allow for 100% participation from all residents within the development from the time it is completed. Employing these techniques on a development scale would also promote public awareness which may encourage those in surrounding existing developments to retrofit existing infrastructure or implement private property BMPs.

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