RUTGERS
New Jersey Agricultural Experiment Station

Water Resources Program

Hamilton Township (Mercer County)

Watershed and Stormwater Management Implementation Plan (Final Draft)

Developed by the Rutgers Cooperative Extension Water Resources Program
Funded by Hamilton Township, Mercer County, New Jersey

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Acknowledgements

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Purpose of the Implementation Plan

The purpose of this plan is to outline strategies for Hamilton Township to implement throughout the community to improve water quality, involve both residents and decision-makers in protecting the environment, increase Hamilton's compliance with current stormwater regulations, and sustain high quality water resources. The recommended projects and strategies are a result of the information gathered, synthesized, and presented in the *Hamilton Township (Mercer County) Hydrology Report* developed by the Rutgers Cooperative Extension (RCE) Water Resources Program and funded by Hamilton Township, Mercer County, New Jersey.

The recommended actions were identified as they will support a series of goals established for Hamilton Township in its ongoing efforts to address water resources. These goals include:

- Engage the community in water resource protection
- Manage water quality
- Minimize localized flooding
- Implement Phase II stormwater controls
- Improve stormwater facility maintenance

Development of the *Hamilton Township (Mercer County) Hydrology Report* was the result of analyzing previously collected data, reviewing the results of water quality sampling, gathering input from local stakeholders, and conducting field visits within the township. Projects that have been identified are expected to have the most effective impact on water resources in Hamilton Township and benefit local water quality beyond the minimum mandated by regulatory agencies.

Projects that involve cessation of anthropogenic pollution are a priority, followed by maintenance of existing and future stormwater management measures, education and involvement of the public in creating sustainable water resources, and low cost-high benefit projects. It should be noted that many of these projects will require a multi-year commitment to fully implement and achieve established goals. Therefore, it is important that this implementation plan remain dynamic and that implementation efforts become an evolving program. Regular meetings with stakeholder groups should be held to solicit information on the ever-changing needs of Hamilton Township so additional projects can be added to this plan and efforts targeted to those needs. This document should also be consulted during the decision-

making process for municipal and county governments as they proceed to plan for growth, keeping environmental and water resources protections a priority.

Water Resources Goals

Community goals and proposed implementation strategies provide direction and guidance for effective allocation of available resources and measuring long-term success. The goals and strategies outlined in the implementation plan serve to focus efforts and secure community-wide support for long-term water resources management efforts.

Engage the community in water resource protection

Water resources management is an ongoing process that must be inclusive to achieve real, measurable improvements in environmental quality. By involving township residents and active local organizations through education and increased awareness of the issues at hand and active participation in strategies to minimize nonpoint source pollution, the community becomes invested in the future sustainability of local water resources.

Manage water quality

Many of the efforts to improve water quality of local streams, rivers, and ponds begin with knowledge on the status and trends of water quality. The strategies necessary to maintain good water quality and improve degraded waters require data on the current condition of waterways so that realistic water management targets can be set. These targets will dictate the implementation projects developed by technical partners to improve water quality.

Minimize localized flooding

Many municipalities across the country have recognizable flood-prone areas, usually along a river, stream, or other large body of water. These areas are categorized as Special Flood Hazard Areas and are under the jurisdiction of the Federal Emergency Management Agency. However, localized flooding problems outside these regulated jurisdictions resulting from poor drainage, inadequate stormwater controls, clogged culverts, obstructed drainage pipes, or sewer backups plague many communities. These localized events can be more frequent and, at times,

more destructive, than less frequent larger events. Systems need to be in place to locate these localized flood areas, determine their extent, and develop solutions to address these problem events.

Implement Phase II stormwater controls

The New Jersey Department of Environmental Protection (NJDEP) Municipal Stormwater Permitting Program addresses pollutants entering our waters from certain storm drainage systems owned or operated by local, county, state, interstate, or federal government agencies. These systems are called "municipal separate storm sewer systems" (MS4s) and are regulated by a General New Jersey Pollution Discharge Elimination System permit issued to municipalities throughout the state. This permit focuses on requiring the municipalities to clean and maintain their MS4 and pass ordinances that will limit water pollution at its source.

Improve stormwater facility maintenance

Water, stormwater, and sewer infrastructure systems in many communities are reaching the end of their functional life. Opportunities exist to reduce costs for maintaining and replacing this aging infrastructure using new techniques and technologies, better preparing our communities for a sustainable future. Green infrastructure planning and design approaches help communities reduce demands on existing infrastructure, extend its functional life where possible, and provide cost-effective and sustainable solutions that conserve and protect water resources while improving the quality of life of a township's citizens.

Implementation Strategies

To support these goals, specific actions have been identified that will help Hamilton Township achieve and sustain a long-term water resources management program. These actions are presented as a table in Appendix A. The action items are outlined in detail in the following pages and more importantly, potential project partners, resources, and funding sources have been identified. With a long-term commitment from the community, efforts should be given to partner with local, state, and federal agencies and programs to help the township in implementing

this ambitious program. Many technical resources and funding programs can provide support as Hamilton Township works to fully implement its water resources management plan.

GOAL 1:
Engage the Community in Water Resources Protection

Recommended Action:

Conduct riparian area investigations.

Objectives:

Riparian areas (lands adjacent to waterways such as rivers and streams) can influence the health of local waterways based upon the land uses near them. A healthy riparian area consists of a buffer of vegetated land surrounding the waterbody, potentially capable of filtering non-point source pollution in runoff from adjacent lands. A healthy riparian area contains a native vegetative buffer to remove suspended solids and other pollutants from stormwater runoff flowing through the length of vegetation. A planted riparian buffer, also called a vegetated filter strip, typically can be turf grasses, native grasses, herbaceous vegetation and woody vegetation, or some combination of these. It is important to note that all runoff must enter and flow through the vegetated areas as sheet flow. Failure to do so can severely reduce and even eliminate the riparian area's ability to remove pollutants. Unhealthy or degraded riparian buffers consist of developed or paved surfaces abutting the waterway, areas with inadequate or invasive vegetation, and areas that exhibit signs of streambank erosion.

Healthy, vegetated riparian areas can be effective in reducing sediment and other total suspended solids (TSS), as well as associated pollutants such as hydrocarbons, heavy metals, and nutrients. The TSS removal rates for vegetative filters depend upon the vegetation planted in the filter strip, but are estimated to range from 60% to 80% (New Jersey Department of Environmental Protection [NJDEP], 2004). The pollutant removal mechanisms include sedimentation, filtration, adsorption, infiltration, biological uptake, and microbial activity. A removal rate of 30% has been estimated for phosphorus and nitrogen (NJDEP, 2004). Vegetated buffers with planted or indigenous woodlands may also create shade along water bodies that decrease aquatic temperatures, provide a source of detritus and large woody debris for fish and other aquatic organisms, and provide habitat and protective corridors for wildlife.

This strategy would entail the recruitment of community volunteers and training them to conduct surveys to identify degraded riparian zones to be restored, disconnected/bypassed riparian zones lacking stormwater function, and high quality riparian zones to be protected and/or preserved. These areas could potentially be listed as stream buffer conservation zones through the current ordinance in Hamilton Township.

Local Project Partners:

- RCE Water Resources Program
- Hamilton Township Environmental Commission
- Riparian property owners
- Township residents
- Not-for profit organization (i.e., watershed association or open space preservation)

Estimated Project Costs:

Training of volunteers to conduct riparian surveys and the coordination and analysis of data generated could cost anywhere from $5,000 to $10,000 per year.

Anticipated Timeline(s):

There are approximately 90.5 miles of rivers and streams within Hamilton Township. These include the Assunpink Creek, Miry Run and its tributaries, Pond Run and tributaries, Edges Brook, Back Creek, Doctors Creek and its tributaries, and a section of the Delaware River. Investigations into the health of these waterways are estimated to take approximately two years to complete.

Potential Funding Sources:

- Association of New Jersey Environmental Commissions (ANJEC) Sustainable Land Use Planning Grants: http://anjec.org/SmartGrowthGrants.htm
- Sustainable Jersey™ Small Grants Program: http://sustainablejersey.com/resources.php?sec_num=1

- The Watershed Institute Grant Program: http://www.thewatershedinstitute.org/resources/twig/index.php

References

New Jersey Department of Environmental Protection (NJDEP), 2004, New Jersey Stormwater Best Management Practices Manual. Division of Watershed Management. Trenton, NJ.

GOAL 1:
Engage the Community in Water Resources Protection

Recommended Action:

Conduct vernal pool habitat surveys and certification.

Objectives:

Vernal pools are confined wetland depressions, either natural or man-made, devoid of any breeding fish populations. After several months or long periods without precipitation, these areas dry up, preventing long-term populations of fish from permanently establishing in the vernal pools. They provide critical habitat for a variety of species of amphibians, specifically due to the fact that they lack fish populations that would normally prey on them. Many of the amphibians that utilize vernal pools as breeding habitat are endangered or of special concern in the State (Lathrop *et al.*, 2005).

In 2001, the NJDEP Endangered and Nongame Species Program partnered with the Rutgers University Center for Remote Sensing and Spatial Analysis (CRSSA) to begin mapping potential areas that could harbor vernal pools across the state (Lathrop *et al.*, 2005). The areas mapped represent potential areas containing vernal pools, but field verification is required to confirm their presence. This mapping has identified 80 potential vernal pool sites within Hamilton Township, but to date only one has been field surveyed. Because they are depressions that retain precipitation, vernal pools have the potential to act as temporary storage for stormwater runoff. Surveying these locations and determining their storage capability may help to preserve stormwater function in remaining natural areas while mitigating flooding issues in the township.

The main objectives of this project are to map and inventory vernal pools in Hamilton Township and determine the status, range and distribution of amphibians dependent upon vernal pools for survival. Because staff resources at NJDEP have become limited, this strategy will rely primarily on trained volunteers to conduct surveys of vernal pools. As data is collected on vernal

pools, the information is submitted to and integrated into the land use regulatory databases of the NJDEP to secure vernal pool protection.

Local Project Partners:

- RCE Water Resources Program
- NJDEP
- Hamilton Township Environmental Commission
- Township residents
- Not-for profit organization (i.e., watershed association or open space preservation)

Estimated Project Costs:

Previously, training of volunteers to survey and submit data was conducted and coordinated by NJDEP at no cost. Currently, no trainings are being conducted for budgetary reasons. NJDEP is, however, still accepting data on vernal pools. Training and coordination of the volunteers and compiling the data generated from the vernal pool surveys could cost up to $15,000 per year.

Anticipated Timeline(s):

With 79 potential vernal pools located within Hamilton Township to be surveyed several times from February through June, it is estimated that the entire project would take four years to complete.

Potential Funding Sources:

- ANJEC Sustainable Land Use Planning Grants: http://anjec.org/SmartGrowthGrants.htm
- Sustainable Jersey™ Small Grants Program: http://sustainablejersey.com/resources.php?sec_num=1
- The Watershed Institute Grant Program: http://www.thewatershedinstitute.org/resources/twig/index.php
- NJDEP Matching Grants Program for Environmental Commissions: http://www.state.nj.us/dep/seeds/matgrant.htm

References

Lathrop, R.G., P. Montesano, J. Tesauro, and B. Zarate, 2005. Statewide Mapping and Assessment of Vernal Pools: A New Jersey Case Study. Journal of Environmental Management. 76:230-238.

GOAL 1:
Engage the Community in Water Resources Protection

Recommended Action:

Implement property owner education programs.

Objectives:

Rutgers Cooperative Extension (RCE) is committed to helping the diverse population of New Jersey adapt to a rapidly changing society while improving their lives through an educational process that uses science-based knowledge. RCE focuses on issues and needs relating to agriculture and the environment; management of natural resources; food safety, quality, and health; family stability; economic security; and youth development. The Water Resources Program is one of many specialty programs under RCE. The goal of the Water Resources Program is to provide solutions for many of the water quality and quantity issues facing New Jersey. This is accomplished through research, project development, assessment and community outreach. RCE's outreach includes educational programming in the form of lectures, seminars, and workshops for citizens and communities. Programs listed below are examples of educational efforts offered by the RCE Water Resources Program for communities throughout New Jersey. Programs are delivered to municipalities and local stakeholders to educate them on specific issues in their community. These materials and the programs described below can be tailored to the specific needs and issues affecting Hamilton Township.

Stormwater Management in Your Backyard

This program provides in-depth instruction on stormwater management. It introduces the factors that affect stormwater runoff, point and nonpoint source pollution, impacts of development (particularly impervious cover) on stormwater runoff, and pollutants found in stormwater runoff. An overview of New Jersey's stormwater regulations is presented including who must comply and what is required. Different types of best management practices (BMPs) are presented and how these BMPs can be used to achieve the quality, quantity and groundwater recharge requirements of New Jersey regulations are clearly illustrated. BMPs commonly discussed

include bioretention systems (rain gardens), sand filters, stormwater wetlands, extended detention basins, infiltration basins, manufactured treatment devices, vegetated filters, and wet ponds.

The program also discusses various management practices that homeowners can install including dry wells, rain gardens, rain barrels, and alternative landscaping. Protocols for designing these systems are reviewed in detail with real world examples provided. A step-by-step guide is provided for designing a rain garden so that homeowners can actually construct one on their property. The course also provides a discussion of BMP maintenance focusing on homeowner BMPs. The course concludes with a discussion of larger watershed restoration projects and how citizens can lead these restoration efforts in their communities. The course is very interactive, and ample time is set aside for question and answer sessions. For more information about *Stormwater Management in Your Backyard*, visit http://www.water.rutgers.edu/Stormwater_Management/SWMIYB.html.

Rain Barrel Education

An additional program for managing stormwater flow from individually-owned properties is a workshop focused on the creation and installation of rain barrels to capture and re-use rooftop runoff. Considering that much of Hamilton Township is residential, there are many neighborhoods where rooftops contribute to impervious surface runoff. While many gutter and downspout systems flow across lawns and landscapes where infiltration can occur, many homeowners frequently connect downspouts directly to street curbs and, in some instances, directly discharge to local waterways. A rain barrel can be placed under a gutter's downspout next to a building to collect rain water from the roof. The rain barrel holds approximately 50 gallons of water which can be used to water gardens and landscapes. Harvesting rain water has many benefits including conserving potable water supplies, saving money on utility bills, and preventing flooding of basements. By collecting rain water, homeowners are help to reduce flooding and pollution in local waterways. With education and implementation, rain barrels can become part of an overall approach for homeowner action. For more information on rain barrel workshops, please visit http://www.water.rutgers.edu/Stormwater_Management/rainbarrels.html.

Streamside Living

Property owners living along streams, lakes, and ponds can assist with maintaining natural stream corridors, as well as protect and enhance their property by practicing watershed friendly property management. Watershed friendly property management entails planning, planting, and caring for lawns and gardens in ways that complement the soils, climate, and natural character and vegetation of the watershed. Properly landscaped streamside areas can be beautiful, environmentally friendly, and easy to maintain. They can also aid in preventing erosion, act as a filter for rainwater from downspouts, walkways and driveways, and promote water conservation. States such as Pennsylvania and Virginia also have their own versions of Streamside Living educational programs that could be used as models for the development of programs specific to New Jersey, especially tailored to the needs and conditions of Hamilton Township. The programs should include pertinent information on: limiting the use of pesticides, herbicides, and fertilizer; establishing a no-mow zone along streambanks and shorelines; protecting storm drains from debris; planting native trees, shrubs, perennials and grasses; and identifying and removing invasive plants. The curriculum should include state and local regulations on the aforementioned issues to ensure that homeowners are in compliance with such rules.

Local Project Partners:

- RCE Water Resources Program
- Hamilton Township Environmental Commission
- Green Team
- Township residents

Estimated Project Costs:

Depending on the types and frequency of educational programs offered and the extent of involvement from the residents of Hamilton, costs are estimated to range up to $5,000 per year.

Anticipated Timeline(s):

Educational programs are anticipated to be an ongoing effort offered by the RCE Water Resources Program in partnership with the Environmental Commission and Green Team to

engage the public in environmental stewardship, ensure sustainable water resources within Hamilton Township, and partner with the community to keep waterways clean.

Potential Funding Sources:

- NJDEP Nonpoint Source Pollution 319(h) Grants: http://www.state.nj.us/dep/watershedmgt/319grant.htm
- U.S. Environmental Protection Agency Environmental Education Regional Grants: http://www.epa.gov/enviroed/grants.html
- Sustainable Jersey™ Small Grants Program: http://sustainablejersey.com/resources.php?sec_num=1

GOAL 1:
Engage the Community in Water Resources Protection

Recommended Action:

Implement rain garden and downspout disconnection demonstration projects.

Objectives:

In developed landscapes, stormwater runoff from parking lots, driveways, sidewalks, and rooftops flows to drainage pipes connected to the sewer system. The cumulative effect of these impervious areas and thousands of connected downspouts reduces the amount of water that can infiltrate into soils and greatly increases the volume and rate of runoff that flows to waterways. Disconnection is the process of diverting the first flush of stormwater runoff from impervious areas to smaller distributed BMPs for stormwater control and disconnecting rooftop downspouts from the sewer system. By redirecting runoff from paving and rooftops to pervious areas in the landscape, the amount of directly connected impervious surface in a drainage area can be greatly reduced.

For disconnection to be safe and effective, runoff must flow into a suitable receiving area. Stormwater must not flow toward building foundations or onto adjacent property. Typical receiving areas for disconnected runoff include lawns, landscaping, infiltration beds, gardens, and other BMPs. Soil amendments can be used to increase soil permeability if necessary. However, site constraints such as small or non-existent lawns may dictate that runoff is directed into a rain garden or, most commonly, an infiltration practice.

Volume reductions occur through infiltration and evapotranspiration in the receiving area. The potential exists for disconnected stormwater runoff to be completely taken "out of the system" by spreading out and infiltrating over pervious surfaces and BMPs. Stormwater that eventually flows onto an impervious surface and then into the storm sewer should at a minimum be initially detained by flowing over rough, pervious surfaces such as grass.

Disconnection of densely developed landscapes with high percentages of impervious cover can be achieved through small-scale efforts. Stormwater infiltration through BMPs, such as rain gardens, is a cost effective way to reduce stormwater flow without the need for large scale infrastructure upgrades. The approach looks to identify areas of the landscape where stormwater naturally flows enhancing these sites so that stormwater runoff is allowed to infiltrate into the soils. This approach distributes management of stormwater over a large number of smaller infiltration areas, including individually-owned properties in residential areas in the form of rain gardens or infiltration strips.

Reduction of impervious surfaces with the installation of permeable or pervious materials is another strategy that can help reduce stormwater flow, increase groundwater recharge, and improve water quality. Pervious paving alternatives are now available for asphalt, concrete, and interlocking concrete blocks with aggregate, sand and grass within void spaces. These surfaces allow water to pass through the land surface into an underlying reservoir (stone or gravel) that provides temporary runoff storage until infiltration to the subsurface soils can occur. Primary applications for these surfaces are low traffic or parking areas that do not experience a high volume of vehicular traffic but cover significant land area with impervious surfaces.

Local Project Partners:

- RCE Water Resources Program
- Hamilton Township Environmental Commission
- Township residents
- Hamilton Township Council
- Schools

Estimated Project Costs:

Depending on the type of demonstration project undertaken, the site of the demonstration project, and the extent of involvement from potential project partners, costs are estimated to range $5,000 to $10,000 per year.

Anticipated Timeline(s):

Initial demonstration projects could be established in approximately two years. Future efforts could make this program an ongoing effort for Hamilton Township and its residents and business community.

Potential Funding Sources:

- ANJEC Sustainable Land Use Planning Grants: http://anjec.org/SmartGrowthGrants.htm
- Sustainable Jersey™ Small Grants Program: http://sustainablejersey.com/resources.php?sec_num=1
- The Watershed Institute Grant Program: http://www.thewatershedinstitute.org/resources/twig/index.php
- NJDEP Matching Grants Program for Environmental Commissions: http://www.state.nj.us/dep/seeds/matgrant.htm
- NJDEP Nonpoint Source Pollution 319(h) Grants: http://www.state.nj.us/dep/watershedmgt/319grant.htm
- U.S. Environmental Protection Agency Environmental Education Regional Grants: http://www.epa.gov/enviroed/grants.html

GOAL 2:
Manage Water Quality

Recommended Action:

Develop and implement a water quality monitoring program for lakes and impoundments.

Objectives:

There are many man-made impoundments and lakes within Hamilton Township. Many of these impoundments were originally created for recreation, water supply, and for stormwater and flood control. These man-made impoundments and lakes in Hamilton Township accumulate sediments and sediment-bound nutrients and may be harboring potential stormwater pollutants. If these impoundments are functioning as a sink for water quality contaminants, then it is likely that the water quality of the lake and its sediments are impacted. Nutrients that are accumulating in these waterways can create eutrophic conditions represented by algal growth and excessive vegetation, loss of dissolved oxygen, and lake filling. The NJDEP maintains a statewide lake monitoring program, but none of the lakes within Hamilton Township are included in the monitoring network at this time.

Water quality monitoring of the lakes in Hamilton Township needs to be undertaken to understand the impact of land use changes on the lakes and the impact of the lakes on the water quality of the various streams in the municipality. Lake monitoring should follow the same sampling protocols as used by the NJDEP Bureau of Freshwater & Biological Monitoring's Ambient Lake Monitoring Network so that the results may be incorporated into any state assessments. Further research would be necessary to determine the impact of these impoundments on water quality within the township.

Local Project Partners:

- RCE Water Resources Program
- NJDEP Bureau of Freshwater & Biological Monitoring
- Hamilton Township Department of Water Pollution Control

Estimated Project Costs:

Project costs need to be calculated on an individual basis for each lake and pond, and will vary depending on size and depth of the waterbody. Costs are estimated to range from $26,000 and $48,000 per year. These costs are based on taking three samples at the five to seven impoundments within Hamilton Township. These samples would need to be collected six times a year for a total of 18 samples at each lake. The costs include staff time and field equipment needed to collect samples as well as the fees associated with analyzing the samples for nutrients, bacteria, and chlorophyll *a*.

Concept Plans:

To submit water quality data for inclusion in NJDEP assessments, any monitoring project needs to develop and implement a quality assurance project plan (QAPP). A QAPP clearly identifies the sampling methodologies, site locations, and laboratory and statistical analyses, to be completed on the samples. The QAPP also outlines how the data will be used upon completion of water quality monitoring. All QAPPs are submitted to NJDEP and must be approved before water quality monitoring can start. More information can be found at the NJDEP's Bureau of Water Quality Standards and Assessment technical support web page (http://www.nj.gov/dep/wms/bwqsa/support_docs.htm).

Anticipated Timeline(s):

Initially this program could be developed and implemented for one year. Additional sampling in following years would help to determine any changes or trends in the water quality of the lakes within the municipality. The NJDEP's Integrated Water Quality Monitoring and Assessment Methods advises that if water quality results exceed the water quality criteria twice within a five-year period, then the waterway's quality may be compromised (NJDEP, 2009). NJDEP has further stated that a minimum of eight samples need to be collected to confirm the quality of waters, with quarterly samples over a two-year period being ideal (NJDEP, 2005; NJDEP, 2009).

Potential Funding Sources:

- The Watershed Institute Grant Program: http://www.thewatershedinstitute.org/resources/twig/index.php
- NJDEP Nonpoint Source Pollution 319(h) Grants: http://www.state.nj.us/dep/watershedmgt/319grant.htm

References

NJDEP, 2009, 2010 Integrated Water Quality Monitoring and Assessment Methods (DRAFT). Trenton, NJ.

NJDEP, 2005, Field Sampling Procedures Manual. Trenton, NJ.

GOAL 3:
Minimize Localized Flooding

Recommended Action:

Develop a hydrologic model for Hamilton Township.

Objectives:

Floods can range from catastrophic events over large areas to minor occurrences affecting a few properties. Many factors go into determining the severability of flooding: season, precipitation amount, concentration of land development in a drainage area, tidal influences, proximity to local waterways, and the condition of the floodplain. Floods are classified based upon their expected rate of occurance. A 100-Year Flood is expected to occur once every 100 years, or have a 1% rate of occuring in a given area. A 500-Year Flood is expected to happen once every 500 years, or have a 0.2% chance of occurring.

Historically, flooding has occurred in Hamilton Township primarily along the Delaware River, Assunpink Creek, and Crosswicks Creek. A stormwater model for Hamilton Township should be developed so that estimation of future scenarios (flood management, increased or decreased development, or implementation of flood controls) can be assessed as to their impact on water quality and quantity. Models are mathematical representations of reality that allow researchers and resources managers the opportunity to perform trial-and-error scenarios on physical structures or environmental landscapes. The ability of models to vary different input parameters simulating and evaluating multiple scenarios is ideal for water management. The method generally followed when modeling hydrology is to monitor a system to be modeled, model the system of interest, and alter the model in some way to represent/predict changes in the system.

A hydrologic model would help decision-makers understand stormwater runoff volumes from subwatersheds within the Township contributing to flooding and allow for determinations of stream and flood responses to stormwater runoff under various storm conditions. The model predictions could be used to help guide future development and land preservation decisions,

target specific areas for flood control projects or stormwater infrastructure upgrades, and manage emergency efforts during a flood event.

Local Project Partners:

- RCE Water Resources Program
- Hamilton Township Department of Water Pollution Control
- Federal Emergency Management Agency (FEMA)
- CH2M Hill

Estimated Project Costs:

This project could cost anywhere from $30,000 to $90,000 to complete. The cost range is large since the availability of data needed to build and run the model and the amount of field work necessary to gather unavailable data is unknown at this time. The project costs include research to determine the status of data available for successful creation of the hydrologic model for Hamilton Township and collection of missing data.

Anticipated Timeline(s):

One year of staff time would be necessary to determine availability of data for use as model input, to collect additional field data necessary for completion of the model, to develop and run the model, and to summarize and present model results. Depending on the availability of data needed to build and run the model and the amount of field work necessary to gather unavailable data, this project could take up to three years to complete.

Potential Funding Sources:

- NJDEP Green Acres Program: http://www.nj.gov/dep/greenacres/
- New Jersey Flood Mitigation Task Force Stream Cleaning Assistance: http://www.njflood.org/assist.html
- New Jersey Flood Mitigation Task Force Home Elevation Assistance: http://www.njflood.org/homeelev.html
- FEMA Flood Mitigation Assistance Program:

http://www.fema.gov/government/grant/fma/index.shtm

- American Rivers & National Oceanic and Atmospheric Administration's (NOAA) Stream Barrier Removal Grants: http://www.americanrivers.org/our-work/restoring-rivers/dams/background/noaa-grants-program.html

GOAL 4:
Implement Phase II Stormwater Controls

Recommended Action:

Complete impervious cover analysis and develop a community disconnection program.

Objectives:

The first step in conducting the impervious cover analysis is to evaluate existing land uses in Hamilton Township to identify the extent of impervious cover. The analysis would then move to identification of opportunities to disconnect impervious surfaces from the Municipal Separate Storm Sewer System (MS4). This analysis would evaluate existing land use to identify the extent of impervious cover and include recommended strategies for disconnecting impervious areas from direct discharge into the MS4 system. The analysis would involve use of geographic information system (GIS) data and mapping followed by field inspection of selected sites for recommendation of appropriate site-specific BMPs. Site-specific strategies should provide localized remediation for sources of stormwater runoff and the associated contaminants while also serving as a demonstration for universal application to foster a more effective restoration and protection program. Disconnected impervious cover would allow stormwater to be detained or infiltrated prior to flowing into the MS4 system, reducing the pollutant loads and increased flows impacting Hamilton Township.

A list of recommended strategies for disconnecting impervious areas from direct discharge into the MS4 system would be developed and presented to Hamilton Township. This strategy should be accomplished in conjunction with the Recommended Action *Implement rain garden and downspout disconnection demonstration projects*. Please see that section for more information.

Local Project Partners:

- RCE Water Resources Program
- NJDEP Division of Watershed Management

Estimated Project Costs:

The project costs are estimated to be $15,000 and include the GIS mapping analysis with site surveys to verify mapping results and to identify site-specific BMP strategies.

Anticipated Timeline(s):

This strategy is estimated to take approximately six months to complete.

Potential Funding Sources:

- ANJEC Sustainable Land Use Planning Grants: http://anjec.org/SmartGrowthGrants.htm
- Sustainable Jersey™ Small Grants Program: http://sustainablejersey.com/resources.php?sec_num=1
- The Watershed Institute Grant Program: http://www.thewatershedinstitute.org/resources/twig/index.php
- NJDEP Matching Grants Program for Environmental Commissions: http://www.state.nj.us/dep/seeds/matgrant.htm
- NJDEP Nonpoint Source Pollution 319(h) Grants: http://www.state.nj.us/dep/watershedmgt/319grant.htm

GOAL 4:
Implement Phase II Stormwater Controls

Recommended Action:

Develop a 'site suitability' map for advanced stormwater management facilities.

Objectives:

During the stormwater management planning process, goals are established and used to measure the effectiveness of BMPs. BMPs are behaviors or structures implemented to mitigate pollutants carried via surface runoff. Structural BMPs act by intercepting contaminated runoff and treating the contaminants before they have the opportunity to reach receiving waters. Bioretention BMPs utilize natural processes in the selected growing medium and vegetation to improve the quality of waters that flow through them. In these media, pollutants are treated by a number of physical, chemical and biological processes. These include: sedimentation, adsorption, filtration, volatilization, ion exchange, aerobic and anaerobic biotransformations, phytoremediation, and storage capacity. Site-specific conditions such as slope, soil type, drainage area, effective groundwater recharge, and runoff storage areas all have an influence on the types and rates how well these processes work to remove pollutants. The identification and evaluation of site conditions and possible constraints are critical to the effective implementation of BMP designs.

A 'site suitability' map for stormwater control devices should be developed and used by Hamilton Township that incorporates information affecting the type of devices needed to manage stormwater based on site conditions. Information to be evaluated includes groundwater recharge rates, hydrologic soil groups, geologic formation and soil types, and flood frequencies. Soils are perhaps the most important consideration for site suitability of stormwater BMPs (NJDEP, 2004). County Soil Surveys can be used to obtain necessary soil data for system planning purposes and used in the preliminary design of stormwater BMP systems. However, the final design and construction plans require soil tests at the exact location of a proposed system to confirm its ability to function properly without failure. The site suitability map would be used by Hamilton Township planning officials when determining whether or not the appropriate BMP

is being installed at a site based upon mapped conditions. Further investigation of site conditions would be necessary once a suitable site is located on the map generated from this recommended action.

This action should be completed in conjunction with the Recommended Action *Complete impervious cover analysis and develop a community disconnection program*.

Local Project Partners:

- RCE Water Resources Program
- NJDEP Division of Watershed Management

Estimated Project Costs:

The project costs are estimated to be approximately $10,000 and include GIS data collection and mapping, and statistical analyses to identify suitable sites for placement of stormwater controls.

Anticipated Timeline(s):

This strategy is estimated to take approximately six months to complete.

Potential Funding Sources:

- ANJEC Sustainable Land Use Planning Grants: http://anjec.org/SmartGrowthGrants.htm
- Sustainable Jersey™ Small Grants Program: http://sustainablejersey.com/resources.php?sec_num=1
- The Watershed Institute Grant Program: http://www.thewatershedinstitute.org/resources/twig/index.php
- NJDEP Matching Grants Program for Environmental Commissions: http://www.state.nj.us/dep/seeds/matgrant.htm
- NJDEP Nonpoint Source Pollution 319(h) Grants: http://www.state.nj.us/dep/watershedmgt/319grant.htm

References

NJDEP, 2004, New Jersey Stormwater Best Management Practices Manual. Division of Watershed Management. Trenton, NJ.

GOAL 5:
Improve Stormwater Facility Maintenance

Recommended Action:

Conduct complete inventory and assessment of stormwater management basins in Hamilton Township.

Objectives:

The original use of stormwater management basins was to mitigate flooding; they are also commonly known as flood control basins. Basins were designed on a site-by-site basis to limit the peak flow rate at the site's outlet by temporarily storing water. This is done by allowing large amounts of stormwater to fill the system and limiting the outflow using a small opening at the lowest point of the structure. Small storms events and the quality of the water were generally not affected by these types of basins.

Although detention basins have been constructed to reduce peak stormwater runoff rates since the early 1970s, it is only since the late 1980s that sufficient information has been available to design these basins to address stormwater quality. To meet new requirements in the Stormwater Management Regulations for stormwater quality, new design approaches are being applied on new development projects. Existing detention basins, however, need to be assessed and retrofit solutions developed. Numerous detention basins can be retrofitted to address water quality and management techniques adapted to more cost-effectively protect water resources in the community.

Currently over 300 detention basins have been identified and mapped in Hamilton Township. Many detention basins can be altered or retrofitted to improve their ability to remove pollutant loads from stormwater runoff and achieve water quality improvements. If these improvements are made correctly, they could also reduce maintenance costs. This implementation strategy would compile a comprehensive inventory of detention basins within the municipality and assess

how well they are functioning (based on original designs) to control stormwater flows and infiltrate stormwater.

Local Project Partners:

- RCE Water Resources Program
- Hamilton Township Department of Public Works (DPW)

Estimated Project Costs:

To completely inventory and assess detention basins within the municipality, it would cost approximately $10,000 to $12,000 per year over the estimated four year timeline. The total project cost ($40,000 to $48,000) would include assessment of all 300+ basins in the township.

Concept Plans:

The RCE Water Resources Program conducted site surveys to assess eight basins within Hamilton Township in the summer of 2011. These detention basins were assessed for possible rehabilitation and enhancement opportunities (Appendix B). These eight basins were chosen as a subset of the over 300 detention basins in Hamilton Township and represent the variety of problems and issues experienced. This strategy would be conducted in the same way as this initial inventory and assessment and the same information regarding the basins would be generated for use by the municipality.

Anticipated Timeline(s):

This strategy is estimated to take approximately four years to complete due to the number of basins located within township boundaries. It is estimated that between 60 and 80 detention basin assessments could be completed each year.

Potential Funding Sources:

- NJDEP Nonpoint Source Pollution 319(h) Grants: http://www.state.nj.us/dep/watershedmgt/319grant.htm

GOAL 5:
Improve Stormwater Facility Maintenance

Recommended Action:

Prepare a comprehensive GIS database of stormwater infrastructure.

Objectives:

Stormwater management infrastructure (pipes, culverts, inlets/outlets, manholes, and basins) is generally designed to have an operational lifespan of several decades. Without proper maintenance and monitoring of such infrastructure, these devices can become overgrown with vegetation, clogged with sediment, debris, and/or garbage, or fail due to a loss of structural integrity. Possession of a comprehensive database containing information on stormwater infrastructure features and their condition that is easily accessible and can be projected geographically can greatly increase efficiency of maintenance efforts of stormwater infrastructure within Hamilton Township.

Information to be contained in this database will include location (street address and lot/block), type and size of infrastructure feature, date constructed, results from detailed site evaluations, ownership, date(s) and type(s) of any maintenance performed, and other actions necessary to ensure proper functioning. Other information can be added as the database is developed based upon the needs of Hamilton Township. A complete inventory of stormwater infrastructure allows for the identification and repair of infrastructure that is performing inadequately before it becomes a major issue. A history of maintenance performed on a particular device helps to locate problem areas within the community. The database would allow Hamilton Township to shift their maintenance strategies from a reactive approach to a proactive one.

Local Project Partners:

- RCE Water Resources Program
- Hamilton Township Department of Water Pollution Control
- Hamilton Township DPW

- Rutgers University Center for Remote Sensing and Spatial Analysis (CRSSA)

Estimated Project Costs:

A complete database of stormwater infrastructure would cost approximately $40,000 to $50,000 over the estimated four year timeline. The total projected cost includes information on all 300+ basins in the township along with pipes, inlets, catch basins, manholes, outfalls, etc.

Concept Plans:

A similar project has been performed by CRSSA at Rutgers University for stormwater basins in the Barnegat Bay Watershed (http://barnegatbaybasins.rutgers.edu/). Data to be included in the Hamilton Township would be similar to the Barnegat Bay database, but information regarding maintenance (basin ownership, last scheduled or performed maintenance, type of maintenance performed, etc.) specific to the needs of Hamilton will be included, as described above.

Anticipated Timeline(s):

This strategy is estimated to take approximately four years to complete due to the extent of the MS4 system within township boundaries.

Potential Funding Sources:

- NJDEP Nonpoint Source Pollution 319(h) Grants: http://www.state.nj.us/dep/watershedmgt/319grant.htm
- New Jersey Environmental Infrastructure Financing Program: http://www.njeit.org/index.htm
- NJDEP Environmental Infrastructure Financing Program: http://www.nj.gov/dep/grantandloanprograms/er_eifp.htm

GOAL 5:
Improve Stormwater Facility Maintenance

Recommended Action:

Implement detention basin maintenance training, inspection, and monitoring program.

Objectives:

Based upon the information gathered during the field assessments of stormwater detention basins (see Recommended Action *Conduct complete inventory and assessment of stormwater management basins in Hamilton Township*) and compiled in an infrastructure inventory database (see Recommended Action *Prepare a comprehensive GIS database of stormwater infrastructure*), the RCE Water Resources Program will develop and deliver a targeted program for staff of Hamilton Township's Department of Public Works (DPW). Content of the program will focus on how the DPW can incorporate alternative approaches into traditional methods used by staff to operate and maintain detention basins.

Stormwater management basins in many communities are reaching the end of their functional design life. Opportunities exist to reduce costs for maintaining and replacing this aging infrastructure through retrofits using new techniques and technologies, better preparing communities for a sustainable future. A thorough inspection and monitoring program can help communities plan for capital investment in infrastructure, extend the functional life of existing systems where possible, and provide cost-effective and sustainable maintenance alternatives that conserve and protect water resources while improving the quality of life of Hamilton Township's citizens.

Local Project Partners:

- RCE Water Resources Program
- Hamilton Township DPW

Estimated Project Costs:

It is estimated to cost approximately $5,000 per year. This includes the development and delivery of training programs and assistance with continued monitoring of detention basins within Hamilton Township.

Concept Plans:

The Hamilton Township detention basin maintenance program will be modeled after the RCE Water Resources Program's successful Green Infrastructure Programs for Sussex County (http://water.rutgers.edu/Projects/Sussex/Sussex.html) and Camden County (http://water.rutgers.edu/Projects/Sussex/Camden.html). Seminars in these county programs covered such topics as 'Opportunities for Municipalities,' 'Detention Basin Retrofits and Maintenance,' and 'Projects & Programs for Green Teams & Environmental Commissions,' among others.

Anticipated Timeline(s):

This strategy is envisioned to be an ongoing partnership between the RCE Water Resources Program and Hamilton Township.

Potential Funding Sources:

- ANJEC Sustainable Land Use Planning Grants: http://anjec.org/SmartGrowthGrants.htm
- Sustainable Jersey™ Small Grants Program: http://sustainablejersey.com/resources.php?sec_num=1
- The Watershed Institute Grant Program: http://www.thewatershedinstitute.org/resources/twig/index.php
- NJDEP Matching Grants Program for Environmental Commissions: http://www.state.nj.us/dep/seeds/matgrant.htm
- U.S. Environmental Protection Agency Environmental Education Regional Grants: http://www.epa.gov/enviroed/grants.html

GOAL 5:
Improve Stormwater Facility Maintenance

Recommended Action:

Execute detention basin repair, rehabilitation, and enhancement projects.

Objectives:

Detention basin field assessments will result in recommended actions needed to improve their functionality (see Recommended Action *Conduct complete inventory and assessment of stormwater management basins in Hamilton Township*). These actions will vary depending on the problem to be addressed, the appropriate corrective action, and the size and extent of the affected detention basin. Any retrofits designed for Hamilton Township should target infiltration of runoff generated from the water quality storm. The "water quality storm" is used to analyze and design stormwater BMPs for water quality improvements and is defined as 1.25 inches of rain over two hours (NJDEP, 2004). This storm is used to compute runoff volumes and peak rates to ensure that stormwater quality BMPs, whether they are based on total runoff volume or peak runoff rate, will provide a standard level of stormwater pollution control. With nearly 90% of all rainfall each year in New Jersey falling in storm events smaller than the water quality storm, these efforts can have a dramatic effect on water quality in the community. It is difficult to estimate the reductions for each pollutant because many of the functions of each basin are enhanced by retrofits. Targeted reductions in TSS, total nitrogen and total phosphorus can be expected to range from 30% - 90% (NJDEP, 2004). Depending upon the final design alternatives chosen for each detention basin (see descriptions of alternatives below), these systems can begin to mimic natural stormwater management processes.

Detention Basin Retrofit Alternatives

Alternative A: Low Flow Vegetated Channel

A common design feature for detention basins is a low flow concrete channel that carries runoff from the inlets to the outlet structure of the detention basin. This feature is intended to direct water to quickly pass through the basin during small storm events to avoid ponding and

maintenance issues. Due to sediment and debris accumulation in these channels and the lack of regular maintenance, however, these channels frequently tend to clog, causing ponding of water in the channel. These small stagnant ponds become ideal mosquito breeding habitat, thereby creating a problem they originally intended to avoid.

Low flow concrete channels act as an impediment to improving water quality in a detention basin. One retrofit approach is to remove the concrete channel and replace it with a vegetated swale. The swale should have a 0.1% side slope to ensure easy maintenance and slopes should not exceed 3.0%. The swale should be seeded with native grasses to minimize maintenance. Where possible, replacement soils should be installed with the top 1.5 feet of soil composed of a bioretention soil mix to encourage infiltration. Below this infiltration media, a 6 inch layer of ¾ inch diameter clean stone should be installed. The native vegetation in the swale should be cut once or twice a year.

Dense native vegetation creates friction along the flow path of runoff through a detention basin. This friction slows water flow allowing sediment to settle out. In addition, water will be held in a detention basin for a longer period increasing infiltration and allowing vegetation to take up nutrients carried in stormwater runoff. Finally, native vegetation that is allowed to grow taller will develop a deeper root structure allowing greater infiltration than soils with short manicured turf grass. The channel should be designed to infiltrate and pass water through the basin within 48 hours after a storm to prevent mosquito breeding.

Alternative B: Low Flow Rip-Rap Channel

This design is similar to the vegetated channel but instead of vegetation, the channel is filled with rip-rap stone. The channel should not be any wider than 10 feet with the bottom at least three feet above the seasonal high groundwater table. The channel should be designed to hold the runoff volume of the water quality storm from the detention basin's drainage area. The infiltration rate of the soil where the channel will be installed should be taken into consideration before sizing. The channel is designed to infiltrate any storm equal to or smaller than the water quality storm within 48 hours. When this retrofit is installed, the low flow concrete channel should be completely removed.

Alternative C: ¾ Inch Stone Filled Sock

Many municipalities are hesitant to remove the low flow concrete channel in detention basins. There is an alternative method that will yield similar results that requires alterations be completed for only a small section of the low flow concrete channel to work; the section is approximately 8 inches wide. Contractors can fill an 8 inch diameter fabric sock with ¾ inch clean stone that is then set in the detention basin and surrounds the outlet of the detention basin. Any runoff must pass through the sock before it enters the outlet. Since, the v-shape of the low flow concrete channel will not allow the sock to rest on the bottom of the channel; water will be able to pass underneath the sock. Therefore, only a section as wide as the sock should be removed from the low flow concrete channel. This will ensure that all the runoff entering the basin passes through the sock before it exits the basin.

The purpose of the sock is to act as a check dam in the basin. The stone-filled sock will reduce the speed of the runoff in the basin and promote more ponding of stormwater. This will provide the stormwater a larger contact area with the bottom of the basin promoting more infiltration and treatment. The stone-filled sock will act as a rough filter removing sediment and nutrients attached to the sediment from the water column and allow to pond to slowly drain to the outlet structure. Higher flows will overtop the sock and make its way to the outlet structure, maintaining the flow control capacity of the basin.

Alternative D: Native and Low Maintenance Grasses and Vegetation

Detention basins with turf grass provide for minimal infiltration. Turf grass has a shallow root structure that does not open up the soil below the surface allowing water to infiltrate. By introducing native grasses and reducing the frequency of mowing from once a week to once or twice a year (in the winter), native grasses develop a deep root structure. The height of grass is directly proportional to the depth of the root structure. Limiting mowing and allowing the grass to grow taller will ensure development of a deep root structure. This method reduces maintenance costs due to less mowing and improves water quality through increases in infiltration and subsequent decreases in stormwater discharges to nearby waterways.

Additionally, many basins throughout New Jersey are over-compacted, thereby limiting their infiltration capacity. Although the root structure of native vegetation may increase infiltration rates, some of these over-compacted basins may need to be deep-tilled to loosen up the soil, and soil amendments may need to be added. Promoting infiltration in these basins is important to improve water quality in the watershed.

Maintenance of Detention Basin Enhancement Projects

The detention basins must be inspected for excessive debris and sediment accumulation at least four times annually, as well as after every storm exceeding one inch of rainfall. Sediment removal should take place when the basin is thoroughly dry. Disposal of debris, trash, sediment, and other waste material should be done at suitable disposal/recycling sites and in compliance with all applicable local, state, and federal waste regulations (NJDEP, 2004).

Mowing of these newly vegetative basins must be performed on a regular schedule based on specific site conditions (once every six months). Vegetated areas must be inspected at least annually for erosion, scour and unwanted growth, which should be removed with minimum disruption to the planting soil bed and remaining vegetation. When establishing or restoring vegetation, biweekly inspections of vegetation health should be performed during the first growing season or until the vegetation is established. Once established, inspections of vegetation health, density, and diversity should be performed during both the growing and non-growing season at least twice annually. Use of fertilizers, mechanical treatments, pesticides and other means to assure optimum vegetation health must not compromise the intended purpose of the basin's vegetation. Vegetation deficiencies should be addressed without the use of fertilizers and pesticides whenever possible. The vegetative detention basin system should be inspected for excess ponding after significant storm events. Corrective measures should be taken when excessive ponding occurs (NJDEP, 2004).

Local Project Partners:

- RCE Water Resources Program
- Hamilton Township Department of Public Works (DPW)

Estimated Project Costs:

The cost of the detention basin retrofit will vary depending on the amount of work that needs to be done to improve the detention basin. Options for detention basin improvement include excavation, re-vegetation with native flora, and/or removal of the low flow channel. The cost estimates vary because the designs to improve the detention basins remain flexible. Cost estimates for the eight assessed basins in Hamilton Township are provided in the following table:

Detention Basin	Estimated Cost	Basis for Cost Estimate
Cypress Lane Basin	$7,500	Materials costs for plantings and trails.
Englewood Basin	$2,500	Materials costs for plantings.
Jimarie Basin	$2,500	Materials costs for plantings.
Highlands Basin	$5,000	Engineering analysis and design costs (need thorough evaluation prior to any improvements).
Peter Rafferty Creek	$12,500	Annual riparian planting program with community volunteers.
Christopher Estates Basin	To Be Determined	Bioretention island, neighborhood rain gardens, and basin renovation.
Pinehurst Basin	$2,500	Materials costs for plantings.
Innocenzi Drive Basin	$10,000	Materials costs for plantings and outlet repair.

Concept Plans:

The RCE Water Resources Program conducted site surveys to assess eight basins within Hamilton Township in the summer of 2011. These detention basins were assessed for possible rehabilitation and enhancement opportunities (Appendix B; Appendix C). These eight basins were chosen as a subset of the over 300 detention basins in Hamilton Township and represent the variety of problems and issues experienced. Recommended actions for the improvement of detention basin efficiency and repairing faulty basins are included in these assessments.

Anticipated Timeline(s):

The modifications of the detention basins should take a short amount of time, however, the timeline for completion of this strategy will depend on the number of basins to be rehabilitated each year and the extent of the repairs/enhancements needed at each basin. It is estimated that between five to ten detention basin projects could be completed each year.

Potential Funding Sources:

- ANJEC Sustainable Land Use Planning Grants: http://anjec.org/SmartGrowthGrants.htm
- Sustainable Jersey™ Small Grants Program: http://sustainablejersey.com/resources.php?sec_num=1
- The Watershed Institute Grant Program: http://www.thewatershedinstitute.org/resources/twig/index.php
- NJDEP Matching Grants Program for Environmental Commissions: http://www.state.nj.us/dep/seeds/matgrant.htm
- NJDEP Nonpoint Source Pollution 319(h) Grants: http://www.state.nj.us/dep/watershedmgt/319grant.htm
- New Jersey Environmental Infrastructure Financing Program: http://www.njeit.org/index.htm
- NJDEP Environmental Infrastructure Financing Program: http://www.nj.gov/dep/grantandloanprograms/er_eifp.htm

References

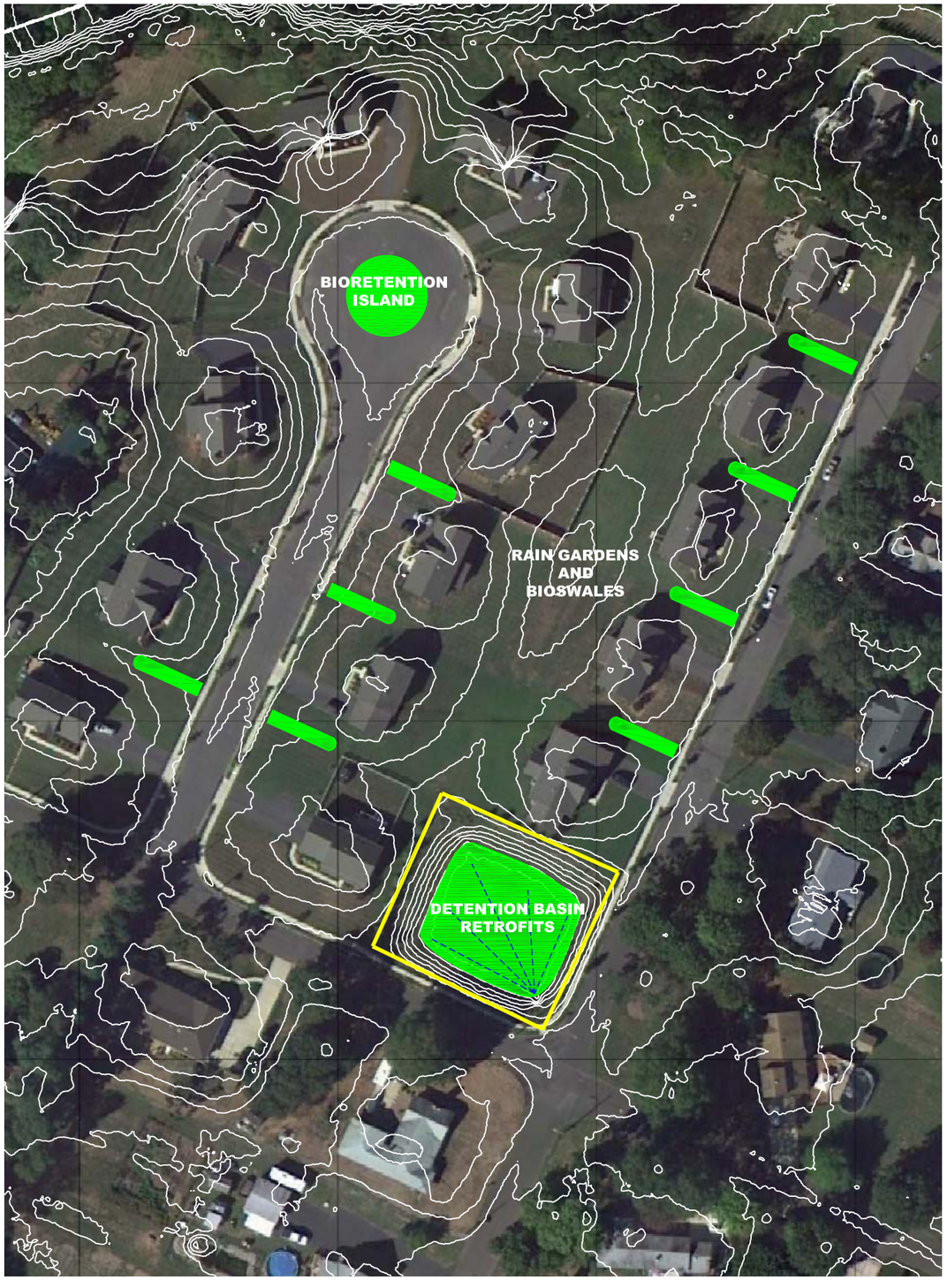
NJDEP, 2004, New Jersey Stormwater Best Management Practices Manual. Division of Watershed Management. Trenton, NJ.

Appendix A: Implementation Strategy Table

Hamilton Township Water Resources Management Program								
Implementation Strategies								
						ESTIMATED COSTS		
	Strategy	**Recommended Action**	**Technical Resources and Project Partners**	**Management Objectives**	**Projected Timeline**	**Order-of-Magnitude Costs (Low)**	**Order-of-Magnitude Costs (High)**	**Notes**
GOAL 1	Engage the community in water resource protection.							
	1	Conduct riparian area investigations.	RCE Water Resources Program (training); Hamilton Twp Environmental Commission; local volunteers	Document health and condition of riparian areas; develop recommendations for restoration, enhancement, and preservation.	2 Years	$5,000	$10,000	This program should become a volunteer-driven effort.
	2	Conduct vernal pool habitat surveys and certification.	RCE Water Resources Program (training); NJDEP; Hamilton Twp Environmental Commission		4 Years	$0	$15,000	This program should become a volunteer driven effort. Target 20 sites per year with 2 visits to each site required. NJDEP has provided volunteer training in the past.
	3	Implement property owner education programs.	RCE Water Resources Program; Hamilton Twp Environmental Commission; Hamilton Twp Green Team	Multiple programs available, including: Turf Management for Healthier Lawn, Streamside Living, Water Conservation/Rain Barrel Education, Downspout Disconnection and Rain Gardens.	Ongoing	$0	$5,000	
	4	Implement rain garden and downspout disconnection demonstration projects.	RCE Water Resources Program; Hamilton Twp Environmental Commission		2+ Years	$5,000	$10,000	
GOAL 2	Manage water quality.							
	5	Develop and implement a water quality monitoring program for lakes and impoundments.	RCE Water Resources Program; NJDEP; Hamilton Twp Water Pollution Control	Establish a water quality baseline for existing water resources.	1+ Years	$26,000	$48,000	Estimate 5-7 impoundments to be monitored with 3 samples to be collected and analyzed 6 times each year in each lake. Per lake cost for analyzing 18 samples $3,600-$5,400. Each event to take 2 days to complete with 2 staff, cost $1,500-$2,000.
GOAL 3	Minimize local flooding.							
	6	Develop a hydrologic model for Hamilton Township.	FEMA; RCE Water Resources Program; CH2M Hill; Hamilton Twp Water Pollution Control	Understand stormwater volume contributions from subwatersheds; determine stream and flood responses to stormwater runoff under various storm conditions.	3 Years	$30,000	$90,000	HEC-HMS hydrology model for understanding flows from subwatersheds (data readily available); HEC-RAS hydraulic model to understand flows in stream channels; detailed stream cross section surveys are needed (model data input and results may be obtained from FEMA, if available).
GOAL 4	Implement Phase II stormwater controls.							
	7	Complete impervious cover analysis and develop a community disconnection program.	RCE Water Resources Program; NJDEP	Identify opportunities to disconnect impervious areas from the Municipal Separate Storm Sewer System (MS4).	6 Months	$10,000	$15,000	GIS mapping analysis with site visits to verify results and identify site specific BMP strategies.

						ESTIMATED COSTS		
	Strategy	**Recommended Action**	**Technical Resources and Project Partners**	**Management Objectives**	**Projected Timeline**	**Order-of-Magnitude Costs (Low)**	**Order-of-Magnitude Costs (High)**	**Notes**
	8	Develop a 'site suitability' map for advanced stormwater management facilities .	RCE Water Resources Program; NJDEP	Develop a working map for Township officials when evaluating proposed stormwater BMPs.	6 Months	$2,000	$10,000	Should be completed along with the impervious cover analysis (Strategy 7).
GOAL 5	Improve stormwater facility maintenance.							
	9	Conduct complete inventory and assessment of stormwater management basins in Hamilton Township .	RCE Water Resources Program; Hamilton Twp DPW	Establish a baseline assessment and develop recommendations for repair, rehabilitation, and enhancement.	4 Years	$40,000	$48,000	Over 300 Basins have been identified in the Township. Conduct approximately 60-80 basin assessments each year.
	10	Prepare a comprehensive GIS database of stormwater infrastructure.	RCE Water Resources Program; Hamilton Twp Water Pollution Control; Rutgers CRSSA	Create a comprehensive Township-wide database of existing infrastructure.	4 Years	$40,000	$50,000	$10,000 per year for 12-week student intern and supervisor.
	11	Implement detention basin maintenance training, inspection, and monitoring program.	RCE Water Resources Program; Hamilton Twp DPW		Ongoing	$0	$5,000	
	12	Execute detention basin repair, rehabilitation, or enhancement projects.	RCE Water Resources Program; Hamilton Twp DPW		Complete 5-10 projects each year			
	12a	Cypress Lane Basin				$0	$7,500	Materials costs for plantings and trails.
	12b	Englewood Basin				$0	$2,500	Materials costs for plantings.
	12c	Jimarie Basin				$0	$2,500	Materials costs for plantings.
	12d	Highlands Basin				$0	$5,000	Engineering analysis and design costs (need thorough evaluation prior to any improvements).
	12e	Peter Rafferty Creek				$2,500	$12,500	Annual riparian planting program with community volunteers.
	12f	Christopher Estates Basin				To Be Determined	To Be Determined	Bioretention island, neighborhood rain gardens, and basin renovation.
	12g	Pinehurst Basin				$0	$2,500	Materials costs for plantings.
	12h	Innocenzi Drive Basin				$0	$10,000	Materials costs for plantings and outlet repair.
		TOTAL ESTIMATED COSTS				**$124,500**	**$260,500**	**Represents multi-year program to be completed over next 5-10 years**

Appendix B: Detention Basin Evaluation Summaries



SCALE: 1" = 100'

PRELIMINARY RECOMMENDATIONS

1. Retrofit existing basin: Convert existing infiltration basin into shallow bioretention facility. Install 6-inch layer of clean stone (3/4"-1 1/2" dia.) with perforated underdrain, 2-inch layer of choker stone (3/8" pea gravel), and 4-inch layer of topsoil. Seed with turf or meadow.

2. Install cul-de-sac bioretention island: Design 50-60 foot diameter landscaped island to capture 'first flush' stormwater runoff volume. Design for 6-8 inch depth and underdrain/overflow to existing storm sewer system.

3. Install rain gardens/bioretention swales along property lines: Design and install shallow swales or landscaped rain gardens to capture, filter, and infiltrate runoff from rooftops, driveways, and 'first flush' from roadways.

4. Conduct homeowner disconnection program: Provide educational program and materials to homeowners and surrounding neighborhood on best management strategies to disconnect impervious areas from directly discharging to storm sewer system.

Rutgers, the State University of New Jersey
Rutgers Cooperative Extension
Water Resources Program
14 College Farm Road
New Brunswick, NJ 08901
(732) 932-9800
water.rutgers.edu

RUTGERS New Jersey Agricultural Experiment Station

Water Resources Program

Christopher Estates Stormwater Management Evaluation
Repair, Rehabilitation, and Enhancement Program

Laura Avenue & Evelyn Avenue
Hamilton Township (Mercer County)
New Jersey

SCALE: 1" = 100'

PRELIMINARY RECOMMENDATIONS

1. Reduce mowing to less than one acre. Maintain 40 foot mowed transition along adjacent residential properties. Routinely maintain six to eight foot (6-8') mowed edge along concrete low flow channels.

2. Clean and maintain concrete low flow channel. Alternatively, remove and replace concrete with dry streambed feature to infiltrate low flows.

3. Establish wet meadow area in basin bottom. Reduce frequency of mowing in meadow areas to two times per year.

4. Plant additional native trees in eastern portion of basin. Increase tree canopy and enhance existing diversity to create small "arboretum." Install 1,000 linear feet of walking path through meadow and arboretum areas.

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RUTGERS New Jersey Agricultural Experiment Station
Water Resources Program

Cypress Lane Stormwater Management Evaluation Repair, Rehabilitation, and Enhancement Program

Hamilton Township (Mercer County)
New Jersey

SCALE: 1" = 50'

PRELIMINARY RECOMMENDATIONS

1. Clear vegetation at inlet and outlet structures. Routinely maintain minimum ten-foot (10 ft.) clear zone at all times.

2. Reduce mowing frequency in wet meadow area to two times per year. Plant native herbaceous wetland species in wet meadow to increase diversity.

3. Routinely maintain mowed perimeter on berm and edge of wet meadow.

4. Plant trees to screen and buffer adjacent residential properties and increase canopy cover.

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RUTGERS New Jersey Agricultural Experiment Station

Water Resources Program

Englewood Blvd Stormwater Management Evaluation
Repair, Rehabilitation, and Enhancement Program

Hamilton Township (Mercer County)
New Jersey

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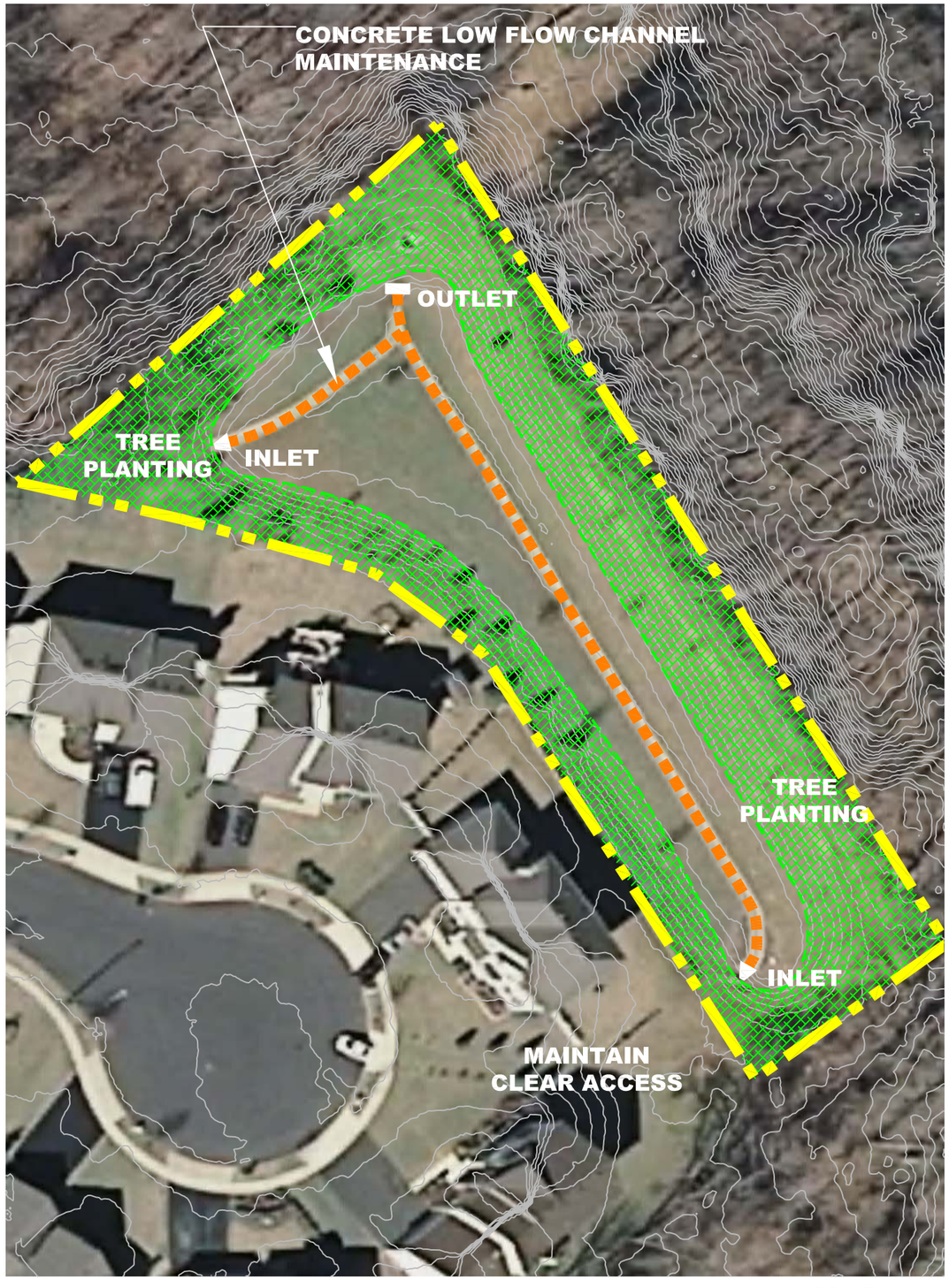
RUTGERS New Jersey Agricultural Experiment Station

Water Resources Program

Innocenzi Drive Stormwater Management Evaluation
Repair, Rehabilitation, and Enhancement Program

Hamilton Township (Mercer County)
New Jersey



SCALE: 1" = 50'

PRELIMINARY RECOMMENDATIONS

1. Clear vegetation and debris/litter near inlet and outlet structures. Remove sediment and debris from concrete low flow channels.

2. Routinely maintain basin bottom and keep low flow channels and outlet structure clear of debris, sediment, and litter.

3. Plant trees on basin slopes to increase canopy cover and provide visual screening of adjacent residential properties.

4. Reduce mowing of basin slopes to two times per year.

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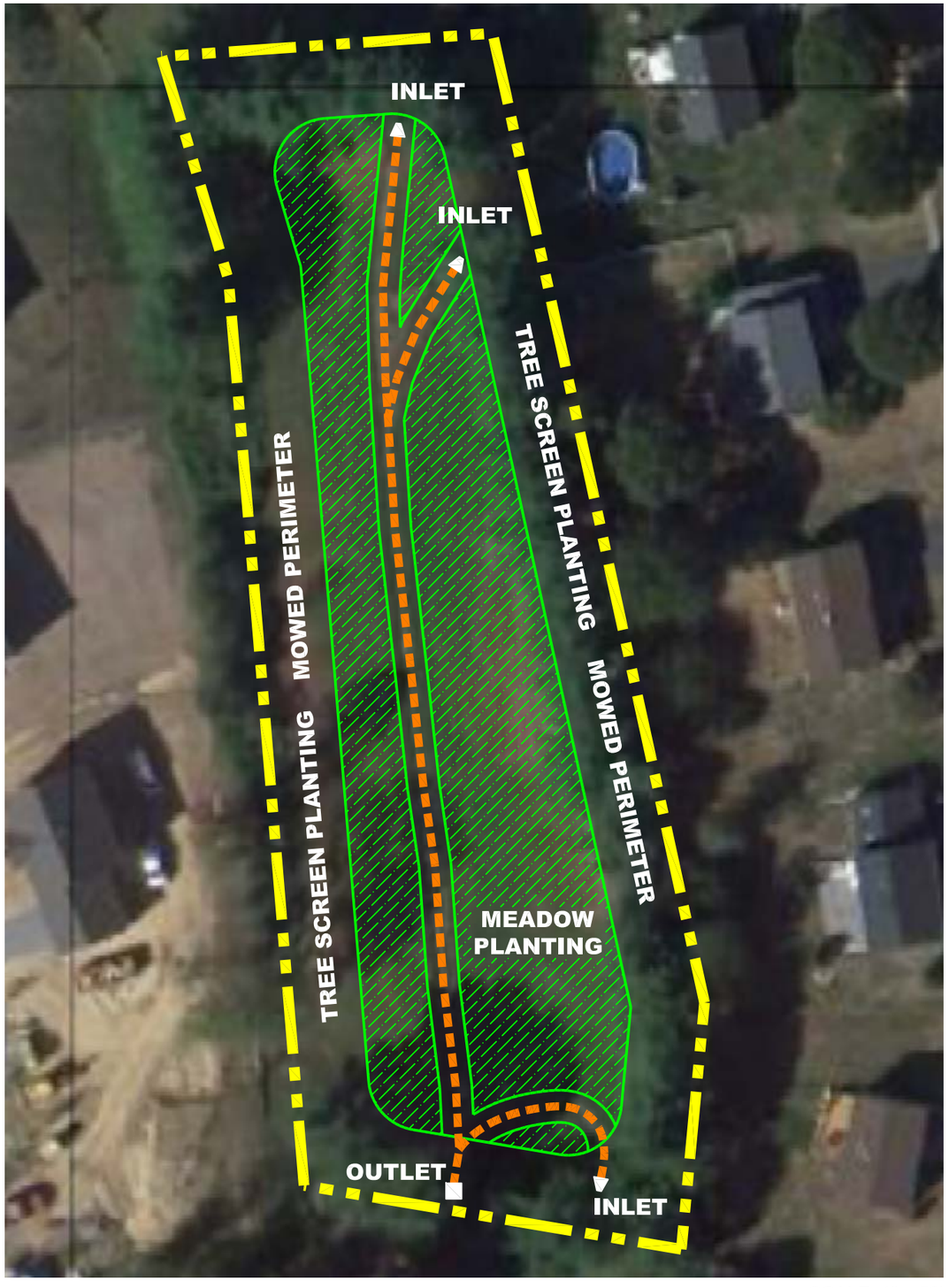
water.rutgers.edu

RUTGERS New Jersey Agricultural Experiment Station

Water Resources Program

Jimarie Court Stormwater Management Evaluation
Repair, Rehabilitation, and Enhancement Program

Hamilton Township (Mercer County)
New Jersey



SCALE: 1" = 50'

PRELIMINARY RECOMMENDATIONS

1. Clear sediment and debris from concrete low flow channels and inlet and outlet structures.

2. Routinely maintain minimum six-foot (6 ft.) mowed edge along all concrete low flow channels. Routinely clear all sediment and debris.

3. Reduce mowing in basin bottom to two times per year. Establish meadow area. Plant native herbaceous vegetation to increase diversity.

4. Plant trees along perimeter to provide visual screen of adjacent residential properties. Routinely maintain mowed perimeter of basin and meadow area.

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water.rutgers.edu

RUTGERS New Jersey Agricultural Experiment Station

Water Resources Program

Pinehurst Court Stormwater Management Evaluation
Repair, Rehabilitation, and Enhancement Program

Hamilton Township (Mercer County)
New Jersey

PRELIMINARY RECOMMENDATIONS

1. Clear vegetation at inlet and outlet structures. Routinely maintain minimum ten-foot (10 ft.) clear zone at all times.

2. Reduce mowing frequency in wet meadow area to two times per year. Plant native herbaceous wetland species in wet meadow to increase diversity.

3. Clear and maintain vehicular access route from Christopher Drive to outlet structure.

4. Maintain access to wet pond areas for routine mosquito monitoring and control.

5. Obtain copy of engineering design plans. Prepare outlet repair/retrofit design to ensure clear flow and minimize ponding in basin.

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Water Resources Program

Rutgers, the State University of New Jersey
Rutgers Cooperative Extension
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water.rutgers.edu

Highlands Stormwater Management Evaluation
Repair, Rehabilitation, and Enhancement Program

Kristopher Drive
Hamilton Township (Mercer County)
New Jersey

Peter Rafferty Creek Stormwater Management Evaluation
Repair, Rehabilitation, and Enhancement Program

Hamilton Township (Mercer County)
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PRELIMINARY RECOMMENDATIONS

1. Work with community organizations to plant riparian buffer along waterway using native flood plain plant species.

2. Implement streamside living program to educate adjacent property owners on landscape practices that minimize impacts to waterways.

3. Develop a tree and shrub planting incentive program creating partnerships between property owners and Hamilton Township.

4. Reduce mowing frequency to 2-3 times per year and total area routinely maintained.

5. Establish healthy, diverse native plant community along riparian corridor.

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Peter Rafferty Creek Stormwater Management Evaluation
Repair, Rehabilitation, and Enhancement Program

Hamilton Township (Mercer County)
New Jersey

Appendix C: Detention Basin Evaluation Presentation

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Water Resources Program

Hamilton Township, Mercer County, NJ

Detention Basin Investigations
and
Preliminary Recommendations

Rutgers Cooperative Extension Water Resources Program

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Basin Investigations

1. Cypress Lane Basin
2. Englewood Blvd. Basin
3. Jimarie Court Basin
4. The Highlands Basin
5. Peter Rafferty Creek
6. Christopher Estates Basin
7. Pinehurst Court Basin
8. Innocenzi Drive Basin

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Cypress Lane Basin

- 3-Acre Facility
- Large shallow detention basin mowed monthly by Township DPW
- Adjacent residential properties with shared property lines – no perimeter fencing
- Native trees planted in basin:
  - Red Oak, Pin Oak, Bur Oak, Ash, Tulip Tree, Sweet Gum, Hophornbeam, River Birch

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Cypress Lane Basin

- Reduce mowing to < 1 acre
  - Mow 40’ transition zone along west edge and 6-8’ edge along low flow channel
- Clean/maintain low flow channel or replace with dry streambed feature to infiltrate low flows
- Establish wet meadow zone in remainder of basin (mow only 1-2 times per year)
- Establish native tree arboretum with community partners

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Englewood Blvd Basin

- < 1 acre facility
- Detention basin mowed monthly by Township DPW (~0.3 acres)
- High berm
- Inlet and outlet structures overgrown
- ¼ of basin colonized by scrub/shrub wetland

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Englewood Blvd Basin

- Clean and clear inlet/outlet structures and repair as needed
- Plant wetland plugs in wet meadow zone (mow 1-2 times per year)
- Mow/maintain berm and clear zone around inlet/outlet structures
- Plant additional trees to screen/buffer basin from adjacent residences
- Investigate for RU mosquito study

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Jimarie Court Basin

- < 1-acre detention basin
- Deep (10-12’) with steep embankments and limited access
- Vegetation near inlet
- Outlet clogged with debris

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Jimarie Court Basin

- Plant native trees on north side of basin
- Plant screen adjacent to residences
- Reduce mowing to access, structures and edge along low flow channel
- Clean low flow channel and inlet/outlet structures
- Keep structures clear of debris

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The Highlands Basin

- Large detention basin ~4-5 acres
- Currently functioning as wet pond
- Requires frequent outlet cleaning
- Mowed monthly by Township DPW

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The Highlands Basin

- Review original design plans and outlet structure details
- Design/install outlet retrofit with removable and/or self-cleaning screens
- Option A – retrofit and manage as wet pond
- Option B – install underdrain system to dewater basin
- Provide access route for routine maintenance and mosquito monitoring & treatment
- Investigate for RU mosquito study

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Peter Rafferty Creek

- 15-20 acres "Drainage Easement"
- Mowed monthly
- Adjacent property owners dumping yard waste along in easement
- Minimal riparian vegetation established
- Invasive vegetation colonizing disturbed areas

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Peter Rafferty Creek

- Work with community partners to plant riparian buffer
- Implement streamside living homeowner education program
- Develop a tree/shrub planting incentive program for homeowners
- Reduce mowing and establish healthy, diverse riparian corridor vegetation

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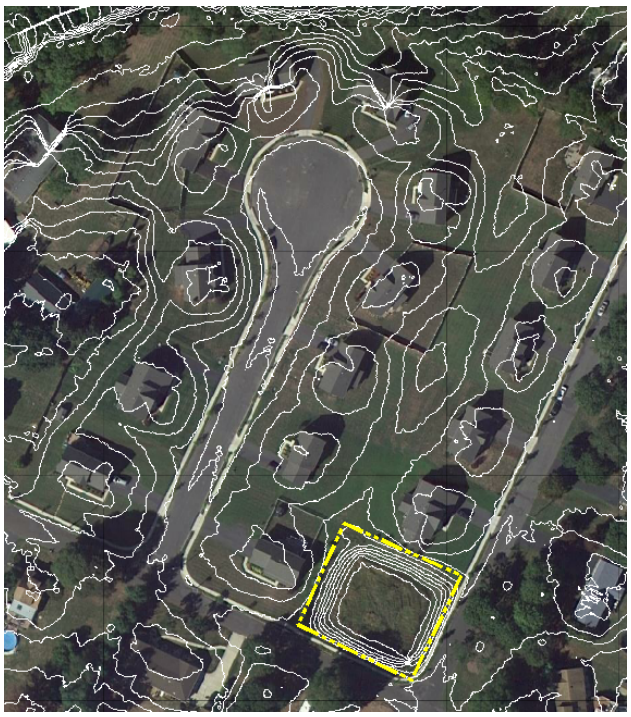
Christopher Estates

- 1-acre basin (6-8’ depth)
- Designed for infiltration
- Outlet 12” above basin floor
- Permanently saturated soils with cattails and invasive wetland vegetation colonizing basin
- Difficult to mow and maintain



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Christopher Estates

- Raise basin floor
  - 6” clean stone
  - 2” choker course stone
  - 4” topsoil
- Install underdrain pipe
- Seed with turf or plant as wet meadow
- Mow monthly if turf or 1-2 times annually if wet meadow
- Install headwall to discharge flow from Evelyn Ave into basin before outlet
- Investigate for RU mosquito study

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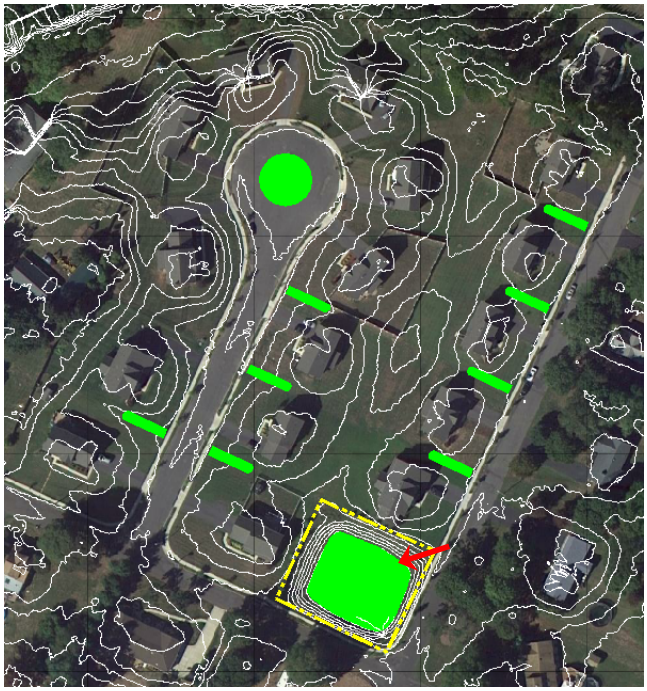
Christopher Estates

- Install bioretention island in cul-de-sac
- Install rain gardens along property lines between homes
- Where possible, locate rain gardens adjacent to inlet structures and have underdrain pipes connect to storm sewer system
- Implement "Downspout Disconnection" program
- Bioretention island and rain gardens to capture, treat, and infiltrate water quality storm volume



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Pinehurst Court Basin

- 1.5 acre detention basin
- Mowed monthly by Township DPW
- Low flow channels filled with debris
- Inlet/outlet structures clogged
- Ruts collecting water

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Pinehurst Court Basin

- Clear and maintain low flow channel and inlet/outlet structures
- Maintain clear mow zone around all structures, low flow channel and basin perimeter
- Establish wet meadow (mow 1-2 times per year0
- Plant screen/buffer trees along residential property lines

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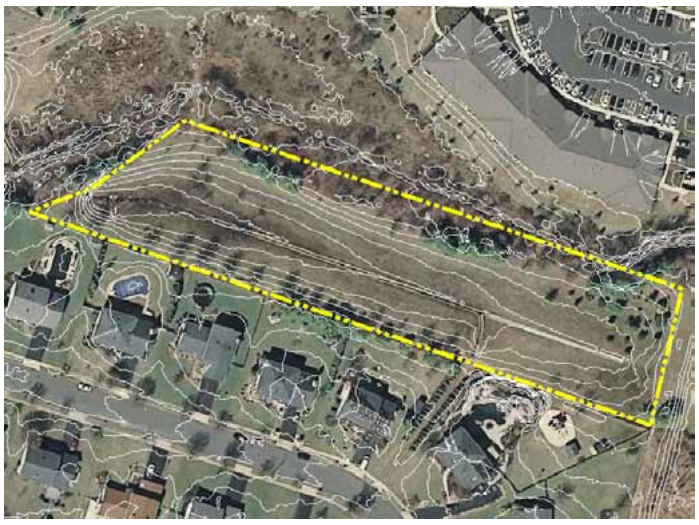
Innocenzi Drive Basin

- 2.5 acre basin
- Standing water in low flow channel
- Mowed monthly by Township DPW
- Outlet structure in disrepair
- Sediment accumulation



Innocenzi Drive Basin

- Reduce mow area by 60-75%
- Maintain perimeter and low channel edge
- Clear and maintain low flow channel
- Repair outlet structure
- Plant trees and screen/buffers

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General Observations

- Maintenance efforts focused on mowing only
- Clear areas need to be established and maintained around all structures (inlets, outlets, and low flow channels)
- Newer basins are deep with steep slopes, difficult to access and maintain

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Preliminary Recommendations

- Reduce mow areas to basin perimeter, berms, and clear zones around structures
- Monthly maintenance needs to include clearing debris from low flow channels and inlet/outlet structures
- Planting trees in and around basins can enhance facilities
- Wet meadow areas can be mowed only 1-2 times per year
- Repair and maintain structures to ensure operation and minimize flooding impacts
- Plan for annual repairs to damaged facilities
- Clear access routes are needed for maintenance and mosquito monitoring/treatment

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