Chapter 5

Milestone 4B
The Troy Brook Regional Stormwater Management Plan

Troy Brook Regional Stormwater Management Plan
Part B: Supplemental Provisions

Completed by the
Rutgers Cooperative Extension
Water Resources Program
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4B.1.0 Introduction

A Regional Stormwater Management Plan has been created for the Troy Brook Watershed, in Morris County, NJ. Initial steps of this process included the formation of a committee, a stormwater characterization and assessment, and a compilation of drainage area specific water quality, quantity and recharge objectives. The final steps before the implementation and adoption of a plan is to identify management measures that will achieve the drainage area objectives.

The management measures have been separated into two parts that will differ in their implementation. Part A defines the regulatory actions that will be adopted into the Areawide Water Quality Plan to address identified stormwater problems. Part B identifies specific management projects that have been quantified as to their potential in pollutant reduction, stream flow reduction, cost, and other characteristics and are voluntary in nature. This document details those project recommended in Part B.

The management measures that will be implemented as distinct projects are categorized into six categories and are detailed in Sections 4B.2, Education; 4B.3, Stormwater Utility; 4B.4, Pathogen Management, 4B.5 Landscaping Professionals, 4B.6 Stressor Analysis and 4B.7, Specific Projects. The specific projects have been ranked among themselves.

4B.1.1 Ranking of Management Measures (in Section 4B.7)

4B.1.1.1 Stormwater Rules at 7:8-3.4(e)

The management strategies presented as projects that are recommended in this document have been ranked using the protocol in the Stormwater Rules at 7:8-3.4(e). Priority is given to those projects that "may affect public health, safety and welfare as evidenced by history or of potential for flood damage, risk of loss of or damage to water supplies; and risk of damage to the biological integrity of water bodies". Problems concerning water quantity are generally addressed and prioritized above water quality issues due to these prioritization guidelines. Also, mitigating water quantity problems often alleviates poor water quality by reducing erosion and direct input of stormwater into the stream. Many of these issues were prioritized in the Milestone 2, Stormwater Characterization and Assessment. Both water quality and water quantity issues were initially prioritized in Section X and XI of that document. Prioritization of subbasins by water quantity characteristics were also determined through the use of aerial loading analysis and detailed at the end of Section IV of the Stormwater Characterization and Assessment for the Troy Brook Watershed.

4B.1.1.2 Planning Committee

The priorities of the Regional Stormwater Management Planning Committee also played a significant role in the prioritization schedule offered in this document. These priorities heavily correlated with those determined through the above methods.

4B.1.1.3 Prioritization of Other Voluntary Measures

The management strategies other than the specific individual projects have not been ranked together with the projects due to their nature of encompassing the entire watershed and the necessity of having these measures completed concurrently with the projects. It is the intention of the committee to not place education, stormwater utilities, pathogen management, landscaping registration, and stressor analysis on a waiting list, but to proceed directly with implementation as circumstances permit.

4B.1.1.4 Priority Storms

During stormwater analysis of the Troy Brook Watershed many design storms and actual storms were evaluated. Combining results of hydrologic and hydraulic models together with the priorities of the Troy Brook Regional Stormwater Planning Committee, the critical storm was determined to be the small "nuisance" storms, falling between the New Jersey Water Quality Storm (1.25"/2 hours) and the 2-yr storm (3.5"/24 hours). It was these storms that were primarily addressed by this plan.

4B.1.1.5 Time schedule

A schedule that details the tasks necessary to bring all projects to fruition should be completed by each town according to priorities of the town. Overall, a goal of completing fifty per cent of the projects within the first decade after adoption is a recommended minimum.

4.B.1.2.0 Cost Estimates

The cost estimates of a management measure were not considered in the prioritization procedure. This must be performed on a case by case basis. The cost estimates are preliminary and require a more detailed assessment.

Cost estimates for the recommended management measures are given in first table in each municipal section that follows. The cost of the disconnection of impervious surfaces was determined by determining runoff volumes for the two-year design storm using TR55. This volume was then routed through a bioretention system or rain garden that was two feet deep with an infiltration rate of 0.5 inches per hour. The lower cost of the bioretention basin was taken as $2 per square foot of basin plus 25% for engineering costs while the higher cost used $4 per square foot plus 25% for engineering costs. The cost for educational programs includes the cost to construct demonstration rain gardens and the cost to deliver educational programming at several locations within the subbasin. The costs for the remaining management measures can be found in Table 1, 4 and 7. These estimates are based upon best engineering cost estimates and upon similar projects completed in New Jersey. Please note that these are only estimates. Actual costs will be a function of the market prices during the time of construction.

4B.1.3.0 Management Measures Grouped and Named

Section 4B.7 contains tangible projects that can be created to directly mitigate water quantity and water quality issues. These projects are grouped within each municipality and have a unique numerical identifier. This identifier begins with two letter representing the municipality where the project will be primarily contained (ML=Mountain Lakes; PT=Parsippany Troy Hills; HT=Hanover Township). The first two digits are the subbasin number in which the project is primarily contained; and the numbers that follow that represent the number of objectives that the project meets from Milestone 3 (one digit) and the final number attempts to indicate the range in which the cost of the project falls (1=less than 100K; 2=less than 200K, etc.). In the case this method does not present a unique ID, the cost digit is adjusted.

4B.2. Education

Many of the water quality and water quantity objectives can be achieved by addressing the impact of existing development in the Troy Brook Watershed. Education plays a key role in reducing the impacts from existing development. Several educational programs already exist in New Jersey that can be used to begin this process. It is important to note that often education is not enough to encourage people to change their behavior. To this end, programs need to be established that provide tools and resources to homeowners, businesses and public entities to help them take the actions that are needed.

The programs that are described below can be used to empower local residents to take action to improve the Troy Brook. All but one of these programs have been offered throughout New Jersey and have been very successful at training volunteers and encouraging homeowners and municipalities to implement stormwater management strategies. These programs can be customized for many different situations. They also lend themselves to be adapted into "train the trainer" programs where other organizations can assume ownership of the program in different areas and deliver the program as part of their organization's activities. The adoption of some or all of these programs could have a significant impact on reducing flooding and improving the water quality of Troy Brook.

New Jersey Educational Programs

The programs listed below are a sample of educational programs that are available in New Jersey. The NJDEP, Whippany River Action Committee, Passaic River Coalition, and the New Jersey 4H are a few other organizations that also offer educational programs. The educational programs that will create true change in the actions of people must provide stakeholders with hands on activities and contain a strong outreach component. It is for this reason that the Rutgers Cooperative Extension programs play an important role and offer programs where the agency is able to come to the municipality and work with the local stakeholders to educate them on specific concerns in their area.

The Environmental Protection Agency (USEPA) and the NJDEP offer newsletters, brochures and other outreach materials and these can be used by the watershed groups in an additional effort to educate stakeholders. However, priority must be given to hands on instruction.

4B.2.1 Rutgers Cooperative Extension Water Resources Program Stormwater Management in Your Backyard Program

This program provides a detailed overview of stormwater management. It introduces the factors that affect stormwater runoff, point and nonpoint source pollution, the impact of development (particularly impervious cover) on stormwater runoff, and the pollutants found in stormwater runoff. An overview of New Jersey's stormwater regulations is presented including who must comply and what they are required to do. Additionally, the concept of Total Maximum Daily Loads (TMDLs) is introduced along with various other requirements of the Federal Clean Water Act that have serious implications on New Jersey. A thorough discussion of different types of best management practices (BMPs) that can be implemented to control stormwater runoff is presented and how these BMPs can be used to achieve the quality, quantity and groundwater recharge requirements of New Jersey regulations. The BMPs discussed include bioretention systems (rain gardens), sand filters, stormwater wetlands, extended detention basins, infiltration basins, manufactured treatment devices, vegetated filters, and wet ponds. The workshop also discusses the various management practices that the homeowner can install including dry wells, rain gardens, rain barrels, and alternative landscaping. The protocol for designing these systems is reviewed in detail with real world examples provided. A step by step guide is worked through for designing a rain garden so that homeowners can actually construct one on their property. The students have an opportunity to bring in sketches of their property for the class to review and discuss various BMP options for each site. The course also provides a discussion of BMP maintenance focusing on the homeowner BMPs. The course concludes with a discussion of larger watershed restoration projects and how the students can lead these restoration efforts in their community. The course is very interactive and ample time is set aside for question and answer sessions.

The initial target groups for educational programs in the Troy Brook Watershed should be areas of dense development around the larger reservoirs of water. Key areas would include the Rainbow Lakes section of Parsippany-Troy Hills and the Lake Parsippany area of Parsippany-Troy Hills.

For more information, please contact Christopher Obropta at 732-932-4917 or obropta@envsci.rutgers.edu.

4B.2.2 Rutgers Cooperative Extension's Environmental Stewardship Program

Rutgers Cooperative Extension has formed a partnership with Duke Farms to create a statewide Environmental Stewardship certification program. Participants learn land and

water stewardship, best management practices, environmental public advocacy, and leadership. Each group meets twenty times for classroom and field study. They are taught by experts from Rutgers and its consortium partners. Students are certified as Rutgers Environmental Stewards when they have completed sixty hours of classroom instruction *and* sixty hours of volunteer internship. Northern classes are held at the Essex County Environmental Center, Duke Farms and the Rutgers EcoComplex. Consortium partners can ask students to provide volunteer assistance in the satisfaction of their internship requirements.

Graduates of this program become knowledgeable about the basic processes of earth, air, water and biological systems. They increase awareness of techniques and tools used to monitor and assess the health of the environment. They gain an understanding of the research and regulatory infrastructure of state and federal agencies operating in New Jersey that relate to environmental issues. Unlike some programs, they are also given an introduction to group dynamics and community leadership. Participants are taught to recognize the elements of sound science and public policy based in science while acquiring a sense of the limits of the current understanding of the environment. The goal of the Rutgers Environmental Stewards program is to give graduates knowledge to expand public awareness of scientifically based information related to environmental issues and facilitate positive change in their community.

For more information please log on to: www.rcre.rutgers.edu/envirostewards.

4B.2.3 Rutgers Cooperative Extension Water Resources Program Restore-A-Waterway Program

Restore-a-Waterway is a technical service provider program offered by the Rutgers Cooperative Extension Water Resources Program. The Program is funded jointly by the United States Department of Agriculture Cooperative State Research, Education , and Extension Service (USDA CSREES), New Jersey Sea Grant, and the New Jersey Agricultural Experiment Station (NJAES). The goal of the program is to provide technical assistance to citizen groups that want to take action in restoring the condition of a waterway. Rutgers Cooperative Extension (RCE) provides expertise to these groups to assist them in their efforts. Forms of technical assistance include helping these groups to:

- physical waterway characterizations,
- the development and implementation of chemical and biological quality assurance project plans (i.e. QAPPs),
- interpretation and analysis of data,
- identifying problems and sources of those problems within a watershed,
- designing solutions to mitigate the identified problems,
- securing funds to implement the designed solutions,
- implementing the solutions.

In addition to offering workshops to help educate citizen groups on these technical issues, Restore-a-Waterway can be adapted for municipal officials to address their specific needs. The implementation of solutions after monitoring and analysis is an important focus of this program.

Target communities would be those that are mentioned and prioritized in this document. Selection, design and implementation of BMPs recommended within this document can be optimized through the use of this program.

If you are interested in participating in Restore-a-Waterway, please contact: Gregory Rusciano at (732) 932-2739 or greg.rusciano@rutgers.edu.

4B.2.4 Community-Project-Based Learning Educational Program

The RCE Water Resources Program has joined forces with Research in Education Applied to Learning (R.E.A.L.) Science to create a new method of science instruction called "Community-Project-Based Learning." R.E.A.L. Science is a nonprofit organization that provides a support system for innovative standards-based authentic science projects along with effective teacher in-service training programs in science education. Community-Project-Based Learning incorporates the authentic practice of real scientists into the regular classroom setting. Community-Project-Based Learning identifies a real environmental problem in the community and works with the students to address these driving questions: Is there a real problem with our watershed? What is our contribution to the problem? If there is pollution in our watershed, how can we fix it? The project objectives include the students investigating various aspects of the natural environment on and around the school grounds, students documenting findings, and students communicating these findings to fellow classmates and the community. Working in teams, the students design a solution to a problem and present these solutions to their classmates. The best solutions are selected and built on the school grounds.

These projects expose students to the actual practice of scientists in the fields of ecology and environmental science and cover issues in geology, biology, chemistry, and applied mathematics. Lessons and activities are designed with classroom teachers to instruct students within the state standards-based curriculum. The students work together to address relevant environmental problems in their community.

Students participate as legitimate members of a scientific community. They work with their teachers, parents, local scientists, and other knowledgeable members of the community to create a solution to a relevant environmental problem in their community. As scientists, the students assemble existing data, collect new data, and work with professionals from the community to fully understand the problem, while honing their skills and learning within the guidelines of the New Jersey State Core Curriculum Content Standards.

An ideal target community would be the Bee Meadow Elementary School which is directly across the street from Bee Meadow Pond in Hanover Township. There is an

effort underway in the Bee Meadow area that would reduce stormwater runoff and the concomitant pollution. This effort, which will require the maintenance of a buffer around the pond, would greatly benefit from this interaction within the community.

For more information, please contact Christopher Obropta at 732-932-4917 or obropta@envsci.rutgers.edu.

4B.2.5 Best Management Practices in Landscaping (under development)

Landscapers contribute to the application of fertilizer, the removal of yard waste, the construction of gardens and the maintenance of the grounds surrounding the streams and lakes within a watershed. For these reasons, a program that will be aimed at teaching the best management practices (BMPs) of landscaping could be required as a part of the licensing processes of landscapers.

As yet undeveloped, this program has the potential to be administered through the Environmental Steward or the Restore Our Waterways programs. After initial development of the program, it is possible for the municipality to offer it or have it offered through the box stores that carry lawn maintenance equipment and fertilizers. Key aspects of this educational program will be soil testing and the subsequent application of necessary nutrients; the design, implementation and maintenance of rain gardens; buffer establishment and maintenance and the BMPs of waste disposal.

Registration of Landscaping Professionals

Addressing this significant population can have a strong impact on stormwater management and will best be served by a general registration of landscapers. This is one recommendation that could be undertaken by the individual municipalities. Requirements for using the best management practices can then be more efficiently delivered to the interested parties.

4B.3.0 Stormwater Utility

Voluntary programs are excellent methods of addressing water quality and quantity concerns, but sometimes these programs fail to achieve the required goals, and a regulatory approach is needed. To address flooding related problems and water quality problems, such as those experienced in the Troy Brook Watershed, many communities across the country have considered the option of forming a utility specifically for the purpose of managing stormwater. Although the concept of a “Stormwater Utility” was first proposed in the 1970s, it is within the last ten years that the growth of utilities with a specific mandate to manage stormwater has increased rapidly. These utilities perform various services, which may include overseeing the collection, treatment, and disposal of stormwater, and in some cases assuming the responsibility for maintenance of the stormwater collection systems. These Stormwater Utilities are typically funded through a dedicated revenue stream. As of May 2005 there were over 400 utilities operating

throughout the U.S. to manage stormwater flows, but to date, no municipality or county within New Jersey has created such a utility (NJDEP 2005). For a municipality or a county to establish a viable Stormwater Utility, enabling legislation must be enacted.

In a 2005 report entitled *Recommendations for Stormwater Utility Implementation in New Jersey*, several suggestions were put forth to apply modifications to existing laws to facilitate the implementation of stormwater utilities. It is recommended that each law that is modified should support the following functions:

- Authorize creation and operation of stormwater utility systems
- Authorize imposition of user fees to finance operation and maintenance and repayment of bonds
- Require that stormwater system user fees be based on the stormwater runoff contribution of each parcel of land
- Reference a stormwater utility manual that provides guidance regarding stormwater utility implementation and establishment of defensible user fee structures. A manual of this type has been circulated describing a hypothetical stormwater utility implementation process for "Greentown Borough".

As a part of these recommendations that were presented to the State, five specific laws were identified for changes that would allow provisions for stormwater function and services that were listed above. The five laws and recommendation modifications are as follows:

1. NJSA 40

   NJSA 40 could have language added that would authorize municipalities to create stormwater utilities by ordinance. Section NJSA 40:62 currently deals with municipal utilities and water districts and would be an ideal area to add language that would impose user fees and require that the fees be based on the stormwater runoff contribution of each parcel of land.
2. Local Bond Law

   Under the Local Bond Law, NJSA 40A:2-1 et.seq., bond ordinances to finance municipal public utilities may commit the municipality to impose user fees to pay off the bonds and fund the operation of the utility (NJSA 40A:2-15(d)).
3. Municipal and County Sewerage Act

   The Municipal and County Sewerage Act, NJSA 40:A26A-1et seq., currently authorized municipalities and counties. The act currently authorizes imposition of fees on users of "sewerage services", and does not define "sewerage services". NJSA 40A:26A-10 can be amended to specify fees for use of stormwater systems based on the runoff contribution of each parcel of land.
4. Municipal and County Utilities Authority Law

   Stormwater-specific provisions should be added to the Municipal and County Utilities Authority Law, NJSA 40:14B-1 et seq. Definitions of stormwater, stormwater system, and service charges should be amended to refer to stormwater systems.

5. County Improvement Authorities Law

   The County Improvement Authorities Law, NJSA 40:37A-44 et seq., should be modified to specifically authorize implementation of stormwater management functions and provide for imposition of user fees to finance construction, operation and maintenance fo stormwater management facilities.

Municipal stormwater discharges are regulated as point sources under the Clean Water Act (1972). However, control of stormwater is often extremely difficult in urban environments due to both the large volumes of stormwater generated, as well as the space constraints, and so stormwater management is an issue facing urban centers across the country. Uncontrolled stormwater flows pose a danger to both constructed and natural environments, and the collection and rapid routing of water through urban stormwater infrastructure results in problems related to both water quantity and quality. Municipal surface water runoff in urban areas is typically collected in storm sewer systems and conveyed to the nearest receiving water body. The volume of the runoff, the rate of flow, and the water quality are determined by the amount of a watershed's impervious surface, modifications of the landscape, and the natural drainage patterns and topography within a drainage basin. Original storm sewer systems were designed to rapidly route stormwater out of developed areas to the discharge point. As previously undeveloped land is developed with impervious covers such as blacktop, rooftop, and concrete, the volume of stormwater continues to increase.

While older stormwater conveyance systems were built to efficiently move water downstream, the modern approach now views stormwater as an important component in managing integrated urban water resources. Current strategies are multi-dimensional, and consider water quantity and quality issues, multiple-use facilities, riparian corridors, wetland preservation and creation, and groundwater recharge (NSFMA 2006).

In forward-looking communities stormwater is considered a resource, and the management of stormwater is viewed as an important function of local government on par with the oversight of the drinking water supply and sewage treatment operations. Today stormwater management includes planning, design, construction, operation, and maintenance of specific water control structures and dedicated financial resources required to support these activities. The benefits of successful stormwater management include handling of excess drainage, reduction of the damage caused by flooding, protection of transportation systems, protecting property values, providing long term system maintenance, and environmental enhancement (NSFMA 2006). However, the costs of construction, operation, and maintenance of flood control measures is typically beyond the financial resources available to individual property owners, and in many cases individual municipalities.

Although the creation of a stormwater utility would require fees to be assessed on property owners throughout the watershed, it would provide a steady source of funding that could be used to leverage larger grant or loan funds to implement stormwater control projects.

4B.4.0 Management of Pathogens in Recreational Waters

As a part of the larger Whippany River Watershed TMDL for fecal coliform, the Troy Brook Watershed requires diligence in detecting sources of waste products that could be associated with pathogens. The parties in the watershed that are responsible for detecting sources have up to this point focused their efforts on waterfowl and other wildlife. Due to the existence of aging infrastructure, the implementation of a Microbial Source Tracking (MST) study is recommended to differentiate the sources of bacteria.

TMDL

Although there are several lakes in the watershed that have been place on Sublist 5 of the Integrated List (see Characterization and Assessment, Section II M), there are no TMDL reported to the EPA and no potential sources identified. However, many of the projects and other proposed management measures have been recommended and ranked according to the need to address these impairments.

As a part of the larger Whippany River Watershed fecal Coliform TMDL, the Troy Brook Watershed Regional Stormwater Management Plan prioritizes the issues of fecal Coliform through projects, pathogen detection and goose management recommendations. However, the TMDL of the Whippany River does identify failing septic systems as a source of pathogens to the watershed, and the Troy Brook Watershed does not contain any septic systems that this committee is aware.

Microbial Source Tracking

An MST survey will provide data that can identify if the source of the bacteria is human, bovine or another animal. If the results of an MST study indicate human sources, an targeted analysis can be performed on the sanitary sewers that are upgradient of the detection. With no known septic systems in operation in this watershed, contamination from human waste would be expected to be due to a breech in the transport system of household waste. This analysis could consist of viewing the interior of the sanitary sewer with special video or camera equipment.

Goose Management

It is becoming a town mandate to reduce the number of resident Canada geese that reside around waterways with mowed areas surrounding them. Addressing this issue may be due to the unsanitary conditions these animals present at public recreational areas, but the result of reducing pathogen input to the waters is coincident.

Each municipality should have a specific plan that details the tasks necessary to keep the resident waterfowl population to a manageable, sustainable number. Key solutions include buffers that are not mowed around waterways. Numerous publications exist on the subject and should be evaluated on a town by town basis.

4B 5.0 Landscaping Professionals

Landscaping professionals should be required to register with the municipality and be notified of proper procedures to comply with MS4 regulations and additional best management practices related stormwater management.

Hiring a professional landscaper for lawn care in residential areas is a growing practice in New Jersey. Landscapers seek to be permitted for pesticide application and irrigation. Although not all landscapers need to permitted/licensed, beginning an educational program that offers alternatives to traditional management of lawns can have a positive impact on stormwater management.

A program being developed by the Rutgers Cooperative Extension Water Resources Program in cooperation with the Rutgers University Continuing Education will include Best Management Practices and the maintenance that is required. It is expected that this program will increase the use of stream buffers, rain gardens and infiltration in general and become an essential part of the continuing education for professional landscapers.

4B 6.0 Watershed Wide Stressor Analysis

The Ambient Biomonitoring Network stations and the macroinvertebrate surveys performed by Rutgers Cooperative Extension Water Resources Program have tested the waters of the Troy Brook Watershed and have consistently found impairments ranging from moderate to severe. Additionally, many committee members and members of the public have expressed concern as to the biological makeup of the stream. For these reasons, it is recommended by this plan that a watershed wide stressor analysis program be implemented.

4B.7.0 Specific Projects

4B.7.1. Mountain Lakes

In the Borough of Mountain Lakes several objectives have been identified as a result of completing Milestones 2 and 3. One of the top objectives within the Borough of Mountain Lakes is the individual lake, Mountain Lake, which has been identified on Sublist 5 as being impaired for fecal coliform. This lake has also been linked to a loss of biodiversity based upon the macroinvertebrate sampling conducted downstream of the outlet for Mountain Lake. The subbasins of Mountain Lakes that are contained in the Troy Brook Watershed are shown in Figure 1.

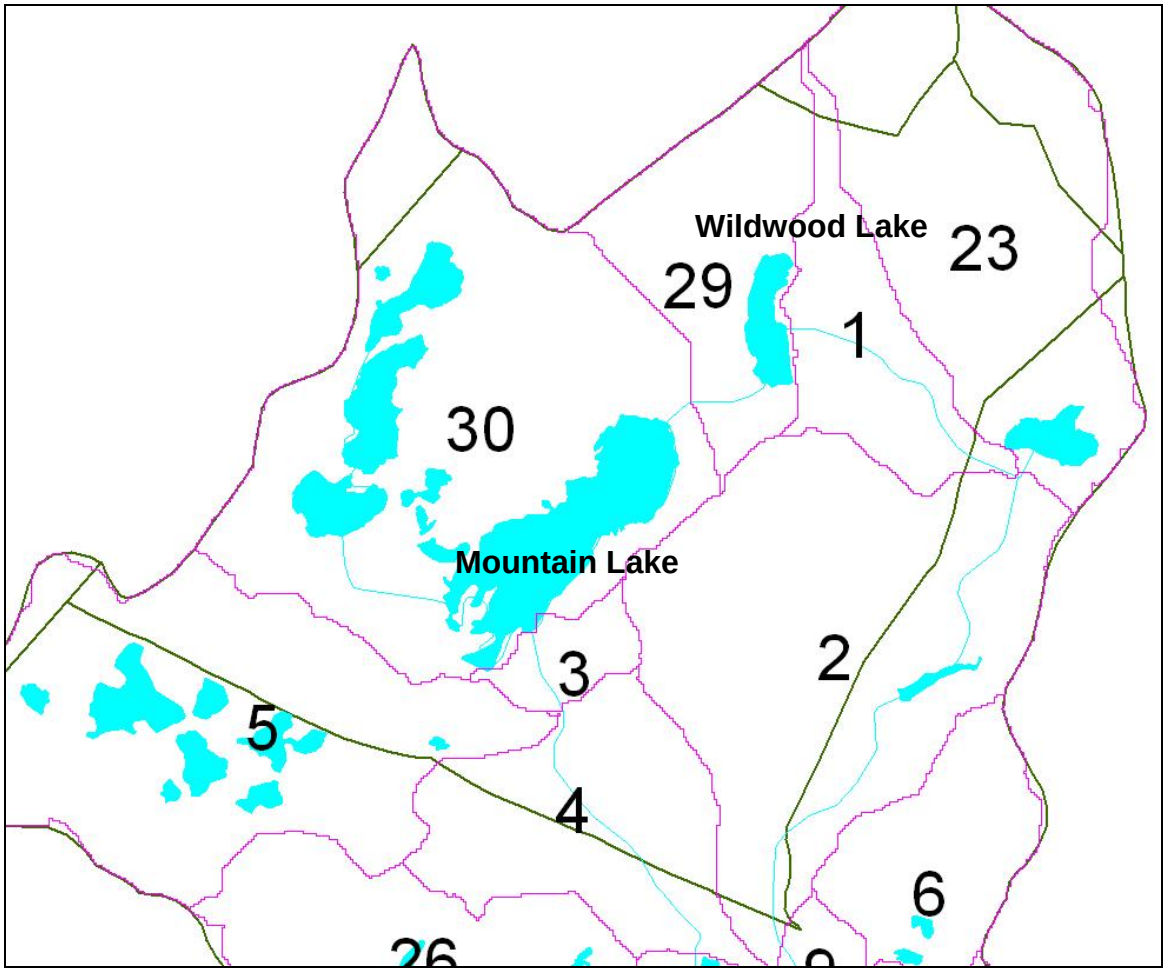


Figure 1: The Subbasins of the Borough of Mountain Lakes

Geese have been identified as a potential source of fecal coliform. The Borough of Mountain Lakes has been successful at decreasing the resident goose population through recently developed tactics such as addling eggs and culling the population. This decrease correlates to a decrease in beach closures and lower in-lake fecal coliform concentrations.

Although the Borough of Mountain Lakes has passed a pet waste ordinance, there are still issues associated with individuals not obeying the ordinance. In a related study of bacterial contamination, Dr. George Van Orden has examined the environmental impact of catch basin cleaning. His report shows that regular cleaning of catch basins reduces pollutant loads to waterbodies.

The nonpoint source analysis also identified Subbasins 3 and 29 as potentially high nonpoint source contributors in the Troy Brook Watershed. Both subbasins consist of primarily residential land use and do not contain any stormwater management facilities. Mountain Lakes does have a low phosphorus fertilizer ordinance to help minimize the environmental impact of residential lawns.

An additional objective that was identified in the Borough was poor drainage at Crescent and Center Streets, resulting in the creation of mosquito breeding habitat. The town is currently evaluating solutions to the problem and intends to proceed with a plan that will minimize mosquito habitat and maximize stormwater recharge.

Based upon the groundwater recharge analysis (C&A, Section V) Subbasins 2, 5 and 30 have been identified as areas where groundwater recharge can be promoted (also See Map 3, Appendix D). Groundwater recharge will help maintain the baseflow of the Troy Brook and eliminate high peak flows that could cause bank erosion and stream bottom scouring.

All projects with their estimated costs have been presented in Table 1. These projects may cover water quality issues, water quantity issues and/or groundwater recharge issues. The objectives (cross referenced from Milestone 3) that the project addresses have been noted in Table 3.

Table 1: Mountain Lakes Projects and Costs

Ranking of Recommendations	Unique Project Identifier	Location (Subbasin No.)	Management Measure	Type of BMP	Cost
1	ML0558	5 (only portion in Mountain Lakes)	Disconnection of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	$381,000 to $762,000
2	ML0454	4 (only portion in Mountain Lakes)	Disconnection of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	$163,000 to $327,000
3	ML0011	Sites to be identified	Microbial Source Tracking	Sampling Program for Guidance	unknown
4	ML0253	2	Disconnection of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	$131,000 to $261,000
5	ML2942	29 and 30	Catch basin retrofits	MS4 retrofit	$60,000
6	ML2940	29 and 30	Extra catch basin cleaning	MS4 maintenance	No additional cost – changes in cleaning schedule
7	ML0231	2	Retrofitting for stormwater storage	Bioretention system (Cresant and Center)	Unknown

8	ML0312	3	Biological Impairment of Mountain Lake Site A/ANO236	Stressor Analysis	Unknown
9	ML0551	5	Education programming	Stormwater Management in Your Backyard	$10,000 for 10 demo gardens and educational programming
10	ML2941	29 and 30	Goose Management	Culling and Addling	$10,000/year
11	ML2951	29	Education programming	Stormwater Management in Your Backyard	$25,000 for 25 demo gardens and educational programming
12	ML3051	30	Education programming	Stormwater Management in Your Backyard	$15,000 for 15 demo gardens and educational programming
13	ML0351	3	Education programming	Stormwater Management in Your Backyard	$15,000 for 15 demo gardens and educational programming
14	ML0311	3	Habitat restoration in Troy Brook from outlet of Mountain Lakes downstream	Stream bank restoration and channel modifications to improve habitat	$10,000

Recommendations to Address Water Quality and Loss of Biodiversity Issues for the Borough of Mountain Lakes

To address the fecal coliform problem, we recommend the continued implementation of the goose management program including addling and culling of the resident geese. Since the Borough has stopped using volunteers to conduct the program and has retained professionals to implement the program, it has been much more successful *(Cross reference projects with unique ID# ML3051; ML 2940; ML2941 and ML2942)*

The implementation of a catch basin cleaning program that directs the cleaning of end-of the line, or terminal, catch basin twice a year has been set forth in Part A of the Troy

Brook Regional Stormwater Management Plan. These terminal catch basins are defined as those catch basins that discharge directly to lakes, without other catch basins down the line *(Cross reference unique ID ML2940).*

The Borough of Mountain Lakes has previously requested funding from NJDEP's 319(h) program to retrofit 24 catch basins with filter inserts to better eliminate pollutants from entering Mountain Lake and Wildwood Lake. We believe that this effort would be beneficial to the water quality of these lakes and should be undertaken. These inserts should be maintained as recommended by the manufacturer. These inserts can clog and cause flooding if not maintained properly. However, past experience proves that the Borough has been very aggressive about maintaining stormwater infrastructure and if fully capable of keeping these systems operating. The Borough should consider the use of New Jersey Corporation for Advanced Technology (NJCAT) approved technologies. For the most recent list of approved technologies, please see www.NJCAT.org. *(Cross reference ML 2942)*

The County roads that transect the municipality should are also mandated through the Statewide Basic Requirements and are to be maintained at the same interval. Through the changes proposed in Part A of the Troy Brook Regional Stormwater Management Plan, if a terminal catch basin exists on a county road, the county is responsible for maintaining the schedule of maintenance every six months.

The Ambient Biomonitoring Site immediately downstream from Mountain Lake was assessed as being severely impaired. To address this loss of biodiversity, a stressor analysis using United States Environmental Protection Agency (USEPA) protocol is recommended. There are several possibilities as to why this impairment may exist. The outlet of Mountain Lake requires stream bank restoration and channel modification that would be expected to improve habitat. It is also possible that the impairment is in part due to an increase in temperature at the sampling location from the lake discharge. The lake tends to heat up during the warmer months and then appears to discharge from the surface over the spillway. This, along with a variety of other factors, can potentially have a detrimental effect on the sampling location. *(Cross reference unique project ID ML0311 and ML0312).*

The site at Crescent and Center Streets is an existing wooded wetland that could be enhanced for stormwater storage and treatment. By restoring the ecosystem of the wooded wetland, the mosquito breeding habitat could be attenuated. In the meantime, the County Mosquito Control Commission should regularly inspect and treat this location to avoid any vector problems *(Cross Reference ML0231).*

Although the Borough of Mountain Lakes has a low phosphorus fertilizer ordinance, these products are difficult to find in local stores. Scotts-Miracle Grow is currently reducing the phosphorus content in their lawn fertilizer. Several of their products will contain no phosphorus, making it easier for residents to comply with the Borough's ordinance. The addition of a low/no phosphorus ordinance for the Troy Brook Watershed is covered in Part A of the Troy Brook Regional Stormwater Management Plan, the

regulatory requirements. This ordinance is proposed in anticipation of the State implementing a statewide ordinance banning the use of phosphorus in fertilizer without a soil testing requirement.

Additionally, the two subbasins (Subbasins 3 and 29) that have been identified as potentially generating high nonpoint source pollution loads can be targeted with education programs. The "Stormwater Management in Your Backyard Program" could be used to educate homeowners on the importance of proper stormwater management, how to build stormwater management systems such as rain gardens or dry wells, and how to maintain these systems. Since the Borough has a very active Environmental Commission, the Commission could partner with the Whippany River Action Committee and Rutgers Cooperative Extension to deliver this program and possibly build several demonstration rain gardens through these two subbasins. These demonstration rain gardens will serve as educational tools and will begin the process of treating stormwater runoff from residential lawns. These educational tools, along with implementation of the No/Low Phosphorus Ordinance proposed in Part A of this plan is expected to alleviate much of the added nutrients to the waterway *(Cross Reference ML0351; ML0551 and ML2951).*

Parcels of urban lands in Subbasins 2 and 4 have been identified as good candidates for controlling stormwater quantity (See Map 2 of Appendix D). Selective sections of these subbasins have been recommended for the full disconnection of stormwater runoff from the impervious area. The BMPs selected for these subbasins is expected to improve water quality and also reduce peak flow and flooding. *(Cross reference ML0253 and ML0454)*

Table 2: Mountain Lakes Projects and Load Reductions

Ranking of Recommendations	Unique Project Identifier	Drainage Area (acres)	Estimated Total Phosphorus Pollutant Removal (lbs/yr)	Estimated Total Nitrogen Pollutant Removal(lbs/yr)	Estimated Total Suspended Solids Pollutant Removal (lbs/yr)	Estimated Water Quantity Reduction & Groundwater Recharge (Mgal/yr)
1	ML0558	37.2	78	818	7438	40
2	ML0454	20.8	29	297	3336	23
3	ML0011	896	NA	NA	NA	NA
4	ML0253	14.8	26	267	2716	16
5	ML2942	800	unknown	unknown	unknown	unknown
6	ML2940	800	unknown	unknown	unknown	unknown
7	ML0231	10.2	unknown	unknown	unknown	unknown
8	ML0312	620	NA	NA	NA	NA
9	ML0551	0.23	0.14	1.2	23	0.25
10	ML2941	840	unknown	unknown	unknown	unknown
11	ML2951	0.58	0.35	2.9	58	0.63
12	ML3051	0.34	0.2	1.7	34	0.37
13	ML0351	0.34	0.2	1.7	34	0.37
14	ML0311	120	unknown	unknown	unknown	unknown
Totals		2570.29	133.89	1389.5	13639	80.62

Note: Preliminary hydrographs for these management measures that are recommended in Milestone 4 are presented in Appendix F.

Recommendations to Promote Groundwater Recharge in the Borough of Mountain Lakes

As already discussed, the BMPs that have been proposed in Subbasins 2 and 4 will promote groundwater recharge (i.e. approximately 39 million gallons per year). Subbasin 30 has been identified as an area suitable for promoting groundwater recharge. The land use in this watershed is predominately forested or surface water (i.e. approximately 60%). These forested areas should continue to be preserved by the Borough. Moreover, Subbasin 30 is another area that could be targeted for educational programming to promote homeowners to better manage stormwater runoff. It has already been recommended that the "Stormwater Management in Your Backyard Program" be delivered in Subbasins 3 and 29. This program would also be appropriate for Subbasin 30. Subbasin 5 is another subbasin that has been identified as an area where groundwater recharge should be promoted. Commercial sites along Route 46 in Subbasin 5 (See Map 3 in Appendix D) could be disconnected in a similar fashion as the parcels in Subbasins 2 and 4. Also, the residential area on the eastern end of the subbasin could be included in the educational programming for Subbasins 3, 29 and 30.

Estimated Load Reductions and Groundwater Recharge for Mountain Lakes Management Measures

Load reductions were estimated for each of the management measures that were recommended for the Borough of Mountain Lakes. Aerial loading coefficients were used to determine the load reductions for total phosphorus, total nitrogen, and total suspended solids. These loading coefficients were multipled by the area disconnected for each of the management measures. Since the management measures were designed to infiltrate all the runoff from the two-year rainfall event, each management measure was assumed to reduce the annual load by 90% based upon a volume reduction. These load reductions are presented in Table 2.

Also presented in Table 2 are the estimated groundwater recharge volumes. Once again, each management measure was estimated to infiltrate 90% of the annual rainfall or 40 inches per year. These volumes are presented infiltrating at a rate in million of gallons per year.

Table 3: Mountain Lakes Funding and Objectives

Ranking of Recommendations	Unique Project Identifier	Management Measure	Required permits	Potential funding sources*	Addresses Objective (Milestone 3)**
1	ML0558	Disconnection of impervious surfaces for two-year storm	Local construction permits	All	2, 3, 5, 6, and 7
2	ML0454	Disconnection of impervious surfaces for two-year storm	Local construction permits	All	2, 3, 5, 6, and 7
3	ML0011	Microbial Source Tracking	No permits are required	1,2,5,7 and 8	1
4	ML0253	Disconnection of impervious surfaces for two-year storm	Local construction permits	All	2, 3, 5, 6, and 7
5	ML2942	Catch basin retrofits	No permits are required	1, 2, and 7	1, 2, 3, and 4
6	ML2940	Extra catch basin cleaning	No permits are required	None	1, 2, 3, and 4
7	ML0231	Education programming	No permits are required	All	5, 6 and 7
8	ML0312	Goose Management	Possible US fish and Wildlife Permit	1, 2, 3, 6, and 7	4
9	ML0551	Education programming	No permits are required	All	2, 3, 5, 6, and 7

10	ML2941	Education programming	US Fish and Wildlife Permit	1, 2, 3, 6 and 7	1, 2, 3, and 4
11	ML2951	Education programming	No permits are required	All	2, 3, 5, 6, and 7
12	ML3051	Education programming	No permits are required	All	2, 3, 5, 6, and 7
13	ML0351	Education programming	No permits are required	All	2, 3, 5, 6, and 7
14	ML0311	Streambank Restoration	General Wetlands Permit 16 and minor stream encroachment permit	All	4

4B.7. 2. Parsippany-Troy Hills

The Parsippany-Troy Hills section of the Troy Brook Watershed is a highly urbanized area with development that employed early traditional stormwater conveyance systems. These systems have served to minimize infiltration and maximize stream volume and velocity while directly affecting the chemical and biological integrity of the stream. Water quantity issues are also found in many areas of this municipality and can have an impact on the degraded water quality within the area. With three moderately impaired benthic macroinvertebrate sampling stations along the main stem in Parsippany-Troy Hills and one moderately impaired site downstream from Lake Parsippany on Eastman's Brook, concern for the future status of the waterway is significant. The subbasins mentioned in this section can be referenced in Figure 2.

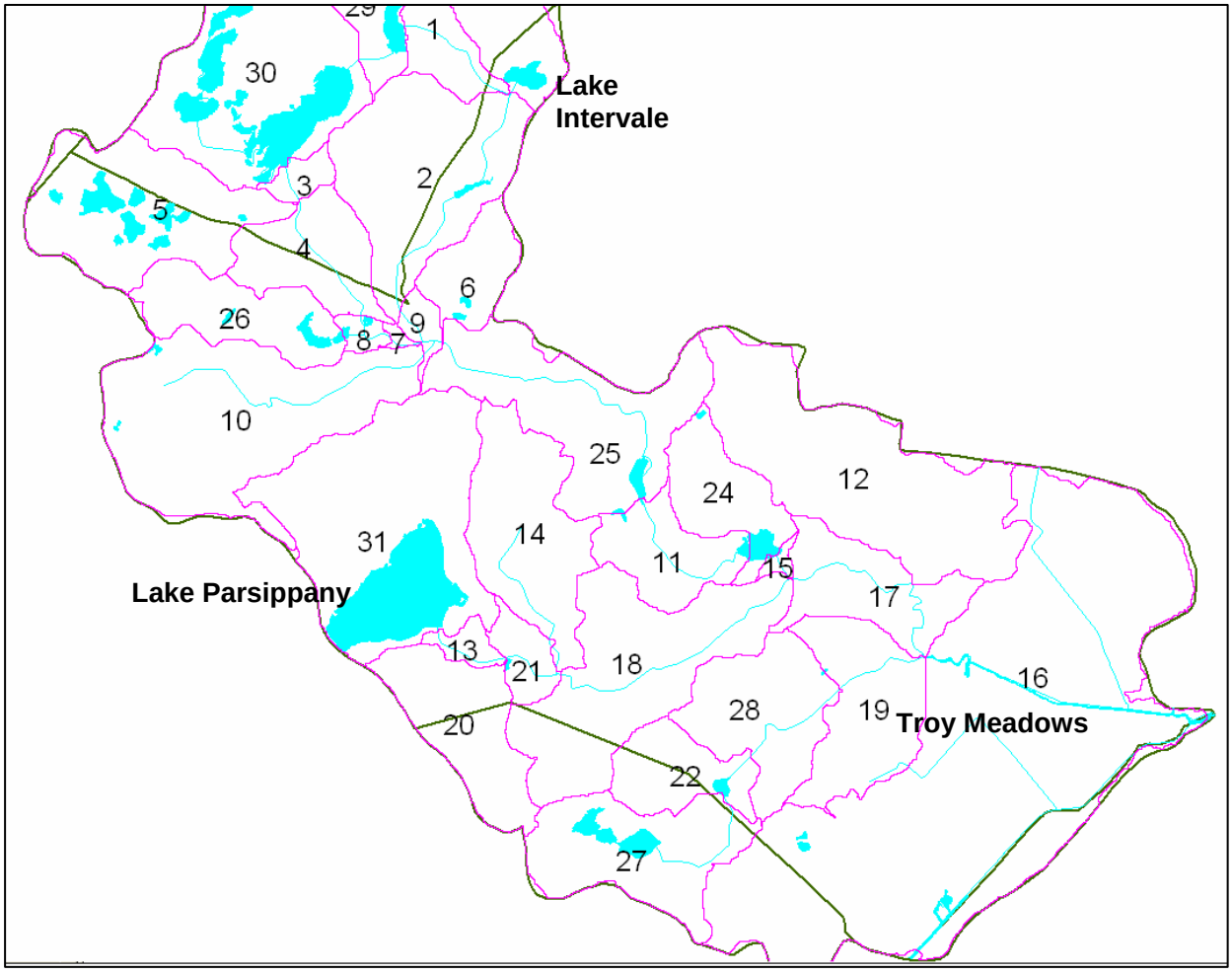


Figure 2: The Subbasins of Parsippany-Troy Hills

Water quantity problems are a top concern of the officials and residents of this municipality. Frequent nuisance flooding episodes disrupt daily routines and increase the stream bank erosion that is ubiquitous within this town. The Troy Brook

Characterization and Assessment quantified the water quantity problems and presented the sensitivity land use and runoff capacity that can effect these areas of flooding.

Parsippany Boulevard (Rt. 202) between Tivoli Gardens and the Senior Center has been identified through theoretical hydrologic and hydraulic modeling and observation as a site where the stormwater drainage is not adequate. Other areas that have been identified as flooding problem areas include the reach between Paris Street and the Municipal Public Works; Homer Street (cement channelization); Smith Road Bridge, the ramp to Littleton Road and the access road to the Municipal Park from Route 46. The culvert under Route 80 has also been reported to flood at certain times due to a lack of maintenance.

Nutrient loading and input of suspended solid material to the waterways have been recognized as widespread problems. Runoff from the three major highways, Route 80, 46 and 287, as well as densely developed areas with connection to storm sewers, contribute to heavy loads of suspended solids to the stream. Forge Pond is an instream impoundment that serves as settling basins, which receives significant nutrient and sediment loads from upstream. Loading of total suspended solids(TSS) and other nonpoint source (NPS) (nonpoint) pollution enter the Troy Meadows Nature Preserve Wetlands at the base of the Troy Brook Watershed. This area is a very sensitive area that serves as a natural filter of the Troy Brook prior to its discharge to the Whippany River. Biological impairments have been reported throughout this municipality in the Troy Brook Watershed.

Three lakes contained within the Parsippany-Troy Hills have been listed on Sublist 5 of the Integrated Report as being impaired for fecal coliform. These lakes include Lake Intervale, Lake Parsippany and Rainbow Lakes. Addressing the significant contributions of fecal coliform from stormwater inputs requires reducing the sources and infiltrating stormwater runoff.

The Township of Parsippany-Troy Hills has the potential of experiencing build out rapidly as it becomes a receiving area of the Highlands Water Protection and Planning Act. With the population of Parsippany-Troy Hills doubling in thirty years and still having some capacity for additional increases, it is critical to use stormwater BMPs to ensure adequate recharge to the aquifers that serve the residents.

Recommendations to Address Water Quantity Issues for the Township of Parsippany-Troy Hills

The flooding of the Parsippany-Troy Hills area needs to be primarily addressed with low impact measures that will infiltrate the precipitation at or near the place where it falls and reduce the amount of connected impervious area that will discharge directly to the stream. An increase in the implementation of bioretention areas and vegetated swales to disconnect impervious surface is recommended and quantified in several subbasins

within Parsippany-Troy Hills. Although these areas have been primarily focused on the reduction of stormwater quantity issues, their impact on the reduction of NPS pollutant contribution to the stream have also been calculated.

The flooding problems along Route 46 and Route 202 (subbasin 25) have been addressed by evaluating all upstream contributions of stormwater (subbasins 2, 4, 5, 7, 8, 9, and 26). A series of infiltration/disconnection projects in these upstream areas (Map 4, Appendix D) is expected to reduce flooding experienced during storms smaller than the two year design storm (3.5 inches over a 24 hour period). As a result of the projects recommended for these subbasins, approximately 62.4 acre-ft or 20.5 million gallons of stormwater runoff will be captured and infiltrated, thereby decreasing the downstream flooding in Subbasin 25 (Cross reference PT0457; PT0751; PT0853; and PT0953).

Additional projects have been identified in Subbasin 25 to reduce flooding. Tivoli Gardens is an apartment complex that borders the Troy Brook just upstream of the Route 202 bridge. This apartment complex has over 8.6 acres of impervious cover. Through the use of rain gardens, approximately 2.6 acres of this impervious cover can be disconnected, resulting in a decrease in runoff volume of 0.45 acre-ft or 0.15 million gallons for the two-year storm (Cross Reference PTPT2552)(See Engineering Drawing, E1, Appendix E).

A similar evaluation was conducted for the shopping center at the intersection of Route 202 and Route 46. (See Engineering Drawing, E2, Appendix E) This shopping center has approximately 11.25 acres of paved parking areas. By incorporating rain gardens into the traffic islands and other open green space at the shopping center, stormwater runoff from approximately 2.25 acres of paved area can be captured and infiltrated. The recommended revisions to the stormwater control ordinance require all commercial properties to disconnect 20% of the paved areas prior to repaving. This reduces the runoff from the two-year design storm by 0.61 acre-ft or 0.20 million gallons. To further investigate opportunities for disconnecting impervious surfaces, an evaluation of this shopping center was conducted to disconnect the maximum extent possible. Without losing any parking spaces, approximately 60% of the paved parking lot could be disconnected. If you include the impervious building roof tops in these calculations, approximately 42% of the shopping center can be disconnected, which is 1.19 acre-feet or 0.39 million gallons for the two-year design storm (Cross reference PT2551).

Several highways traverse the watershed. An evaluation of Route 287 in Subbasin 25 was conducted. Through the use of infiltration systems along this 1,150 linear feet of highway, approximately 1.5 acre-feet of storage can be created, thereby capturing 0.50 million gallons of stormwater runoff (See Engineering Drawing, E3, Appendix E) (Cross reference PT2554). This same concept can be applied to other highways and roadways throughout the Troy Brook Watershed.

The restoration of natural stream morphology is expected to take place as natural buffers are allowed to stabilize banks and buffer widths discourage encroachment. These buffers and setbacks are covered in the Stormwater Management Ordinance. However, there are

specific areas where the stream can be reconnected to the floodplain, which would reduce downstream volume and stream velocity. One problem area is located between Paris Place and the Municipal Public Works Yard (Subbasins 25 and 9). Currently an area of erosion and mosquito habitat, the banks can be graded and vegetated to provide a smooth passage of stream flow. Through the creation of a wetland behind the Public Works Yard and re-establishing floodplain connection behind the homes on Paris Place, approximately 0.72 acre-feet of storage can be created for the two-year design storm and 1.34 acre-feet of storage can be created for the ten-year design storm (See Engineering Drawing, E4, Appendix E) (Cross reference PT2553). This will help prevent flooding downstream, as well as reduce flooding of the homes on Paris Place.

The Morris Corporate Park presently contains a two tiered area that can be retrofitted to infiltrate the runoff of any storm up to the two year design storm (See Engineering Drawing, E5, Appendix E). Originally, two wet ponds existed at this location. A puncture/failure of the liner in the easterly or lower pond has resulted in this pond draining. This lower pond is now functioning as an infiltration basin. Presently, flows from the western or upper wet pond discharge to this lower basin. The upper pond serves as a settling basin, thereby discharging cleaner water to the lower infiltration pond for recharge. Increasing infiltration is one of the recommendations in the Regional Stormwater Management Plan to help improve the water quality, reduce flooding, and maintain baseflow. The total runoff from Subbasin 26 for the two-year storm is 30.3 acre-feet. The western upstream pond can store approximately 10 acre-feet while the infiltration basin is currently sized to recharge approximately 20 acre-feet. This infiltration basin should be enhanced to promote additional groundwater recharge and to improve the aesthetics so that this lower infiltration basin will better conform to the image of the surrounding corporate center (Cross reference PT2653).

Subbasins 11, 16, 17, 18, 19, and 24 also were identified in the characterization and assessment report as areas where flooding problems occur. Several parcels of urban land in these subbasins have been identified that could be retrofitted with stormwater BMPs (See Maps 5 and 6, Appendix D). Each of the stormwater BMPs would be incorporated into the existing landscapes. These systems would be designed to capture runoff from the two-year design storm (3.5 inches of rain over 24 hours) and completely infiltrate the runoff volume. For the two-year design storm, these BMPs will reduce stormwater runoff by 31.2 acre-feet or 10.3 million gallons. It is also estimated that these BMPs will treat and recharge approximately 183.5 million gallons of stormwater on an annual basis (Cross reference PTPT1154; PT1653; PT1751; PT1859; PT1951; and PT2453).

Recommendations to Address Water Quality Issues for the Township of Parsippany-Troy Hills

The nonpoint source analysis in the Characterization and Assessment Report has identified several subbasins in Parsippany-Troy Hills (Subbasins 4, 6, 7, 8, 12, 13, 14, 21, 25, and 26) as potentially high nonpoint source contributors in the Troy Brook Watershed. The modifications to the Stormwater Control Ordinance along with the low phosphorus fertilizer ordinance will help decrease nonpoint source loadings from these

areas. The BMPs selected for the subbasins that were identified in the previous section as needing to control stormwater quantities will also have a positive impact on improving water quality. It has been estimated that these BMPs will reduce total phosphorus loads by 586 pounds per year, total nitrogen loads by 6,306 pounds per year, and total suspended solids loads by 65,531 pounds per year in the Township of Parsippany-Troy Hills from Subbasin 4, 7, 8, 9, 11, 16, 17, 18, 19, 24, and 26.

Although the demonstration rain gardens that will be constructed as part of the educational programs for Subbasins 5, 23 and 31 will only have a minimal reduction in nonpoint source pollutants (see Table 4), these programs have the potential to result in much greater reductions as the communities become educated and embrace stormwater management opportunities on more individual properties. As part of our Restore-A-Waterway program, RCE has already conducted an educational workshop on pond management and rain garden construction for the Rainbow Lakes Association (Subbasin 5). This community is eager to move forward with some assistance from RCE and begin building rain gardens that will have an immediate benefit on improving the quality of Rainbow Lakes and Troy Brook.

Subbasin 6 has been identified as potentially high source of nonpoint source pollution. An office complex is located along Route 46 in Subbasin 6. Since this complex is fairly new construction, it contains a wet pond to manage its stormwater runoff. This pond should be adequate to eliminate this Subbasin as a major source of pollution. Water quality testing may be needed to confirm that the pond is actually functioning as expected.

Subbasin 12 has approximately eleven recreational fields in the subbasin that should have the nonpoint source runoff addressed. Vegetated swales should be considered in the downgradient areas where land is available. Since many of these recreational fields are associated with schools, Subbasin 12 is an excellent candidate for "Community-Project-Based Learning Program." This program will provide an opportunity to educate students, as well as construct BMPs on school grounds to treat stormwater runoff. Also, there are high density resident lands in the northern part of the Subbasin 12. This area can be retrofitted with rain gardens in a similar fashion as Tivoli Gardens in Subbasin 25. These rain gardens would be designed for the water quality storm (1.25 inches of rain over two hours). Finally, Route 80 bisects Subbasin 12 and can be retrofitted with infiltration systems in a similar fashion as Route 287 in Subbasin 25. These systems would be designed for the water quality storm.

Subbasin 13 is immediately downstream of Lake Parsippany. This subbasin appears to have open space that can be used to disconnect stormwater runoff from Route 287, commercial lands and industrial lands. These BMPs would be designed to capture and treat the water quality storm. Also, efforts should be made in this subbasin to preserve the remaining open space.

Subbasin 14 has high density residential and commercial land uses. These lands can be retrofitted with BMPs that capture and treat stormwater runoff from the water quality

storm. Also, the runoff from Route 287 can be captured and treated using infiltration systems or bioretention systems.

Subbasin 21 is primarily industrial and mixed urban land uses. There is sufficient open space in this subbasin where disconnection of stormwater runoff can be promoted. Stream buffers that presently exist should be maintained. Once again, many of these industrial sites can be retrofitted with BMPs that capture and treat stormwater runoff from the water quality storm.

In Parsippany-Troy Hills, as in Mountain Lakes, impairment to the biological community is a result of sedimentation, flashy hydrology, excessive nutrients, among other contributions by the degradation of water quality and quantity due to stormwater inputs. Through implementation of the recommendations here, it is expected that the biological community will positively respond. The EPA Stressor ID is an additional recommendation to properly characterize the total effects on this community.

Recommendations to Promote Groundwater Recharge in the Township of Parsippany-Troy Hills

All the BMPs selected to address the water quantity and water quality issues also promote groundwater recharge. The educational programs will also result in BMPs that promote groundwater recharge and will help encourage residents to take action to infiltrate more stormwater runoff. Table 4 ranks all the projects that were assigned to Parsippany-Troy Hills.

Rank	Unique Identifier	Location (Subbasin No.)	Management Measure	Type of BMP	Cost
1	PT2653	26	Disconnection of impervious surfaces for two-year storm	Convert existing basin into bioretention basin	$130,000 to $260,000
2	PT2553	25	Re-establish access to floodplain behind Public Works Bldg.	Wetlands	$122,000 to $244,000
3	PT0011	0	Microbial Source Tracking	PT26530551	unknown
4	PT2552	25	Disconnection of impervious surfaces at Tivoli Garden Apartments	Rain gardens	$28,000 to $56,000

5	PT2554	25	Disconnection of Route 287 for water quality storm	Infiltration systems	$155,000 to $309,000
6	PT2551	25	Disconnection of impervious surfaces at Rt. 202/Rt.46 Shopping Center (20% reduction in impervious cover from parking area)	Rain gardens and infiltration systems	$25,000 to $50,000
7	PT0457	4 (only portion in Parsippany Troy Hills)	Disconnection of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	$348,000 to $697,000
8	PT0540	5, 23 and 31	Extra catch basin cleaning	MS4 maintenance	No additional cost – changes in cleaning schedule
9**	PT0551	5	Education programming	Restore-A-Waterway	$10,000 for 10 demo gardens and educational programming
10	PT0751	7	Disconnection of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	$49,000 to $98,000
11	PT0853	8	Disconnection of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	$131,000 to $261,000
12	PT0953	9	Disconnection of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	$131,000 to $261,000
13	PT1254	12	Disconnection of Route 80 for water quality storm	Infiltration systems	$185,000 to $370,000
14	PT1352	13 and 14	Disconnection of Route 287 for water quality storm	Infiltration systems	$78,000 to $156,000
15	PT1659	16 (Troy Meadows)	Land Preservation	Deed restrictions or open space preservation	unknown/ongoing

16	PT3151	31	Education programming	Stormwater Management in Your Backyard	$15,000 for 15 demo gardens and educational programming
17	PT1457	14	Disconnection of impervious surfaces for water quality storm	Rain gardens, bioretention systems, infiltration systems	$348,000 to $687,000
18	PT2453	24	Disconnection of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	$120,000 to $240,000
19	PT1154	11	Disconnection of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	$191,000 to $381,000
20	PT2152	21	Disconnection of impervious surfaces for water quality storm	Rain gardens, bioretention systems, infiltration systems	$93,000 to $185,000
21	PT1859	18	Disconnection of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	$817,000 to $1,634,000
22	PT1351	13	Disconnection of commercial building for water quality storm	Rain gardens, bioretention systems, infiltration systems	$15,000 to $30,000
23	PT2351	23	Education programming	Stormwater Management in Your Backyard	$15,000 for 15 demo gardens and educational programming
24	PT1951	19	Disconnection of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	$49,000 to $98,000
25	PT1751	17	Disconnection of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	$6,000 to $12,000

26	PT1251	12	Education programming	Community Project Based Learning	$80,000 over two years for demonstration projects and educational programming
27	PT1253	12	Disconnection of high density residential impervious surfaces for water quality storm	Rain gardens, bioretention systems, infiltration systems	$131,000 to $261,000
28	PT1653	16 (only portion in Parsippany Troy Hills)	Disconnection of impervious surfaces for two-year storm	Rain gardens, bioretention systems, infiltration systems	$147,000 to $294,000

Table 4: Parsippany-Troy Hills Projects and Costs

The cost estimates were determined using the same procedure as outlined above for the Borough of Mountain Lakes. Once again, these are only estimates. Actual costs will be a function of the market prices during the time of construction.

Ranking of Recommendations	Unique Project Identifier	Drainage Area (acres)	Estimated Total Phosphorus Pollutant Removal (lbs/yr)	Estimated Total Nitrogen Pollutant Removal (lbs/yr)	Estimated Total Suspended Solids Pollutant Removal (lbs/yr)	Estimated Water Quantity Reduction & Groundwater Recharge (Mgal/yr)
1	PT2653	218.3	207.7	2,334	26,019	236.6
2	PT2553	120	NA	NA	NA	NA
3	PT0011	7400	NA	NA	NA	NA
4	PT2552	2.61	3.654	39.15	365.4	2.8
5	PT2554	6.93	6.93	69.3	831.5	7.5
6	PT2551	2.25	3.15	33.75	315	2.4
7	PT0457	45.4	66.8	694	7,019	49.2
8	PT0540	716	unknown	unknown	unknown	unknown
9	PT0551	0.23	0.14	1.2	23	0.25
10	PT0751	5.4	8.7	93	856	5.9
11	PT0853	15.8	30.7	320	2,980	17.1
12	PT0953	15.8	24.8	262	2,473	17.1
13	PT1254	52.4	52.4	523.7	6,284	56.8
14	PT1352	22.4	22.4	223.8	2,686	24.3
15	PT1659	2000+	unknown	unknown	unknown	unknown
16	PT3151	0.34	0.2	1.7	34	0.37
17	PT1457	141.5	228	2,418	24,119	153.4
18	PT2453	16.4	17.9	176	2,129	17.8
19	PT1154	22.2	38.1	396	3,823	24.1
20	PT2152	45.5	59.5	622.7	7,697	49.3
21	PT1859	109.3	152.4	1624	16,114	118.5
22	PT1351	4.6	9.74	102.1	927.8	5.03
23	PT2351	0.34	0.2	1.7	34	0.37
24	PT1951	4.9	10.2	107	974	5.3
25	PT1751	0.58	1.2	13	117	0.63
26	PT1251	15.6	0.13	1.13	22.7	0.25
27	PT1253	46.3	64.8	694.2	6479.6	50.16
28	PT1653	15.9	27.2	286	3,026	17.2
		9046.98	1,036.94	11,037	115,349	862.36

Table 5: Parsippany-Troy Hills Projects and Load Reductions
Note: Preliminary hydrographs for these management measures that are recommended in Milestone 4 are presented in Appendix F.

Estimated Load Reductions and Groundwater Recharge for Parsippany-Troy Hills Management Measures

Load reductions were estimated for each of the management measures that were recommended for the Township of Parsippany-Troy Hills and can be found in Table 5. Aerial loading coefficients were used to determine the load reductions for total phosphorus, total nitrogen, and total suspended solids. These loading coefficients were multiplied by the area disconnected for each of the management measures. Since the

management measures were designed to infiltrate all of the runoff from the two-year rainfall event, each management measure was assumed to reduce the annual load by 90% based upon a volume reduction. These load reductions are presented in Table 5. Also presented in Table 5 are the estimated groundwater recharge volumes. Once again, each management measure was estimated to infiltrate 90% of the annual rainfall or 40 inches per year that will run off of impervious surfaces. These volumes are presented in million of gallons. For all the BMPs in the Township of Parsippany-Troy Hills, the estimated annual groundwater recharge is 862 million gallons.

Table 6 describes the permits that may be required to implement this recommendation. The funding sources that are noted in this table are some choices that may have funding available for these types of projects. The objectives that are met are those that are cross referenced from Milestone 3.

Table 6 : Parsippany-Troy Hills Project Funding and Objectives

Rank	Unique Identifier	Management Measure	Required permits	Potential funding sources	Addresses Objective (Milestone 3)
1	PT2653	Disconnection of impervious surfaces for two-year storm	Local construction permits	All	2, 3, 5, 6, and 7
2	PT2553	Re-establish access to floodplain behind Public Works Bldg.	NJDEP Stream Encroachment and Freshwater Wetlands	All	2, 3, 5, 6, and 7
3	PT0011	Microbial Source Tracking	No permits are required	1, 2, 5, 7, and 8	1
4	PT2552	Disconnection of impervious surfaces at Tivoli Garden Apartments	Local construction permits	All	2, 3, 5, 6, and 7
5	PT2554	Disconnection of Route 287 for water quality storm	Possibly NJDEP Freshwater Wetlands	All	2, 3, 5, 6, and 7
6	PT2551	Disconnection of impervious surfaces at Rt. 202/Rt.46 Shopping Center (20% reduction in impervious cover from parking area)	Local construction permits	All	2, 3, 5, 6, and 7
7	PT0457	Disconnection of impervious surfaces for two-year storm	Local construction permits	All	2, 3, 5, 6, and 7
8	PT0540	Extra catch basin cleaning	No permits are required	None	1, 2, 3, and 4
9	PT0551	Education programming	No permits are required	All	2, 3, 5, 6, and 7

10	PT0751	Extra catch basin cleaning	Local construction permits	All	2, 3, 5, 6, and 7
11	PT0853	Education programming	Local construction permits	All	2, 3, 5, 6, and 7
12	PT0953	Disconnection of impervious surfaces for two-year storm	Local construction permits	All	2, 3, 5, 6, and 7
13	PT1254	Disconnection of impervious surfaces for two-year storm	Local construction permits	All	2, 3, 5, 6, and 7
14	PT1352	Disconnection of impervious surfaces for two-year storm	Local construction permits	All	2, 3, 5, 6, and 7
15	PT1659	Land Preservation	No permits are required	6, 7, 8, and 9	2, 3, 5, 6, and 7
16	PT3151	Education programming	No permits are required	All	2, 3, 5, 6, and 7
17	PT1457	Disconnection of impervious surfaces for water quality storm	Local construction permits	All	2, 3, 5, 6, and 7
18	PT2453	Disconnection of impervious surfaces for two-year storm	Local construction permits	All	2, 3, 5, 6, and 7
19	PT1154	Disconnection of impervious surfaces for two-year storm	Local construction permits	All	2, 3, 5, 6, and 7
20	PT2152	Disconnection of impervious surfaces for water quality storm	Local construction permits	All	2, 3, 5, 6, and 7
21	PT1859	Disconnection of impervious surfaces for two-year storm	Local construction permits	All	2, 3, 5, 6, and 7
22	PT1351	Disconnection of commercial building for water quality storm	Local construction permits	All	2, 3, 5, 6, and 7
23	PT2351	Education programming	No permits are required	All	2, 3, 5, 6, and 7
24	PT1951	Disconnection of impervious surfaces for two-year storm	Local construction permits	All	2, 3, 5, 6, and 7
25	PT1751	Disconnection of impervious surfaces for two-year storm	Local construction permits	All	2, 3, 5, 6, and 7
26	PT1251	Education programming	No permits are required	All	2, 3, 5, 6, and 7

27	PT1253	Disconnection of high density residential impervious surfaces for water quality storm	Local construction permits	All	2, 3, 5, 6, and 7
28	PT1653	Disconnection of impervious surfaces for two-year storm	Local construction permits	All	2, 3, 5, 6, and 7

*Potential funding sources:

1. NJDEP 319(h) Program
2. NJDEP Corporate Business Tax for Watershed Projects
3. NJDEP Environmental Services Program
4. United States Department of Agriculture (USDA) Wildlife Habitat Incentives Program (WHIP)
5. USDA Resource Conservation and Development Program
6. Private Foundations
7. Local Stormwater Utility

**Objectives (Milestone 3):

1. Address Fecal Coliform Loading to Sublist 5 Waterbodies
2. Address Nutrient Loading to the Troy Brook
3. Address Loss of Biodiversity
4. Address Areas of Flooding
5. Address Areas of Increased Stream Volume and Velocity
6. Address Recharge to Aquifer and Baseflow Maintenance

4B. 7.3. Hanover

The Troy Brook Watershed contains a 1.38 square mile portion of the Township of Hanover. Individual subbasins located in Hanover can be seen in
Figure 3. Essentially medium to low density residential, the township possesses a significant transitional area, one where site preparation is present but the full capacity of build out has not yet been realized. According to the build out analysis performed by the RCE Water Resources Program, Hanover Township could experience as much as a 70% increase in impervious surface if all land areas were developed to their full potential under existing ordinances.

The Troy Brook Watershed subbasin 27 in Hanover Township contains the trio of ponds collectively called Bee Meadow Pond. These ponds are on-line impoundments on West Brook and were created through the mining of clay in the past. Today, resident geese that surround the pond have been identified as being a contributor to a high fecal coliform problem. Under a concurrent 319(h) grant, two of the banks of the lowermost pond have been retrofitted with a buffer, and a decrease in the resident goose population is expected upon the maturity of this buffer.

Although the soils of Hanover exhibit good qualities for infiltration, the Township relies on traditional conveyance through the construction of curbing and storm sewers. This fact, along with the presence of highly erodible soils (particularly along the West Brook into Troy Meadows) allows for considerable solids to enter the waterways contributing to siltation along the West Brook and eventually in the Troy Meadows Preserve/Wetland.

Drainage from subbasins 20 and 18 contribute runoff to the Eastmans Brook tributary of the Troy Brook, which joins with the runoff coming from the Lake Parsippany area of Parsippany-Troy Hills.

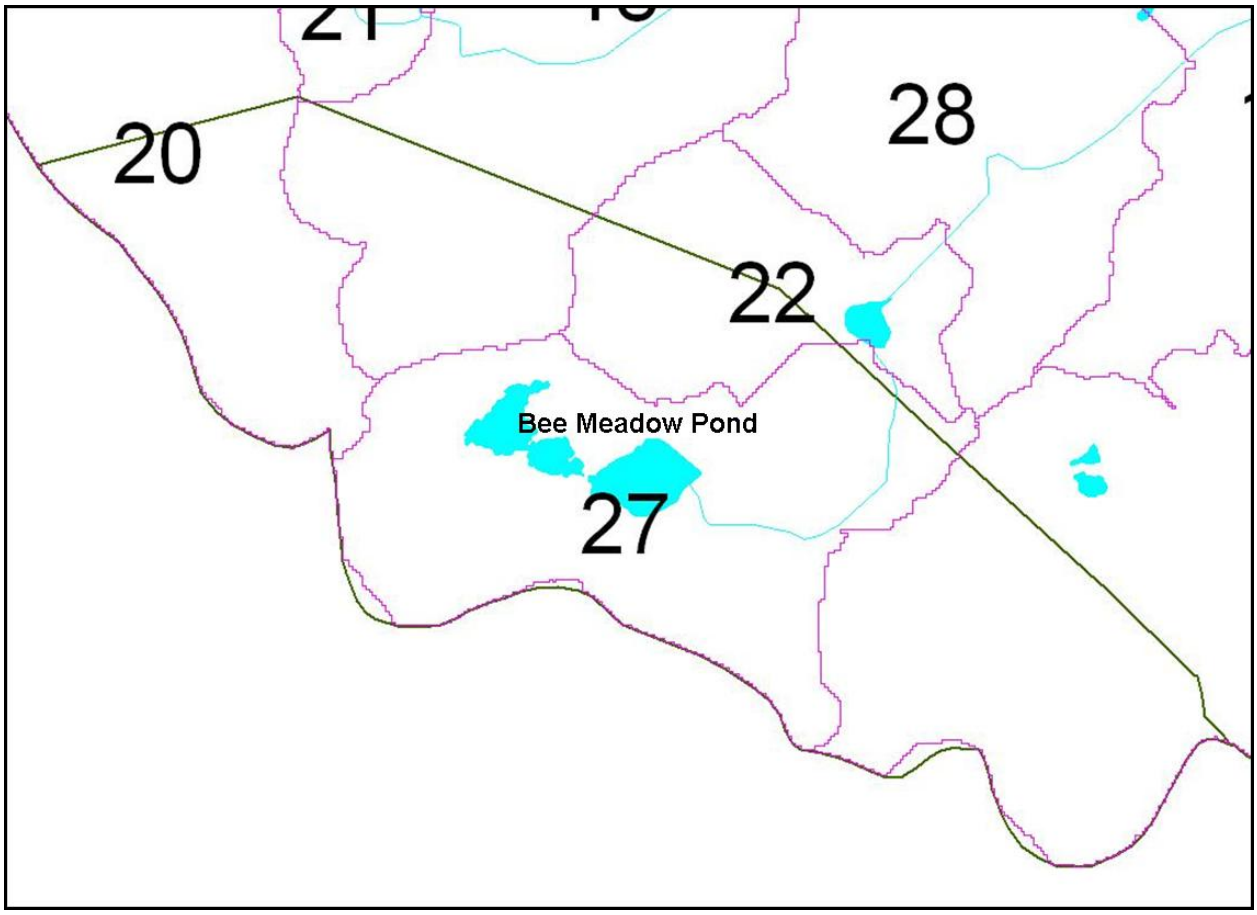


Figure 3: The Subbasins of Hanover Township

Recommendations to Address Water Quality Issues for the Township of Hanover

Due to their large size, the water quality analysis performed for this plan identified Subbasins 16 and 18 as subbasins that contribute to an overall high level of nonpoint source pollution. These two subbasins contain moderately dense residential development at the uppermost drainage sections of the subbasin. The disconnection of the rooftops in these areas could be managed through a series of independent rain gardens. The "Stormwater Management in Your Backyard Program" could be used to educate homeowners on the importance of proper stormwater management, how to build stormwater management systems such as rain gardens or dry wells, and how to maintain these systems. The Township could partner with the Whippany River Action Committee and Rutgers Cooperative Extension to deliver this program and possibly build several demonstration rain gardens through these two subbasins. These demonstration rain gardens will serve as educational tools as well as begin the process of treating stormwater runoff from residential lawns. The educational programming combined with modifications to the Stormwater Control Ordinance and a Low Phosphorus Fertilizer

Ordinance could result in significant reductions in nonpoint source pollution from these two subbasins.

In Subbasin 20, the disconnection of the commercial and industrial properties along the northwest Township boundary is recommended. In Subbasin 22, as in 16 and 18 above, two moderately dense residential areas could participate in the "Stormwater Management in Your Backyard Program" to disconnect impervious areas from direct flow to the stream.

Finally, Subbasin 27 contains a public school that is located directly across the street from Bee Meadow Pond, making this subbasin an excellent candidate for "Community-Project-Based Learning Program." This program will provide an opportunity to educate students, as well as construct BMPs on school grounds to treat stormwater runoff. The Township has a newly hired arborist who is very interested in engaging the school children in environmental activities. The "Community-Project-Based Learning Program" could help build a long-term relationship with students and the Township Parks Department working together to address water resources issues in the municipality.

Hanover Township is expected to experience impairment to the biological community, but there is no data within this municipality. The EPA Stressor ID performed for this watershed is recommended to include Hanover to properly characterize the total biological effects within the Troy Brook Watershed.

Table 7: Hanover Township Projects and Costs

Rank	Unique Identifier	Location (Subbasin No.)	Management Measure	Type of BMP	Cost
1	HT1659	16	Disconnection of commercial and industrial impervious	Rain gardens, bioretention systems, infiltration systems	$457,000 to $915,000
2	HT2051	20	Disconnection of commercial and industrial impervious	Rain gardens, bioretention systems, infiltration systems	$37,000 to $74,000
3	HT0051	0	Microbial Source Tracking	Sampling Program for Guidance	unknown
4	HT1651	16, 18, and 22	Education programming	Stormwater Management in Your Backyard	$25,000 for 25 demo gardens and educational programming
5	HT2751	27	Education programming	Community Project Based Learning	$80,000 over two years for demonstration projects and educational programming

Recommendations to Address Water Quantity Issues for the Township of Hanover

The southeastern subbasin in the Hanover section of the Troy Brook Watershed can contribute to the water quantity load into the Troy Meadows Preservation Area/Watershed. To sustain baseflow and reduce peak flow, the disconnection of 56.3 acres within the Township of Hanover has been recommended. This area lies within Subbasin 16 and is upgradient of the Troy Meadows Wetlands.

In addition to the benefit to water quality, the projects reported in the Water Quality section above will aid in infiltrating precipitation where it falls or close to it.

Recommendations to Promote Groundwater Recharge in the Township of Hanover

All the BMPs selected to address the water quantity and water quality issues also promote groundwater recharge. The educational programs will also result in BMPs that promote groundwater recharge and will help encourage residents to take action to infiltrate more stormwater runoff.

Table 8: Hanover Township Projects and Load Reductions

Rank	Unique Identifier	Drainage Area (acres)	Estimated Total Phosphorus Pollutant Removal (lbs/yr)	Estimated Total Nitrogen Pollutant Removal (lbs/yr)	Estimated Total Suspended Solids Pollutant Removal (lbs/yr)	Estimated Water Quantity Reduction & Groundwater Recharge (Mgal/yr)
1	HT1659	56.3	74.2	777.9	9,621.40	61.02
2	HT2051	15.405	27.1	283.4	2,845.20	16.7
3	HT0051	800	0	0	0.00	0
4	HT1651	0.58	0.35	2.9	58	0.63
5	HT2751	15.6	0.13	1.13	22.7	0.25
Totals		872.285	101.65	1,064.20	12,524.60	78.35

Note: Preliminary hydrographs for these management measures that are recommended in Milestone 4 are presented in Appendix F.

Estimated Load Reductions and Groundwater Recharge for Hanover Management Measures

Load reductions were estimated for each of the management measures that were recommended for the Township of Hanover. Aerial loading coefficients were used to determine the load reductions for total phosphorus, total nitrogen, and total suspended solids. These loading coefficients were multipled by the area disconnected for each of the management measures. Since the management measures were designed to infiltrate all of the runoff from the two-year rainfall event, each management measure was assumed to reduce the annual load by 90% based upon a volume reduction. These load reductions are presented in Table 8. Also presented in Table 8 are the estimated groundwater recharge volumes. Once again, each management measure was estimated to infiltrate 90% of the annual rainfall or 40 inches per year. These volumes are presented in million of gallons.

Rank	Unique Identifier	Management Measure	Required Permits	Potential Funding Sources*	Addresses Objective (Milestone 3)**
1	HT1659	Disconnection of commercial and industrial impervious	Local construction permits	All	2, 3, 5, 6, and 7
2	HT2051	Disconnection of commercial and industrial impervious	No permits are required	All	2, 3, 5, 6, and 7
3	HT0051	Microbial Source Tracking	No permits are required	All	2, 3, 5, 6, and 7
4	HT1651	Education programming	No permits are required	All	2, 3, 5, 6, and 7
5	HT2751	Education programming	No permits are required	All	2, 3, 5, 6, and 7

Table 9: Hanover Township Projects Objectives and Funding

Potential funding sources:

1. NJDEP 319(h) Program
2. NJDEP Corporate Business Tax for Watershed Projects
3. NJDEP Environmental Services Program
4. United States Department of Agriculture (USDA) Wildlife Habitat incentives Program (WHIP)
5. USDA Resource Conservation and Development Program
6. Private Foundations
7. Local Stormwater Utility
8. NJ Green Acres
9. County Open Space Preservation

Objectives (Milestone 3):

1. Address Fecal Coliform Loading to Sublist 5 Waterbodies
2. Address Total Suspended Solid Loading to the Troy Brook
3. Address Nutrient Loading to the Troy Brook
4. Address Loss of Biodiversity
5. Address Areas of Flooding
6. Address Areas of Increased Stream Volume and Velocity
7. Address Recharge to Aquifer and Baseflow Maintenance

Appendix D: Milestone 4 Reference Maps

List of Reference Maps:

1. Mountain Lakes and Potential Areas for Disconnection
2. Close up of Mountain Lakes Disconnection
3. Potential Areas to be Retrofitted with BMPs to Promote Groundwater Recharge in the Mountain Lakes portion of Basin 5
4. Close up of Parsippany-Troy Hills Basins 26, 4, 8, 9, and 7
5. Close up of Parsippany-Troy Hills Basins 24, 18, and 11 in Troy Hills
6. Close up of Parsippany-Troy Hills and Hanover Basin 16

Appendix E:

Engineering Drawings

Engineering Drawing 1: Tivoli Gardens: Roof and parking Lot Drainage Concept Plans

Engineering Drawing 2: Example of 20% disconnection for Route 202/Route 46 Shopping Center

Engineering Drawing 3: Route 287: Highway Stormwater Management Concept Plans

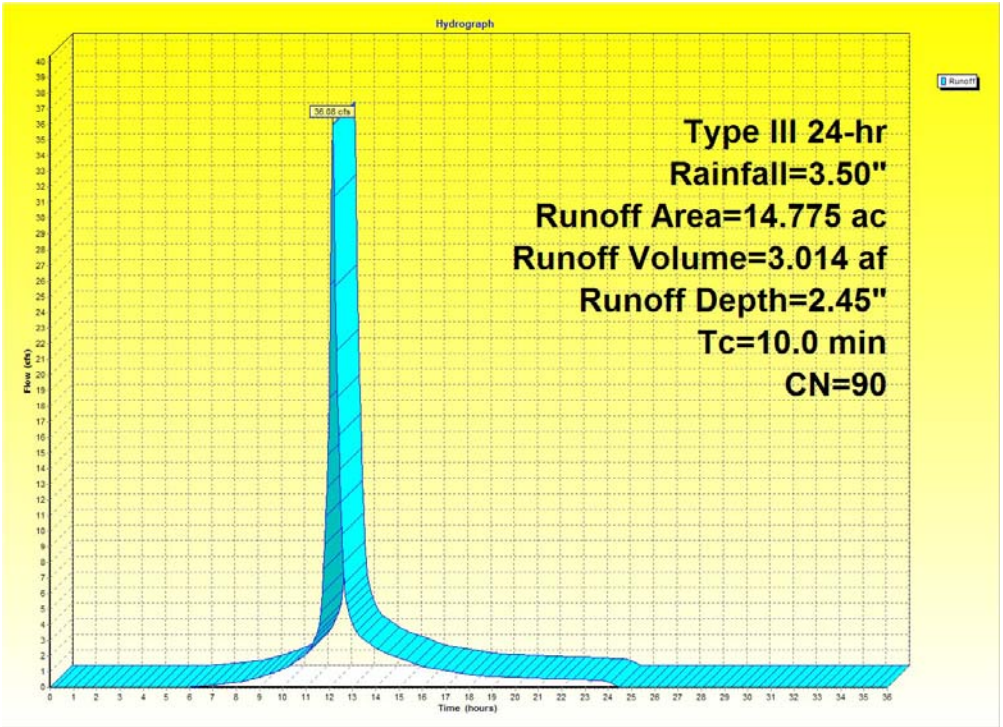
Engineering Drawing 4: Public Works Building and Paris Place Constructed Wetlands Concept Plans

Engineering Drawing 5: Morris Corporate Park: Infiltration Basin Improvements Concept Plans

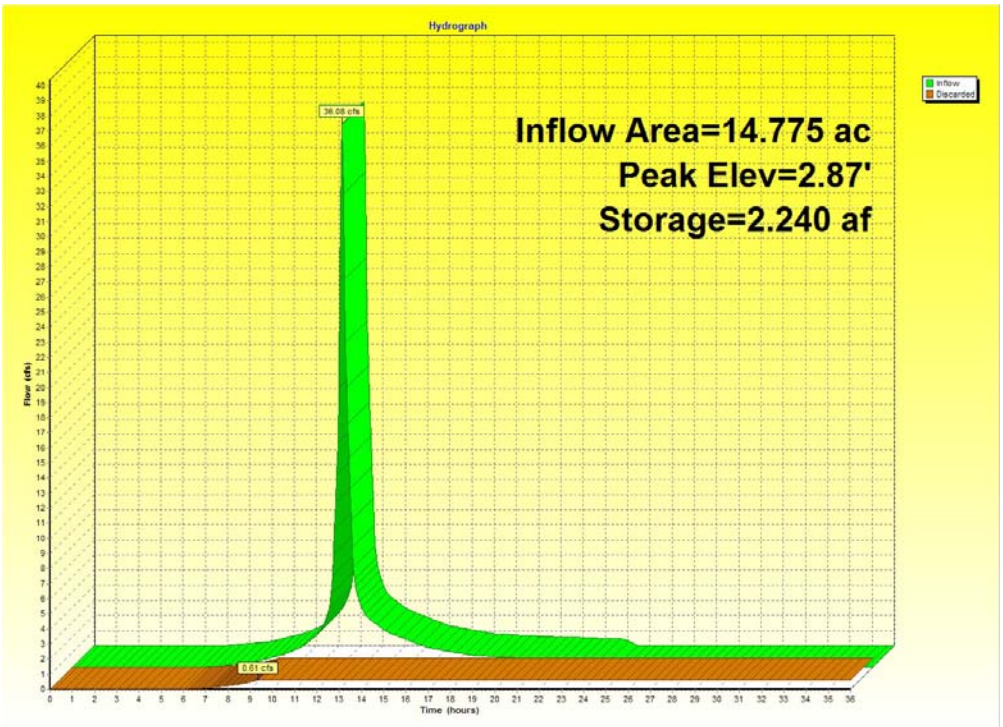
These AutoCAD drawings are too large for this format and can be provided upon request

Appendix F:

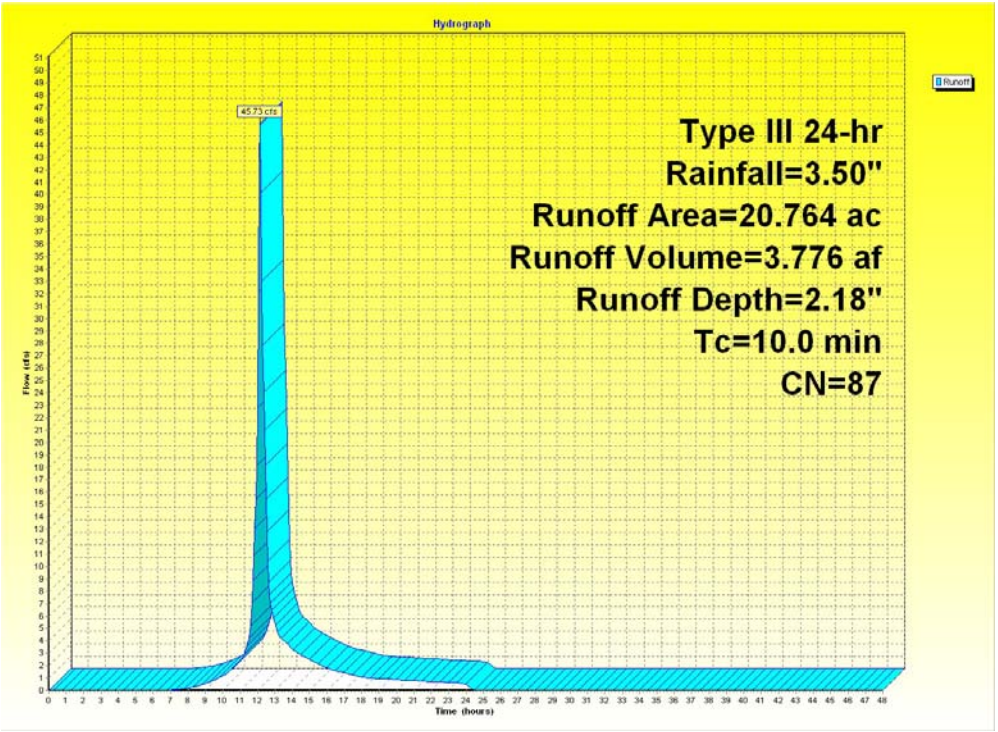
HydroCAD Hydrographs for Management Measures recommended in Milestone 4



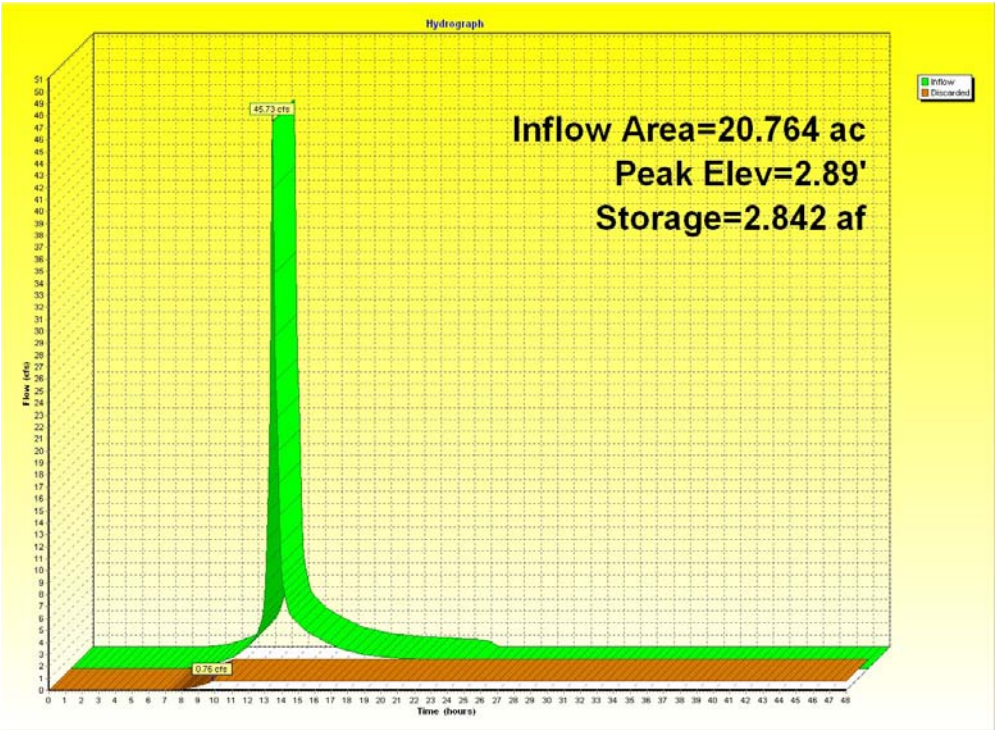
Hydrograph for Areas to be Disconnected in Basin 2 of the Borough of Mountain Lakes



Routing of Hydrograph through Bioretention System (2ft. deep with 0.5 in/hr infiltration rate) (Existing Hydrograph and Routed Hydrograph are shown)



Hydrograph for Areas to be Disconnected in Basin 4 of the Borough of Mountain Lakes



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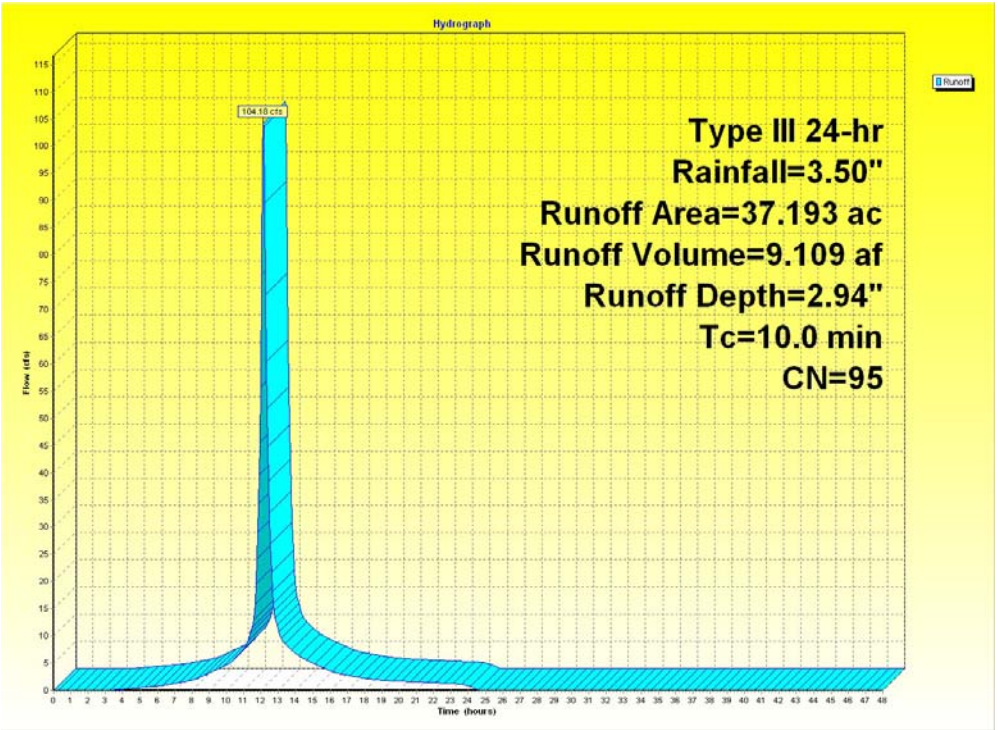
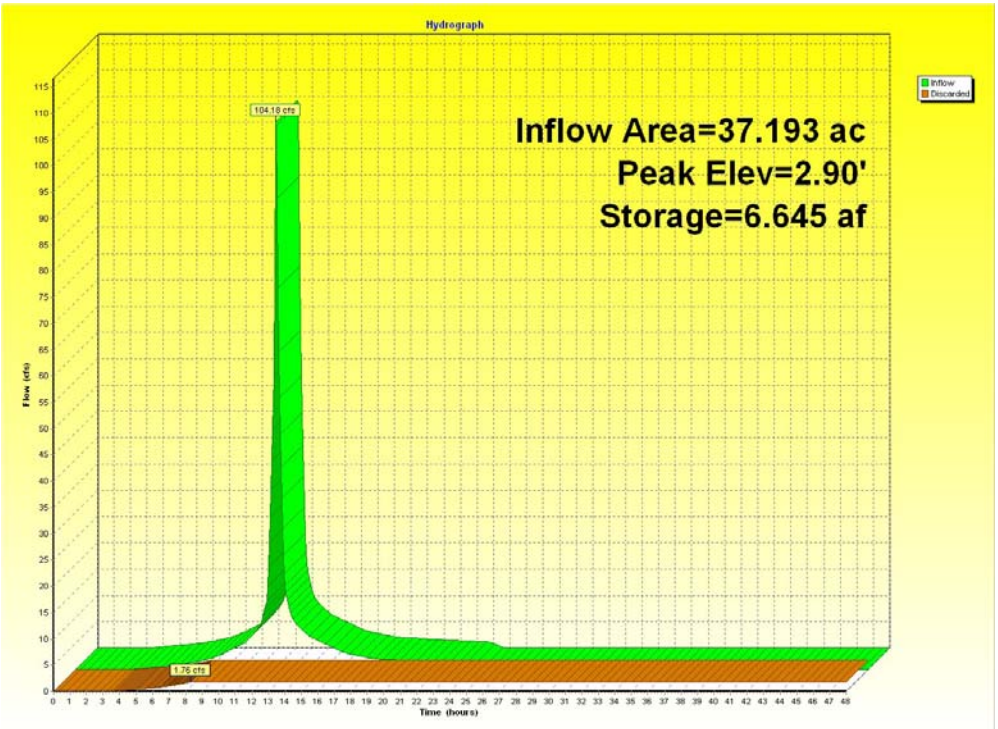
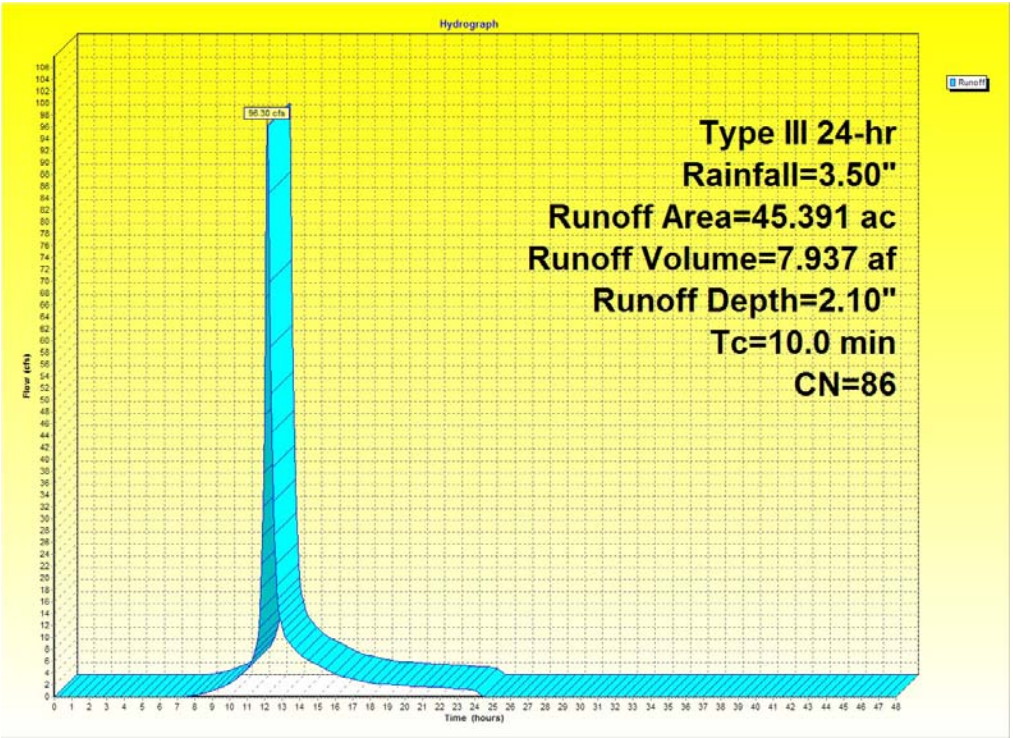


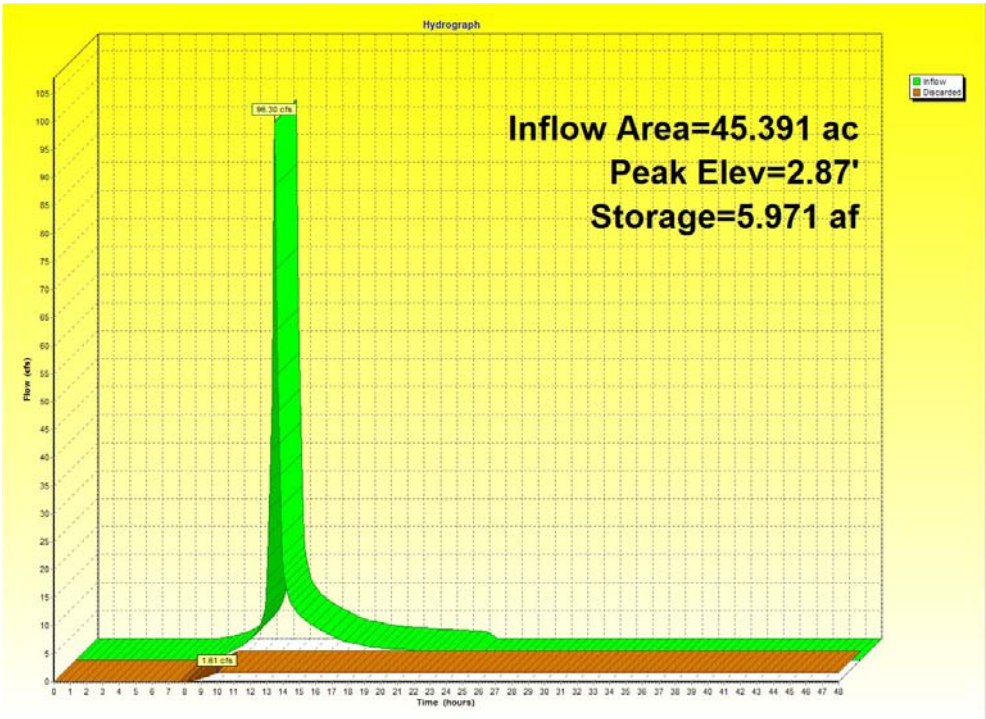
Hydrograph for Areas to be Disconnected in Basin 5 of the Borough of Mountain Lakes



Routing of Hydrograph through Bioretention System (2ft. deep with 0.5 in/hr infiltration rate) (Existing Hydrograph and Routed Hydrograph are shown)



Hydrograph for Areas to be Disconnected in Basin 4 of the Township of Parsippany-Troy Hills



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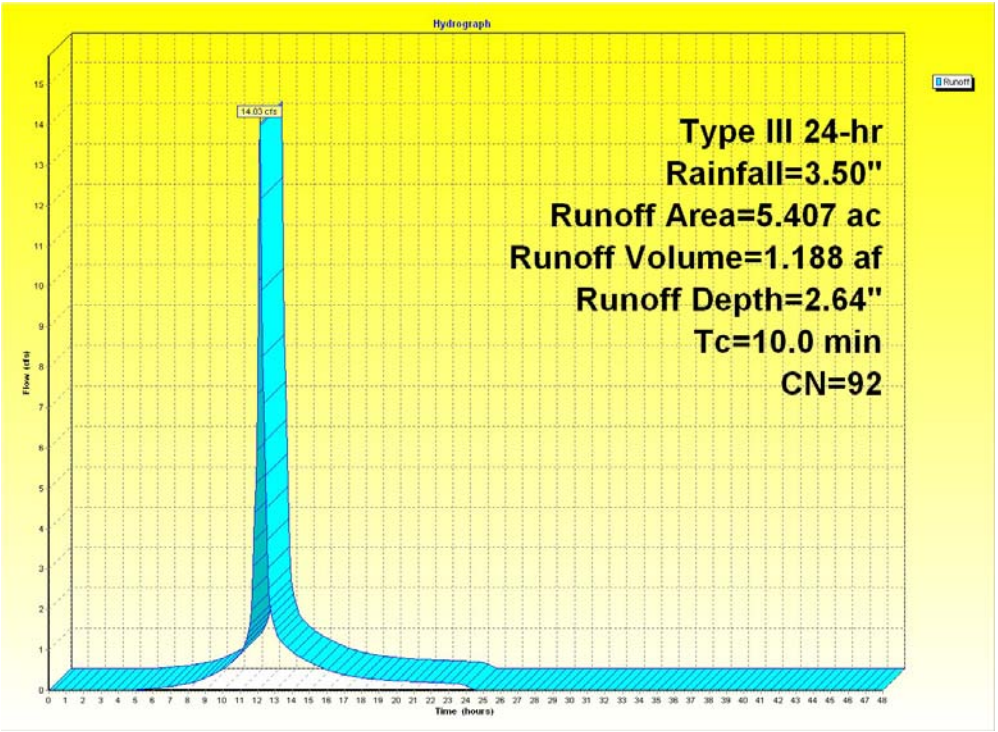
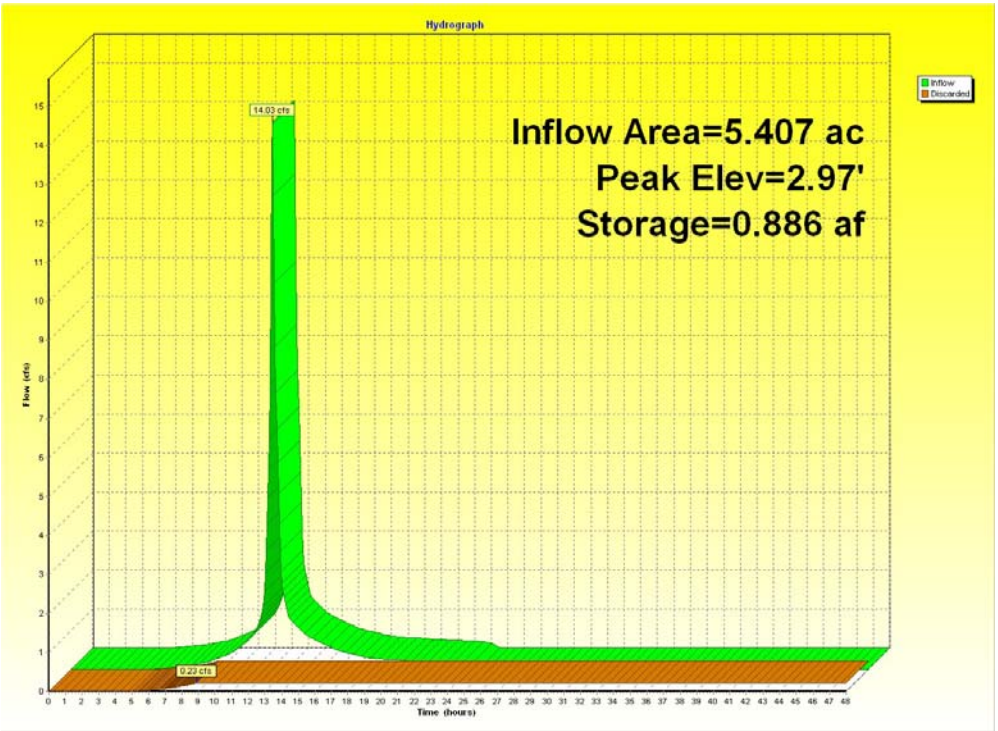


Hydrograph for Areas to be Disconnected in Basin 7 of the Township of Parsippany-Troy Hills



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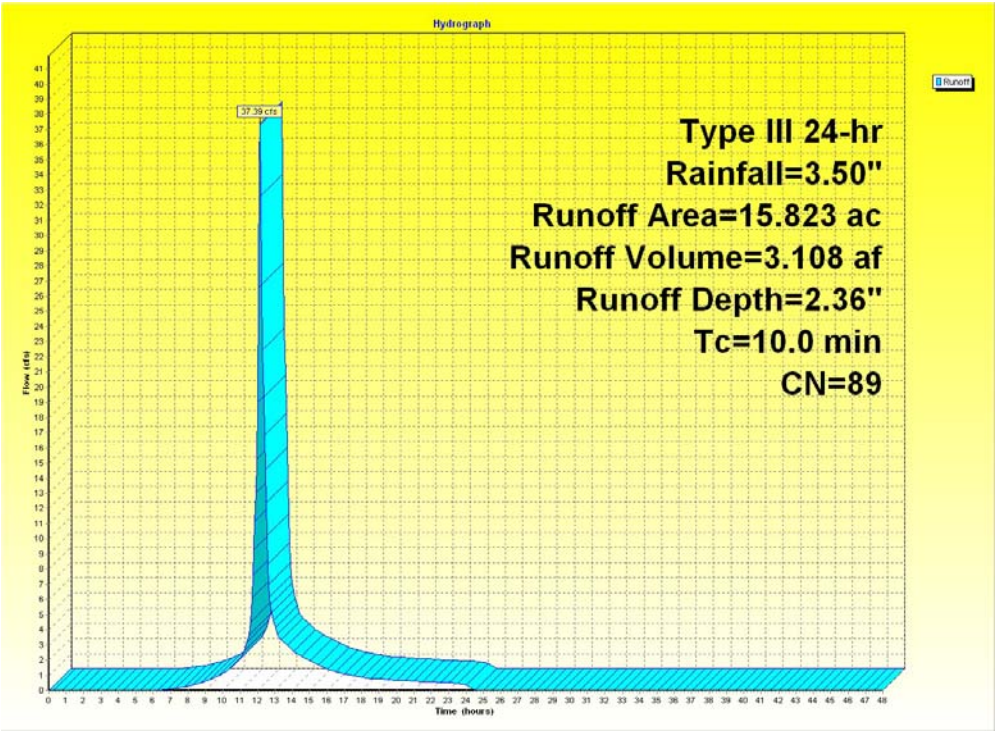
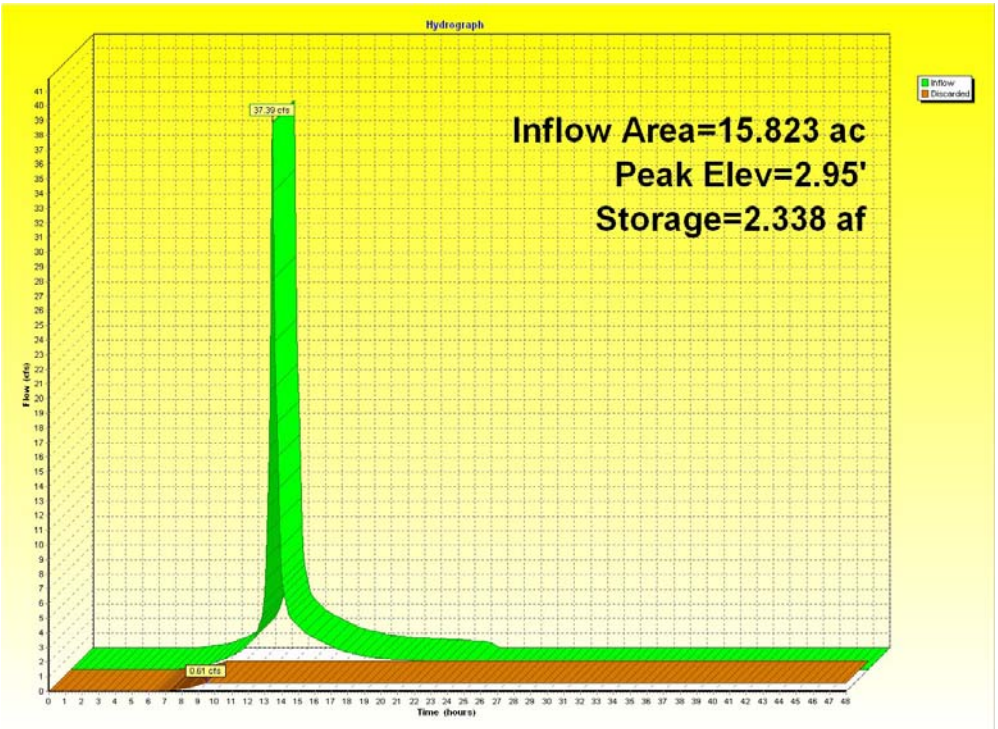


Hydrograph for Areas to be Disconnected in Basin 8 of the Township of Parsippany-Troy Hills



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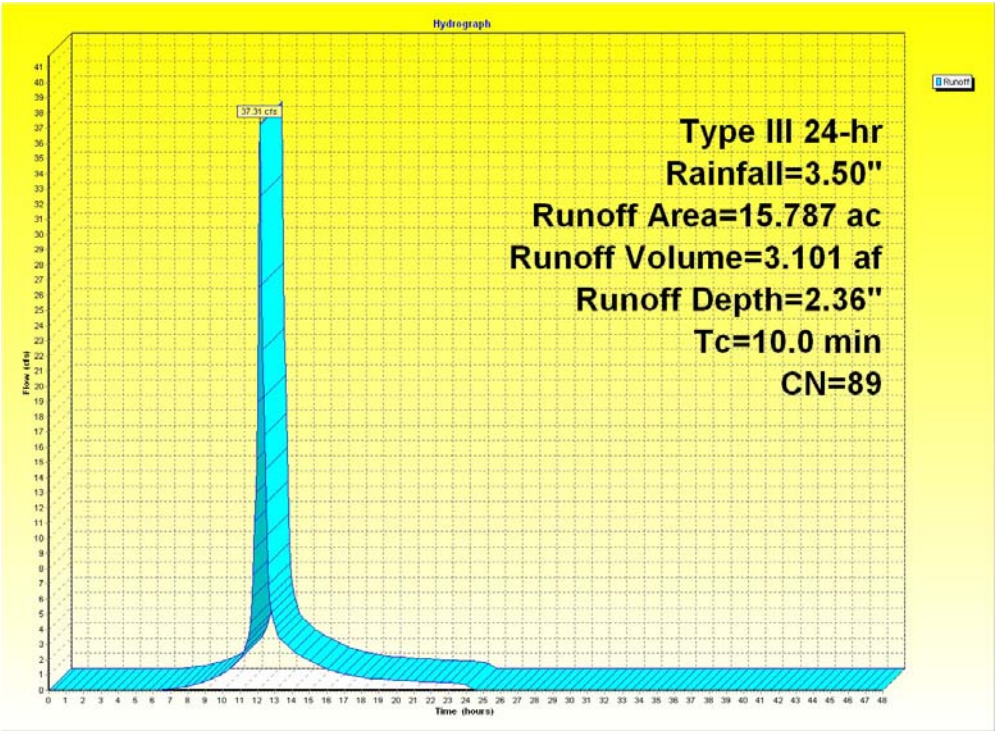
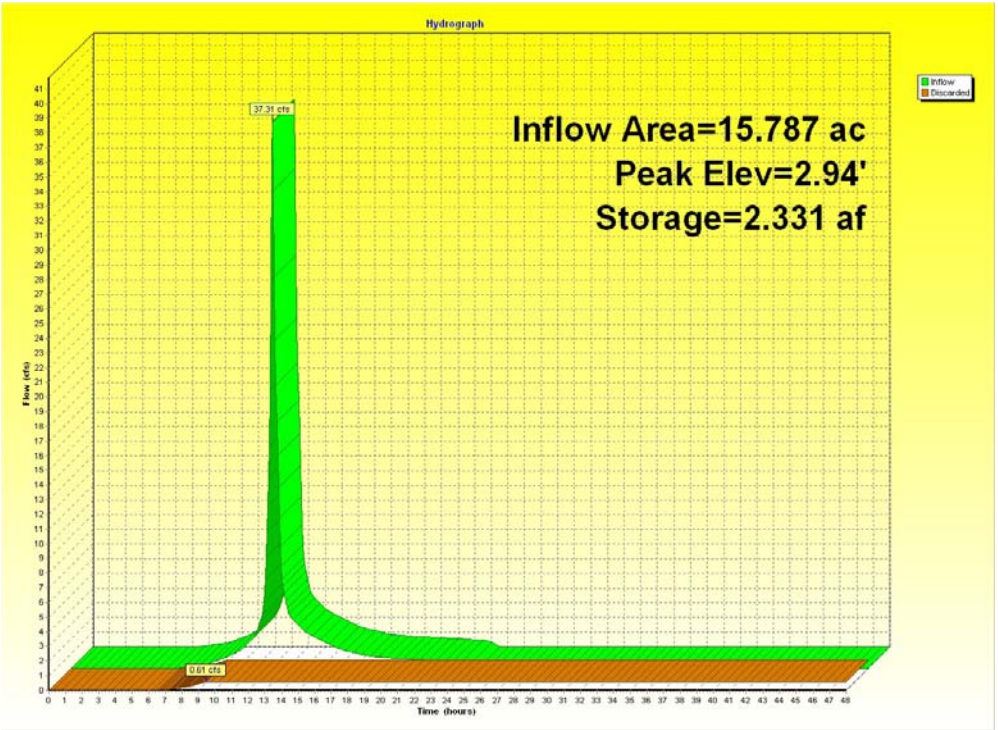


Hydrograph for Areas to be Disconnected in Basin 9 of the Township of Parsippany-Troy Hills



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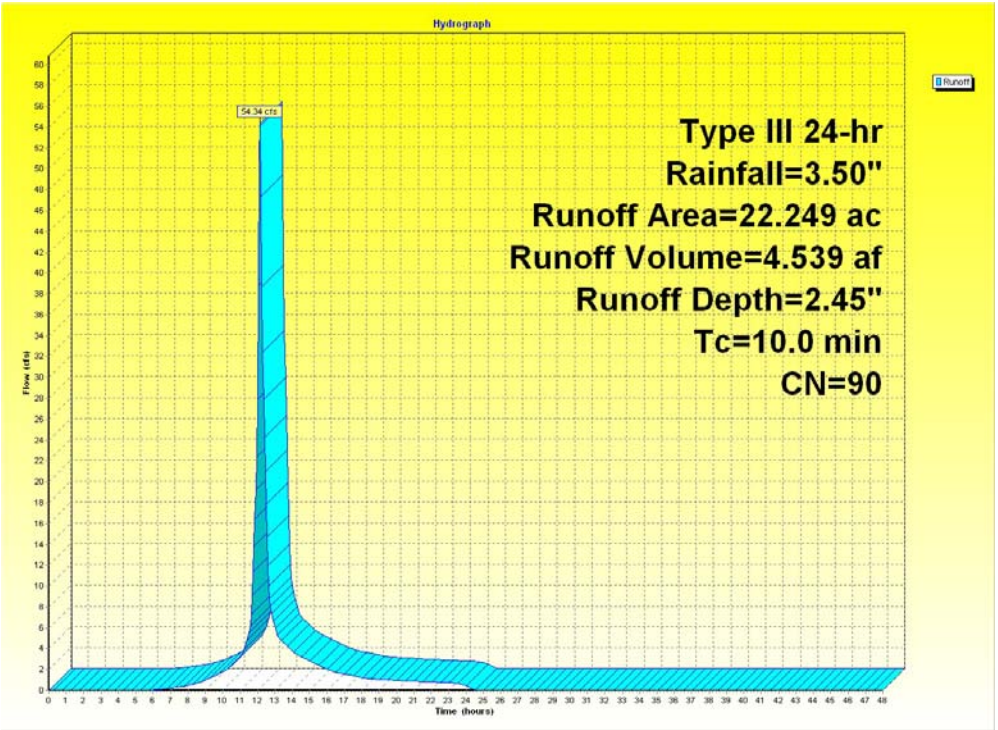
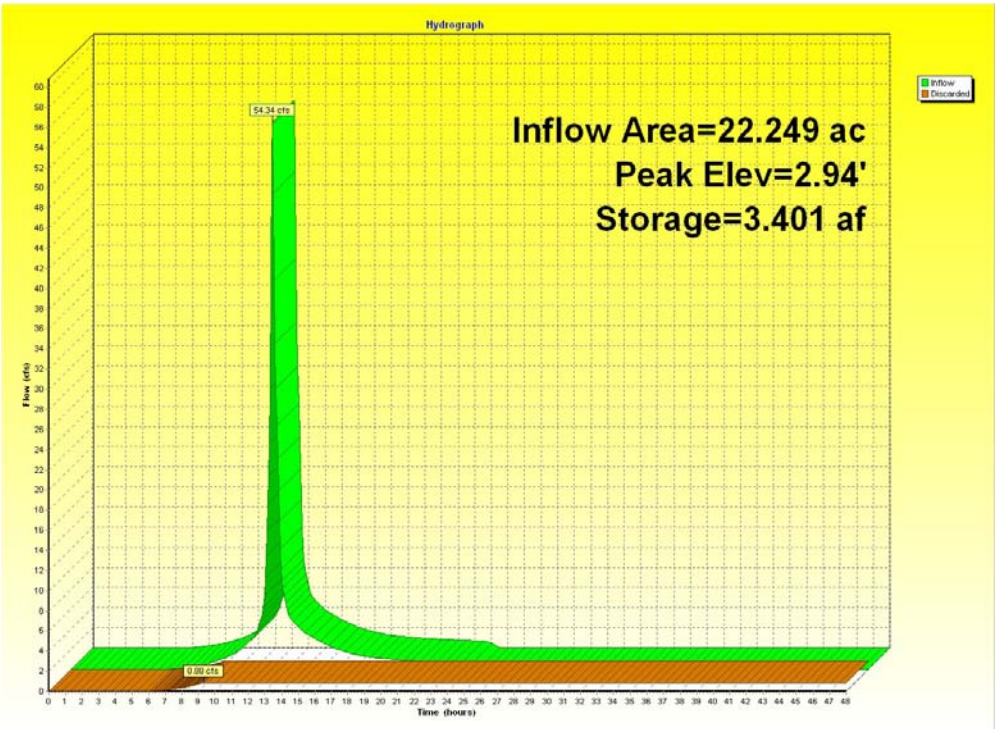


Hydrograph for Areas to be Disconnected in Basin 11 of the Township of Parsippany- Troy Hills



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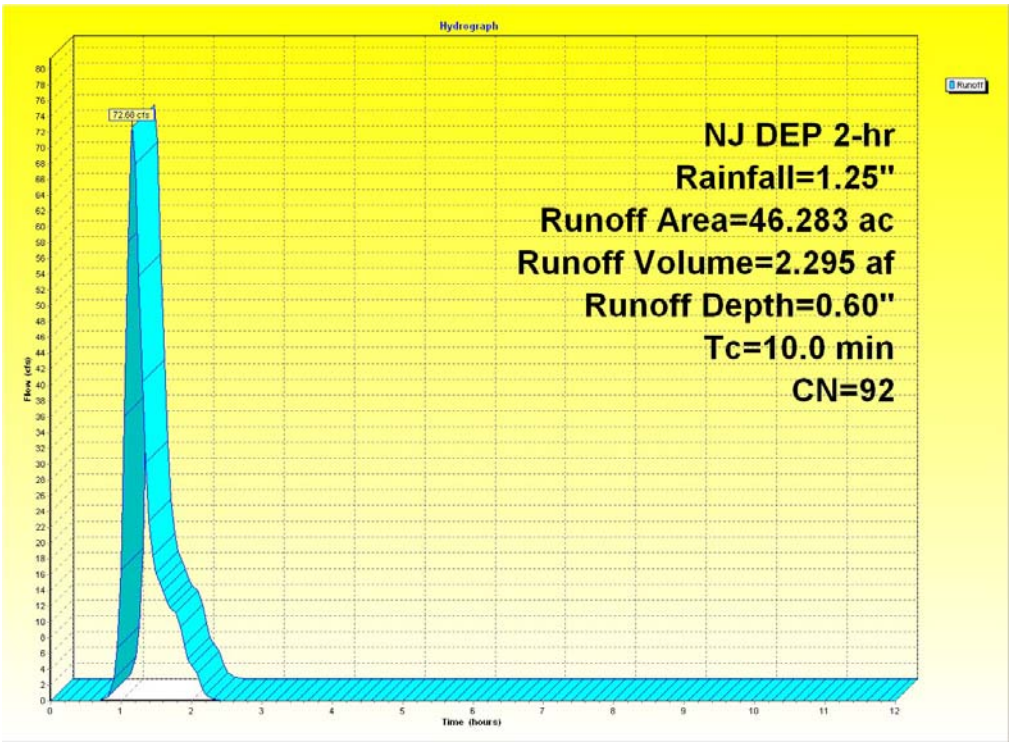
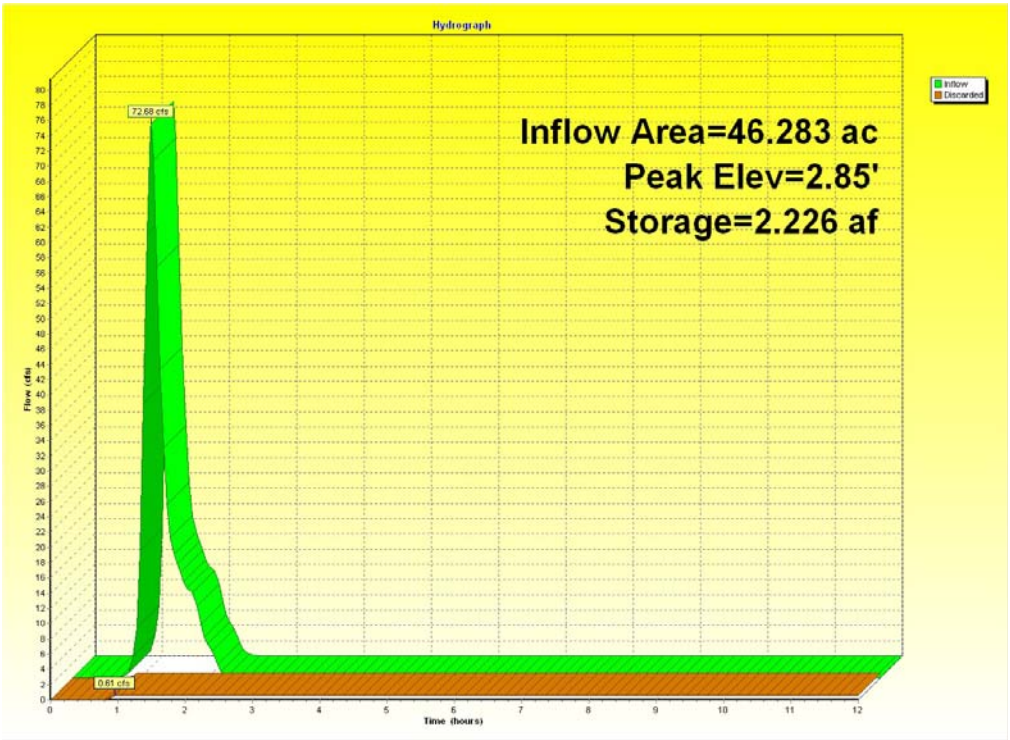


Hydrograph for High Density Residential Areas to be Disconnected in Basin 12 of the Township of Parsippany-Troy Hills



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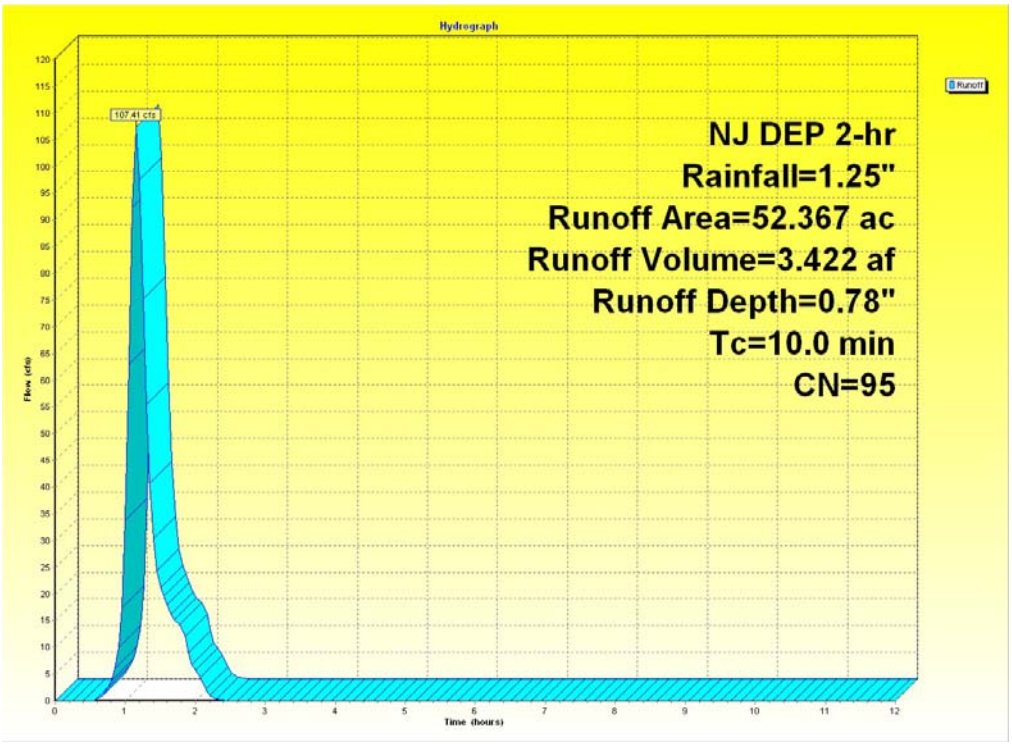
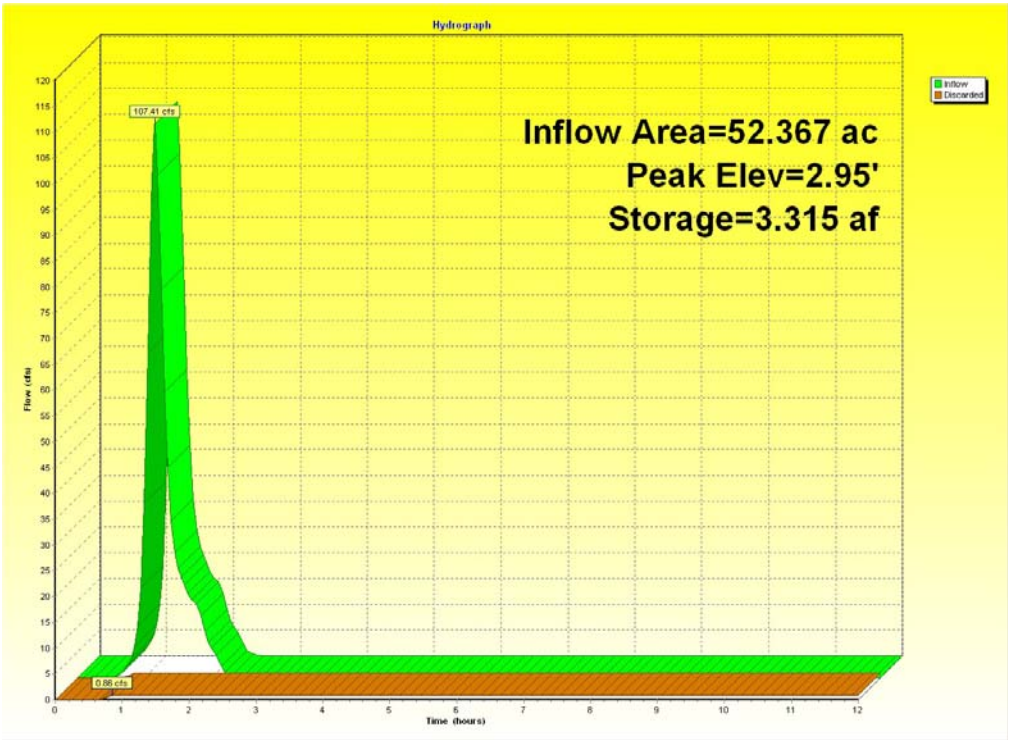


Hydrograph for Areas near Route 80 to be Disconnected in Basin 12 of the Township of Parsippany-Troy Hills



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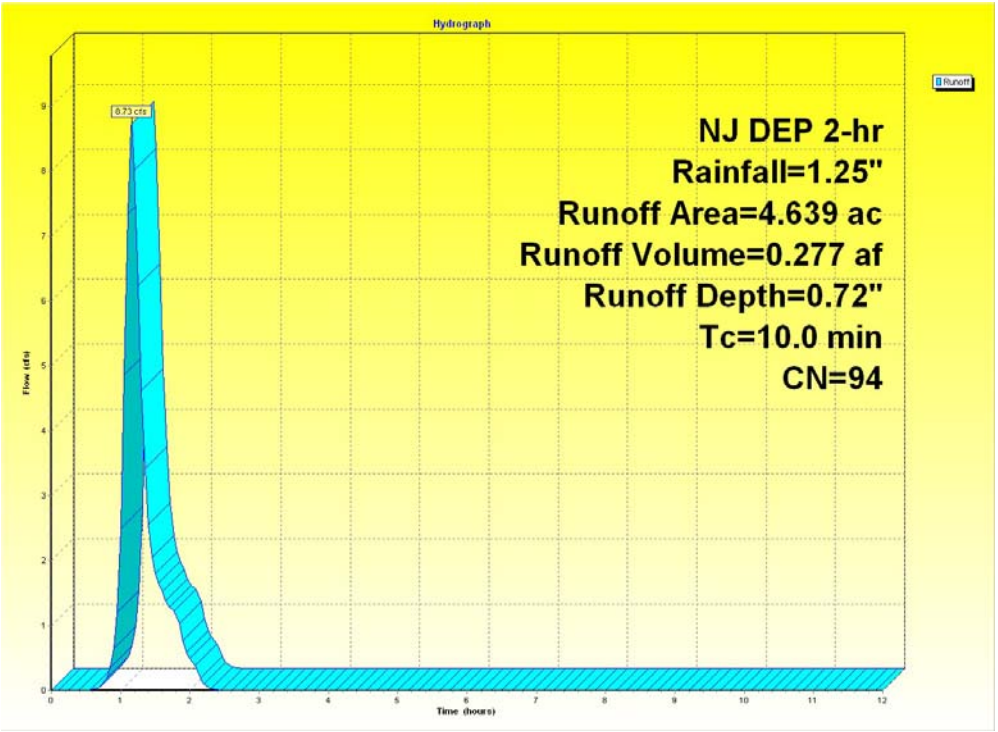
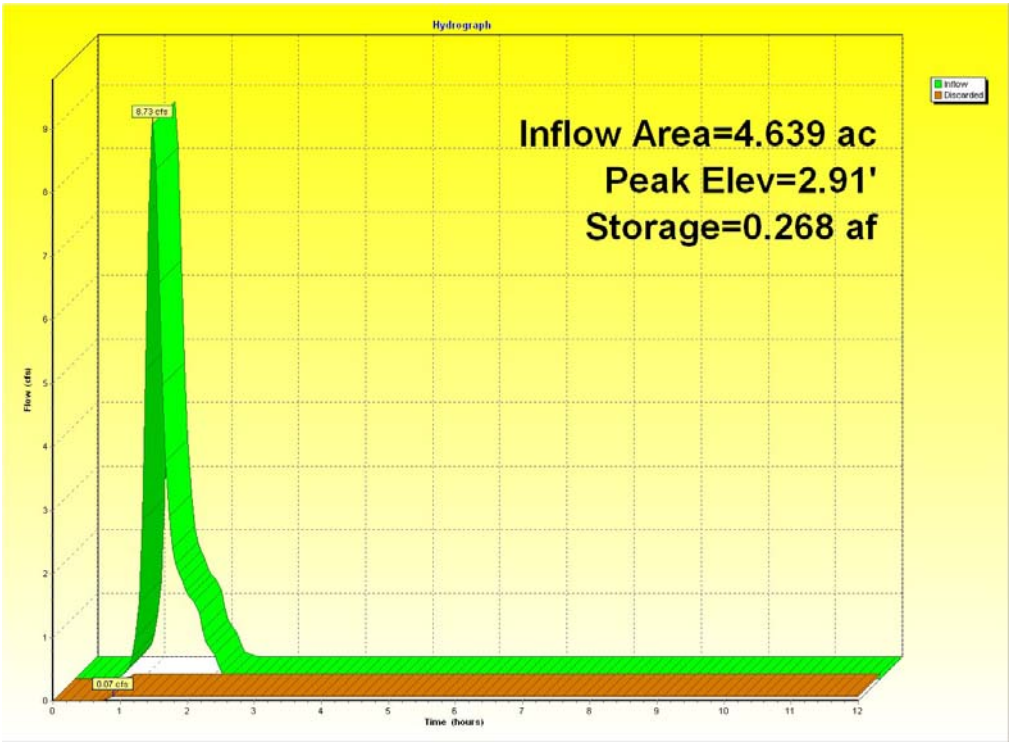
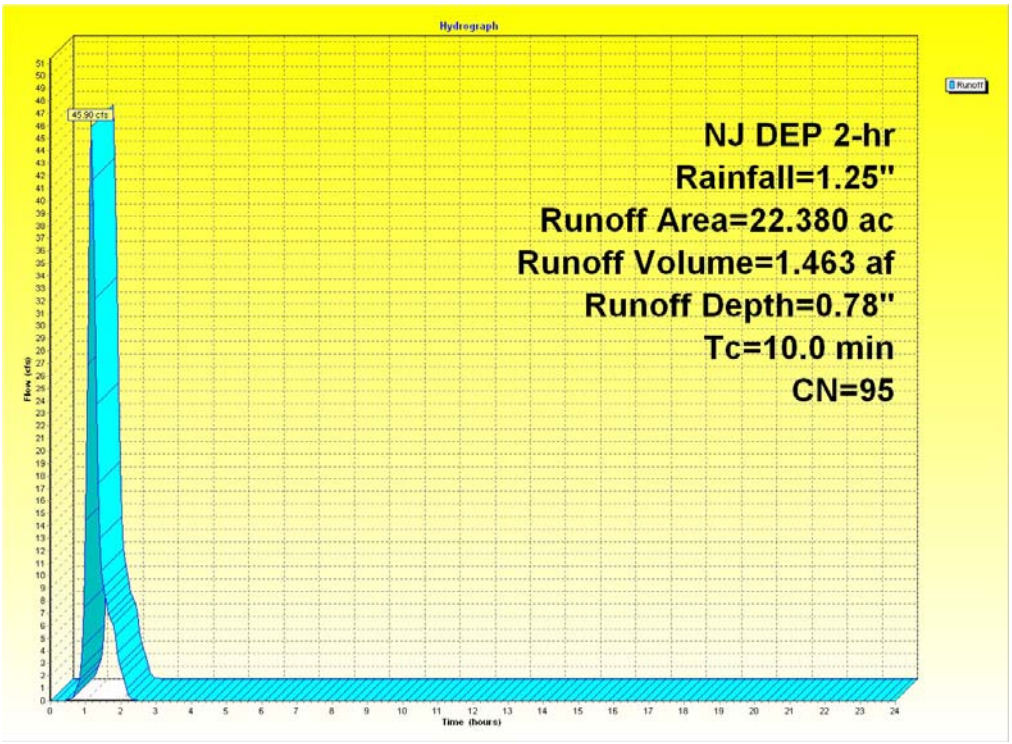


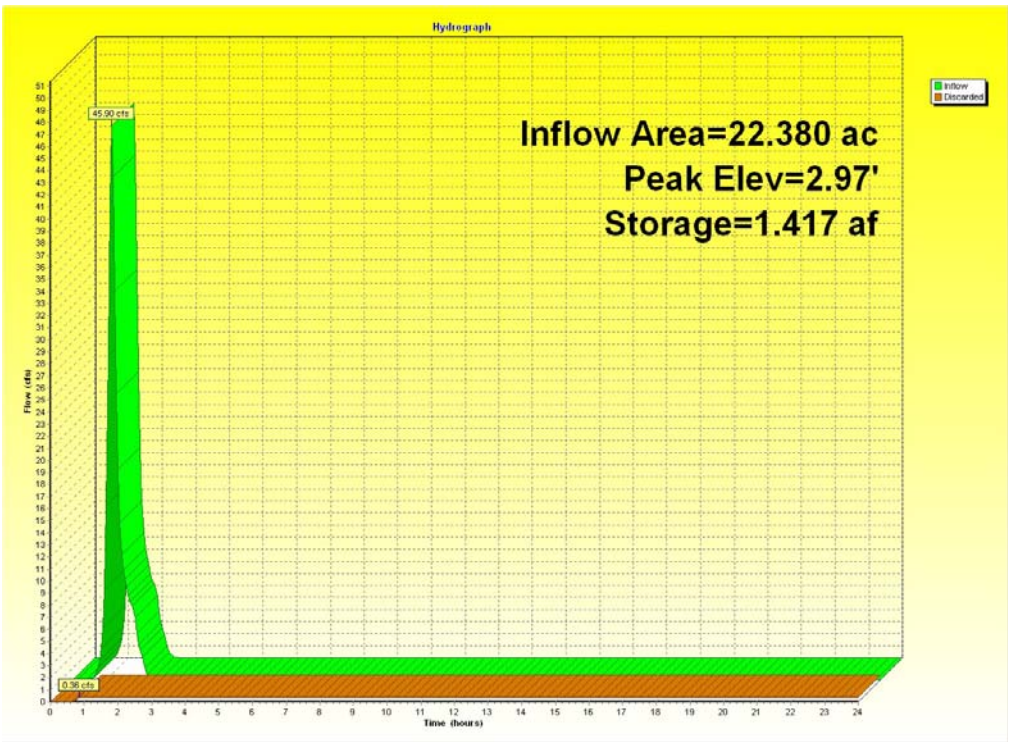
Hydrograph for a Commercial Building to be Disconnected in Basin 13 of the Township of Parsippany-Troy Hills



Routing of Hydrograph through Bioretention System (2ft. deep with 0.5 in/hr infiltration rate) (Existing Hydrograph and Routed Hydrograph are shown)



Hydrograph for Areas near Route 287 to be Disconnected in Basins 13 and 14 of the Township of Parsippany-Troy Hills



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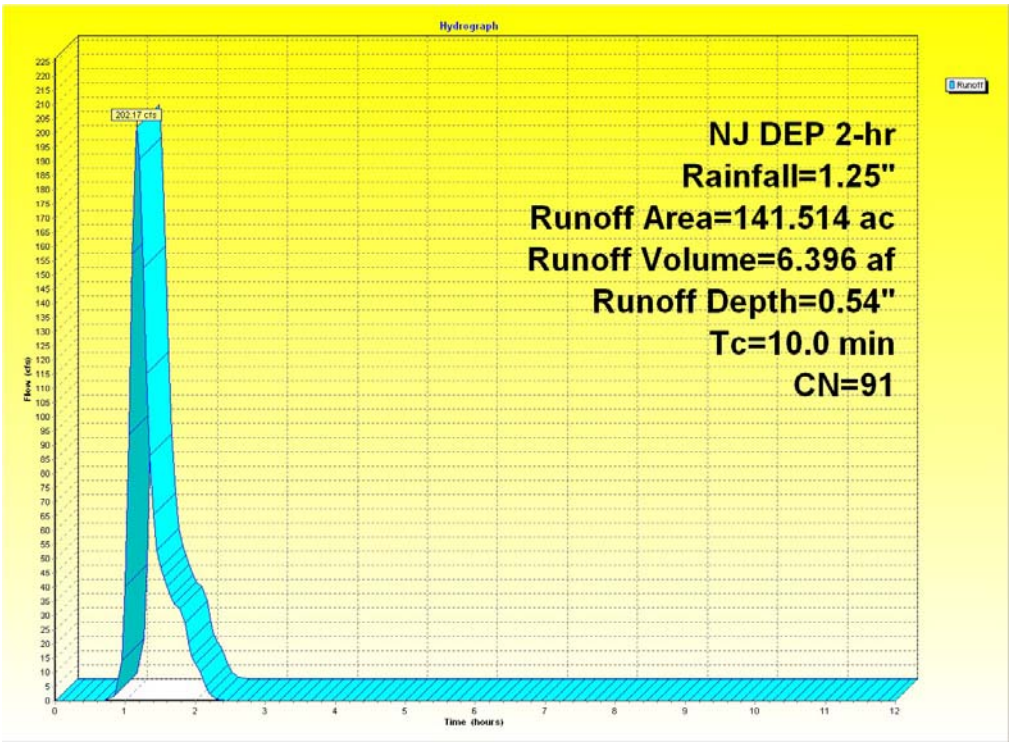
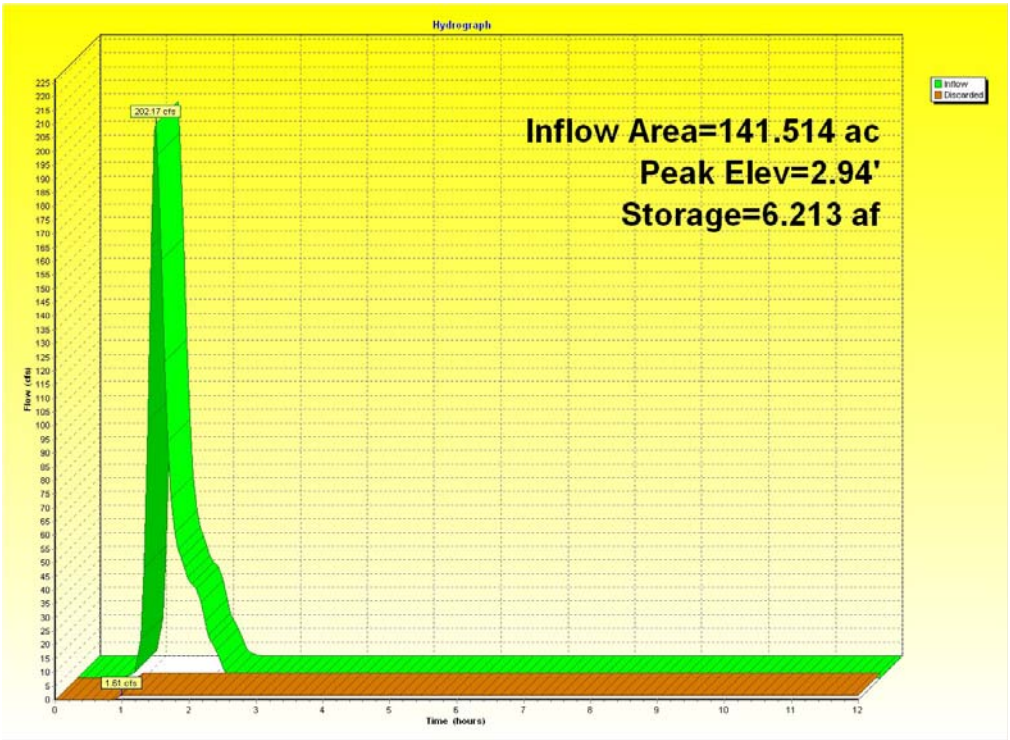


Hydrograph for Areas to be Disconnected in Basin 14 of the Township of Parsippany-Troy Hills



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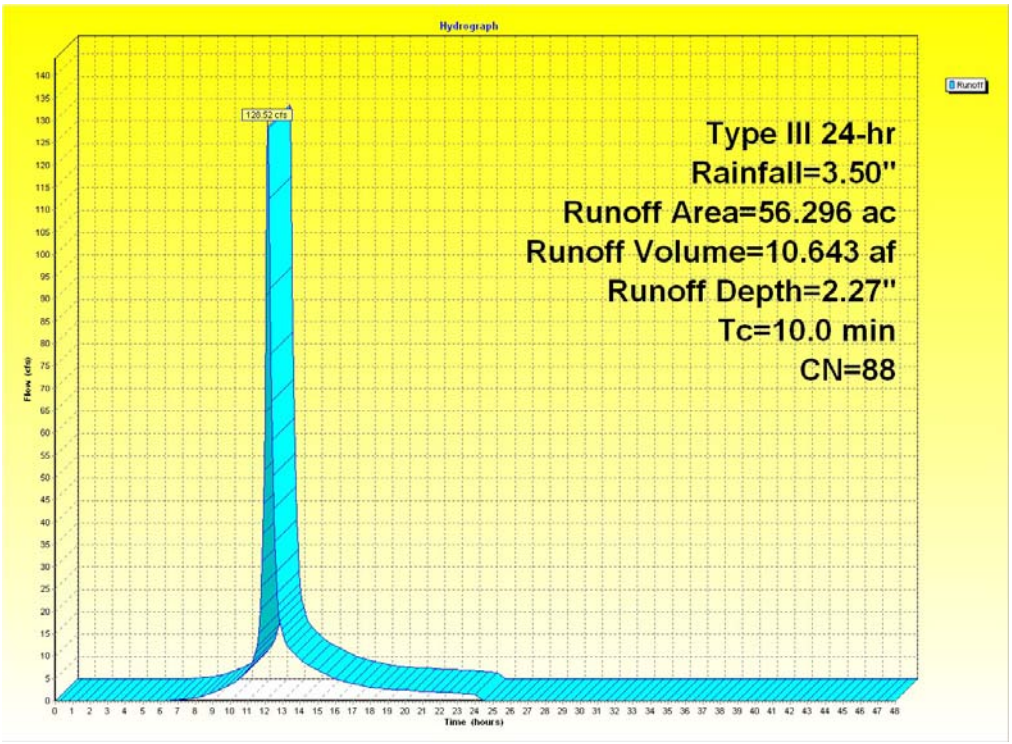
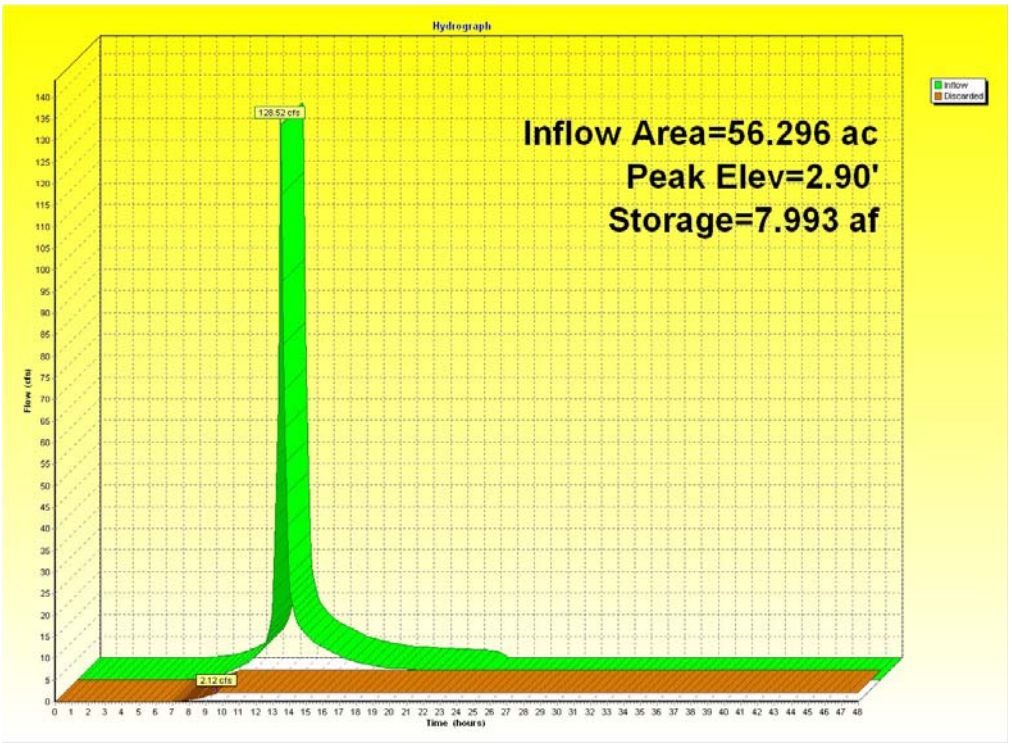
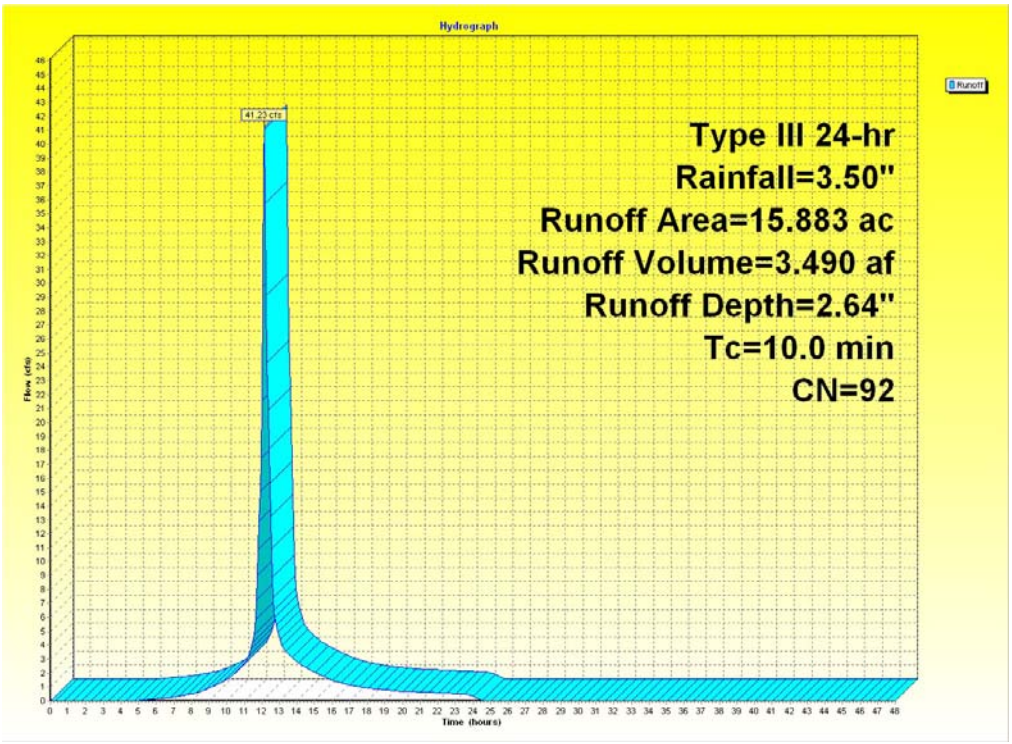


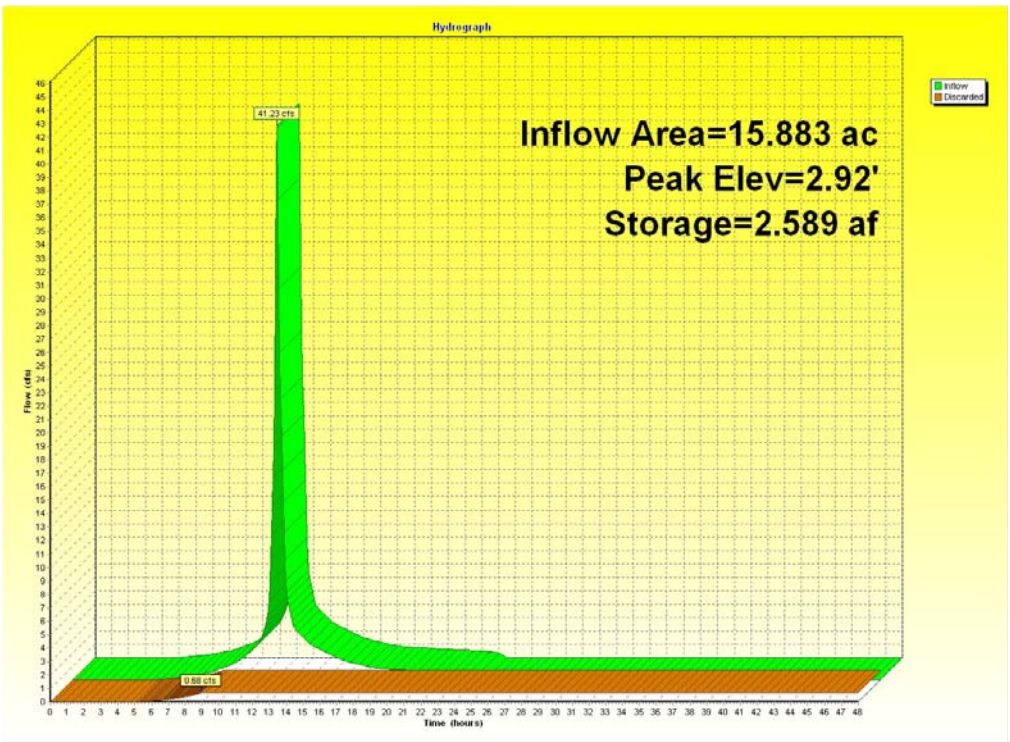
Hydrograph for Areas to be Disconnected in Basin 16 of the Township of Hanover



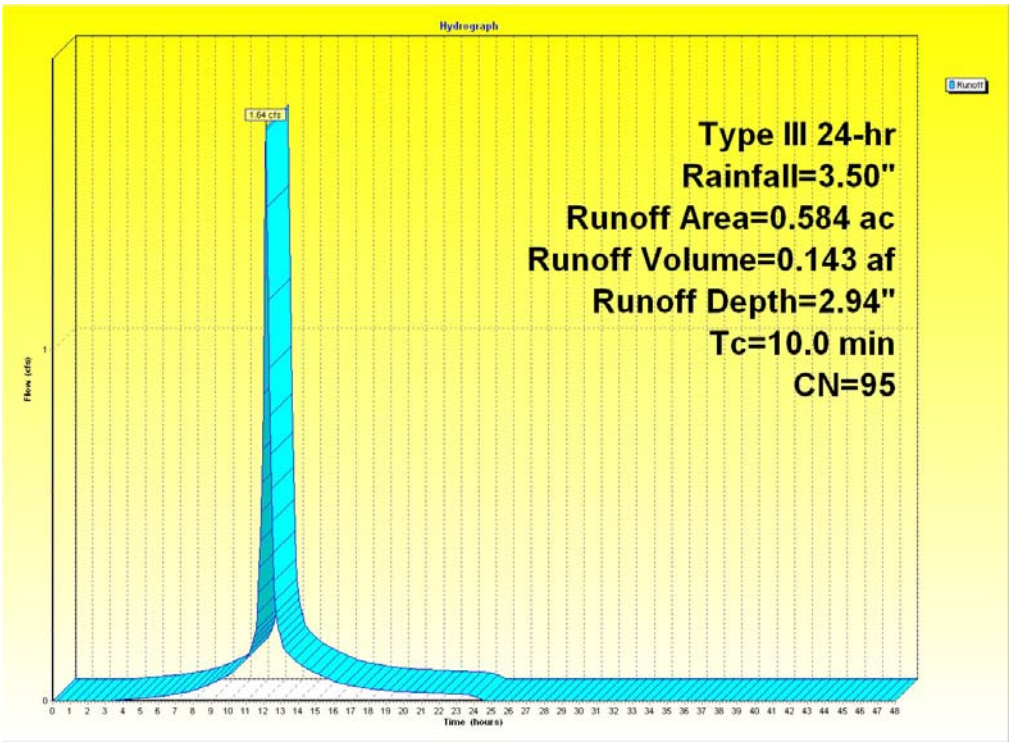
Routing of Hydrograph through Bioretention System (2ft. deep with 0.5 in/hr infiltration rate) (Existing Hydrograph and Routed Hydrograph are shown)



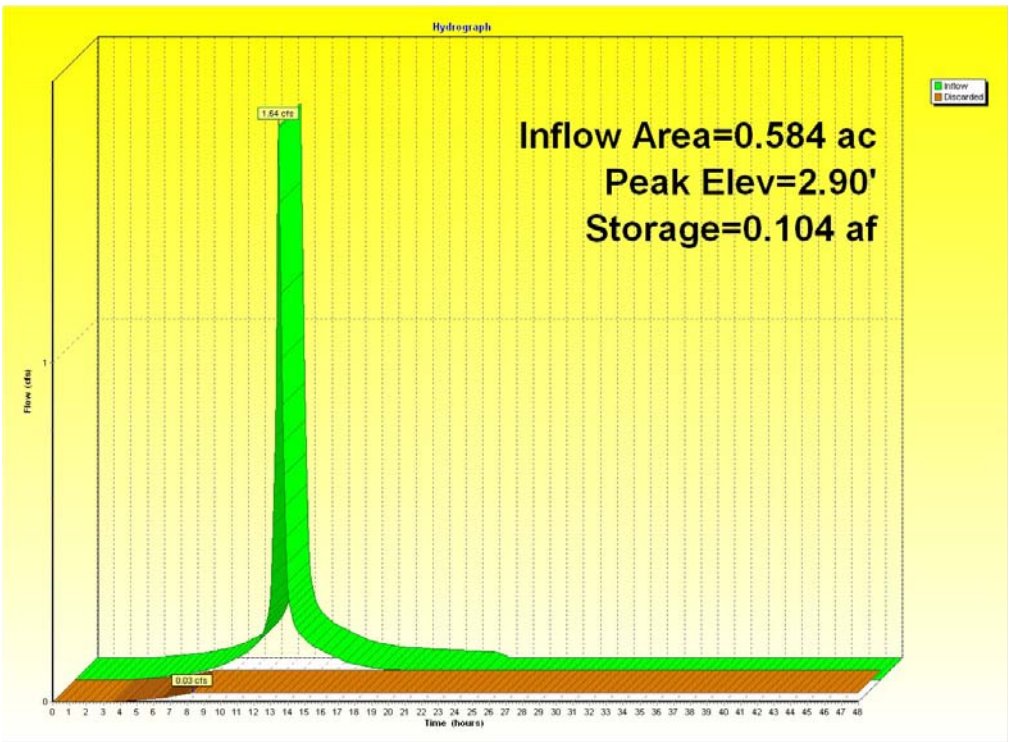
Hydrograph for Areas to be Disconnected in Basin 16 of the Township of Parsippany-Troy Hills



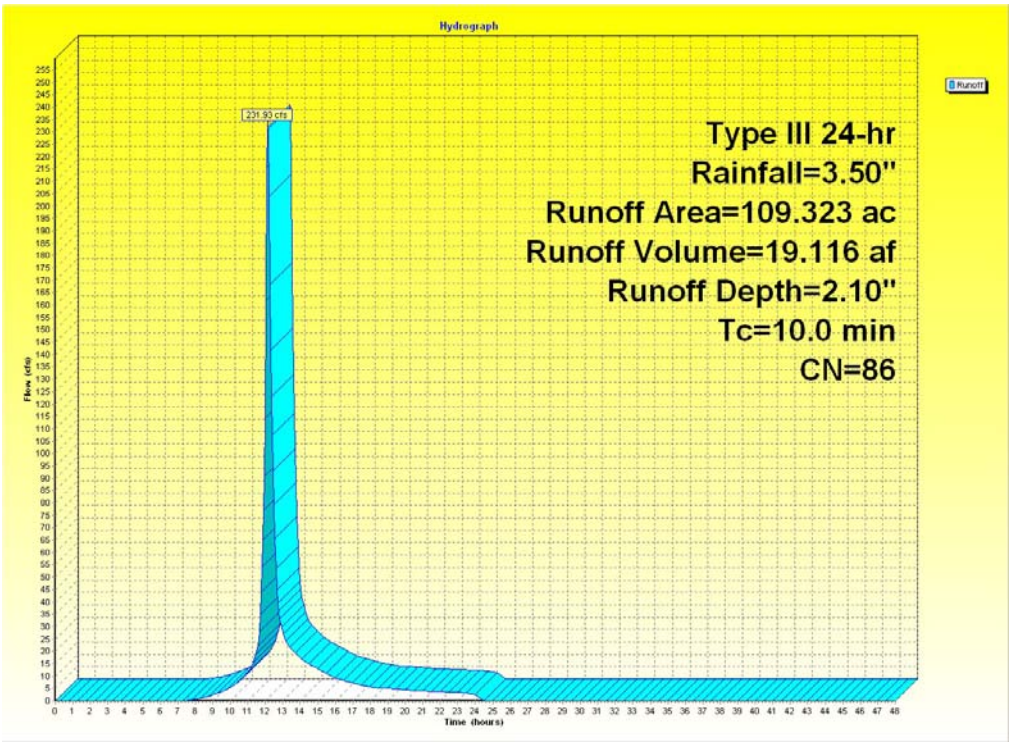
Routing of Hydrograph through Bioretention System (2ft. deep with 0.5 in/hr infiltration rate) (Existing Hydrograph and Routed Hydrograph are shown)



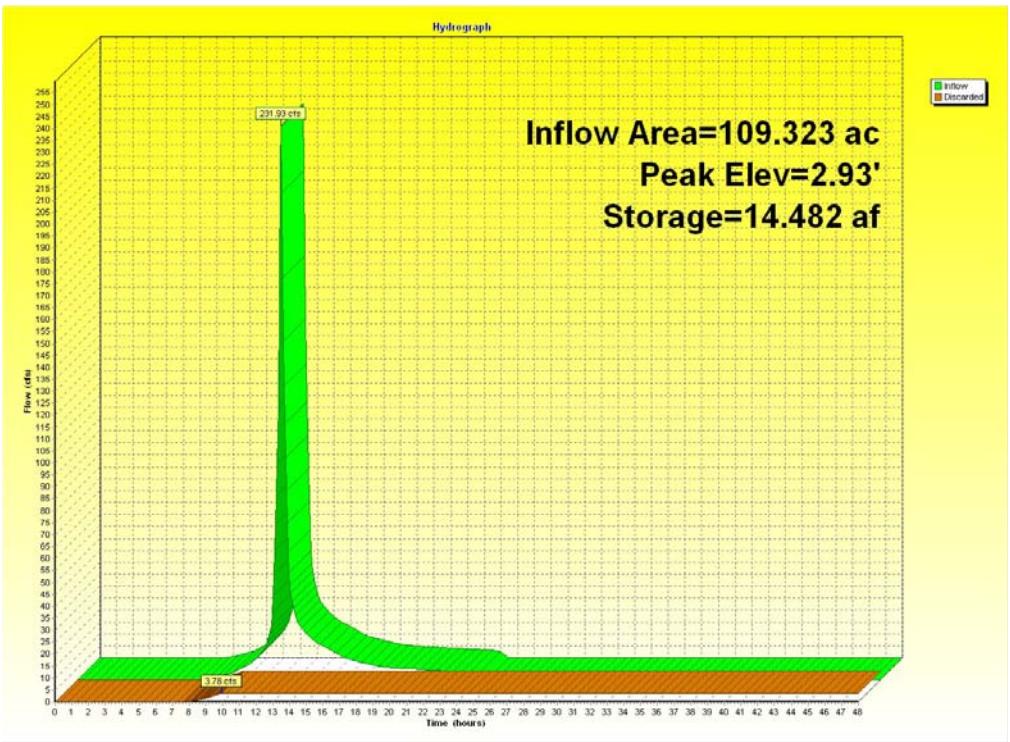
Hydrograph for Areas to be Disconnected in Basin 17 of the Township of Parsippany-Troy Hills



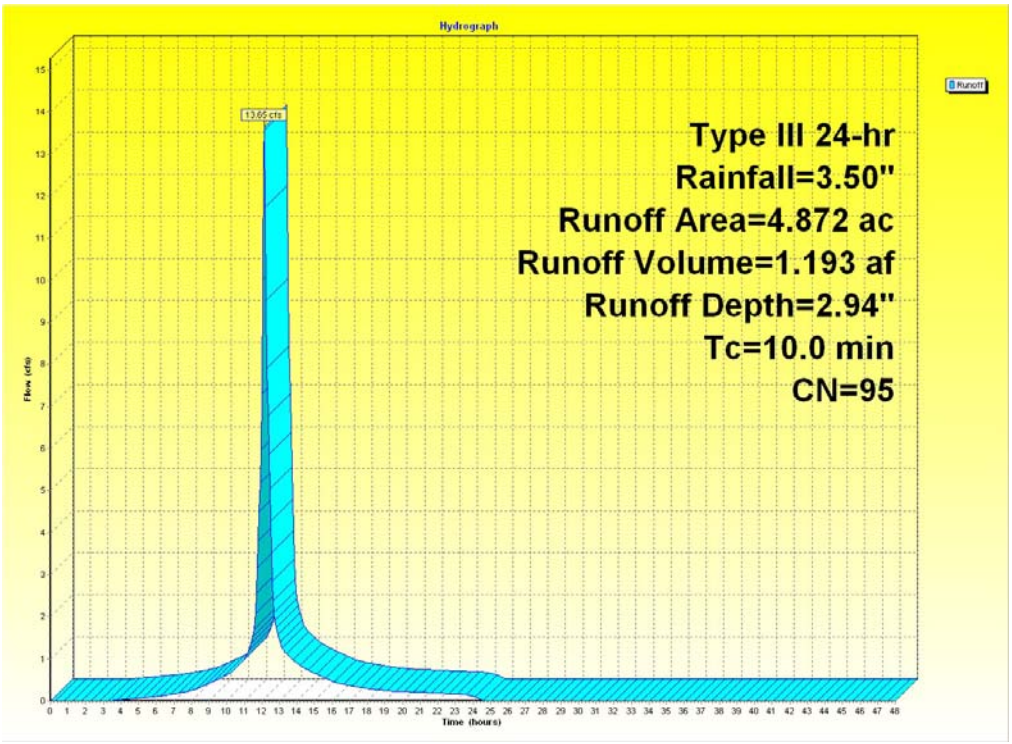
Routing of Hydrograph through Bioretention System (2ft. deep with 0.5 in/hr infiltration rate) (Existing Hydrograph and Routed Hydrograph are shown)



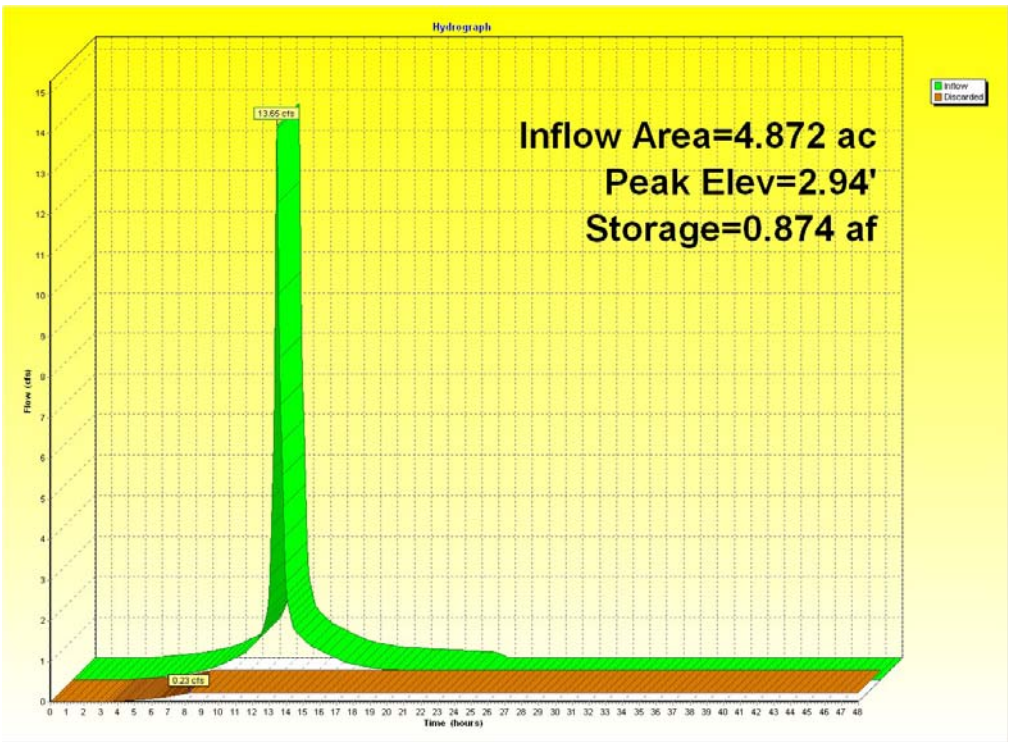
Hydrograph for Areas to be Disconnected in Basin 18 of the Township of Parsippany-Troy Hills



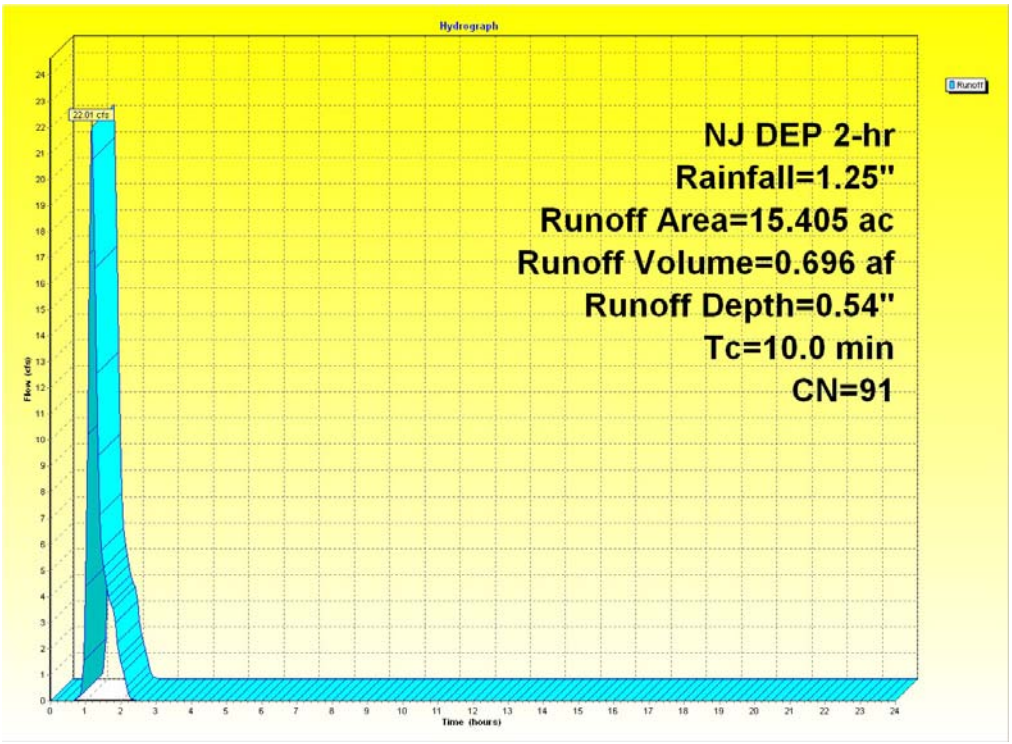
Routing of Hydrograph through Bioretention System (2ft. deep with 0.5 in/hr infiltration rate) (Existing Hydrograph and Routed Hydrograph are shown)



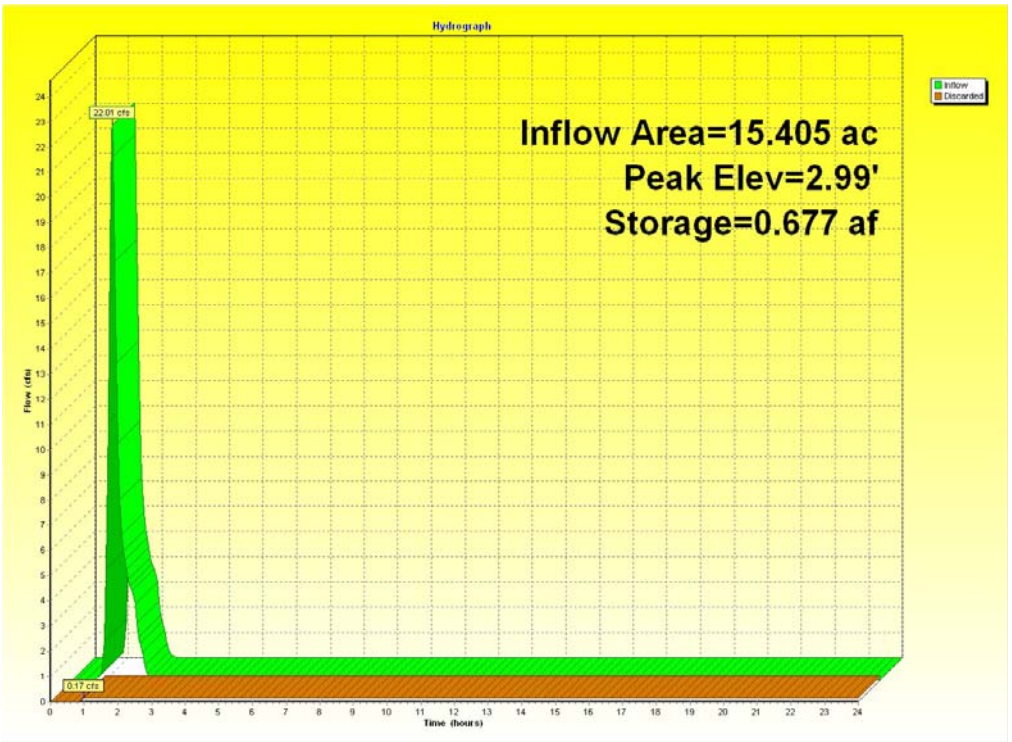
Hydrograph for Areas to be Disconnected in Basin 19 of the Township of Parsippany-Troy Hills



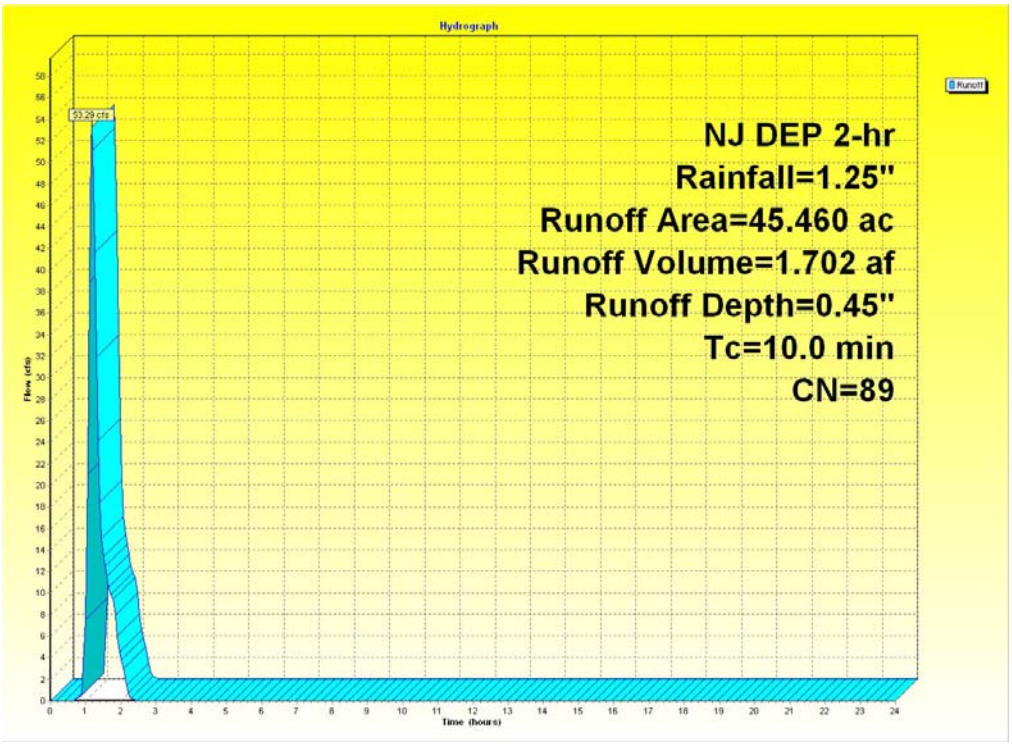
Routing of Hydrograph through Bioretention System (2ft. deep with 0.5 in/hr infiltration rate) (Existing Hydrograph and Routed Hydrograph are shown)



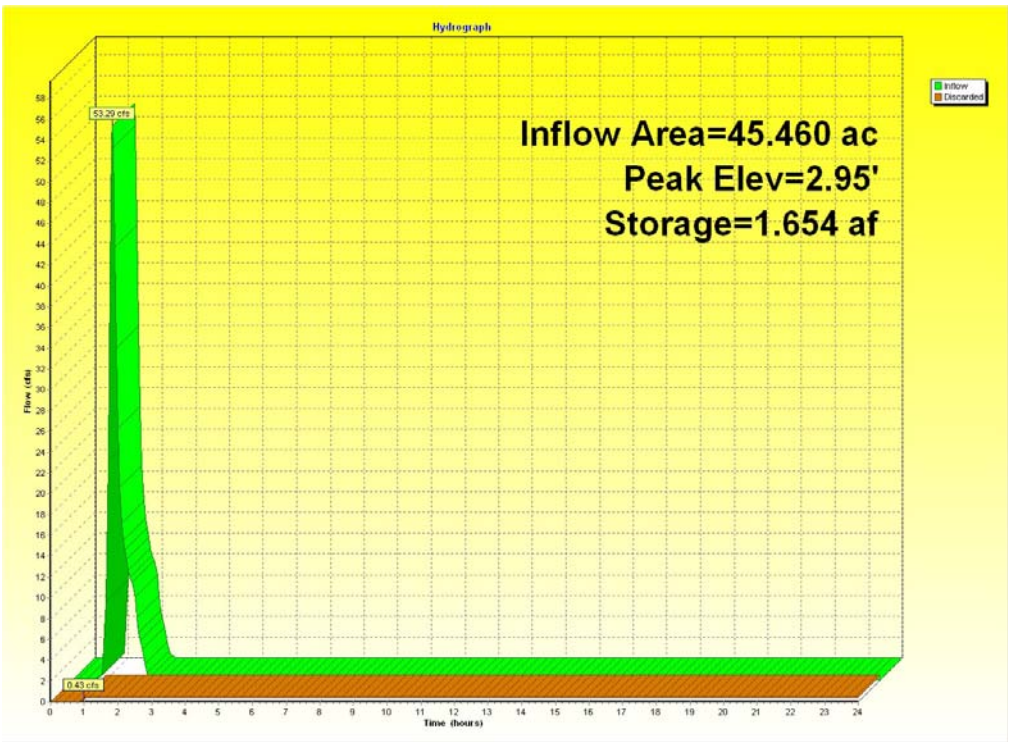
Hydrograph for Areas to be Disconnected in Basin 20 of the Township of Hanover



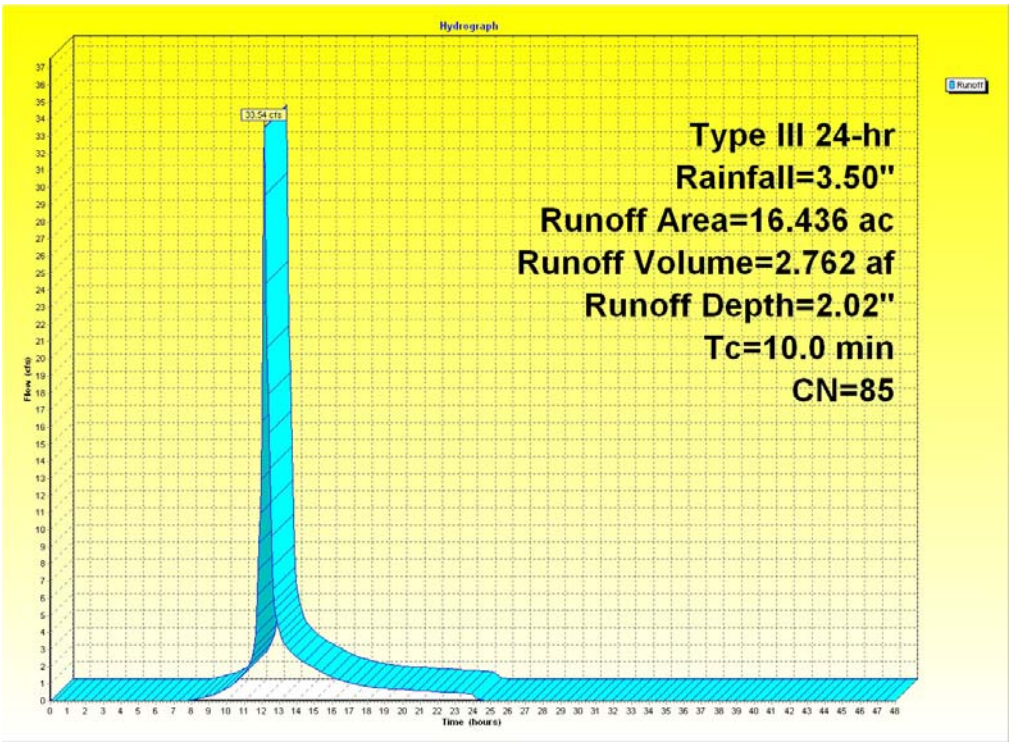
Routing of Hydrograph through Bioretention System (2ft. deep with 0.5 in/hr infiltration rate) (Existing Hydrograph and Routed Hydrograph are shown)



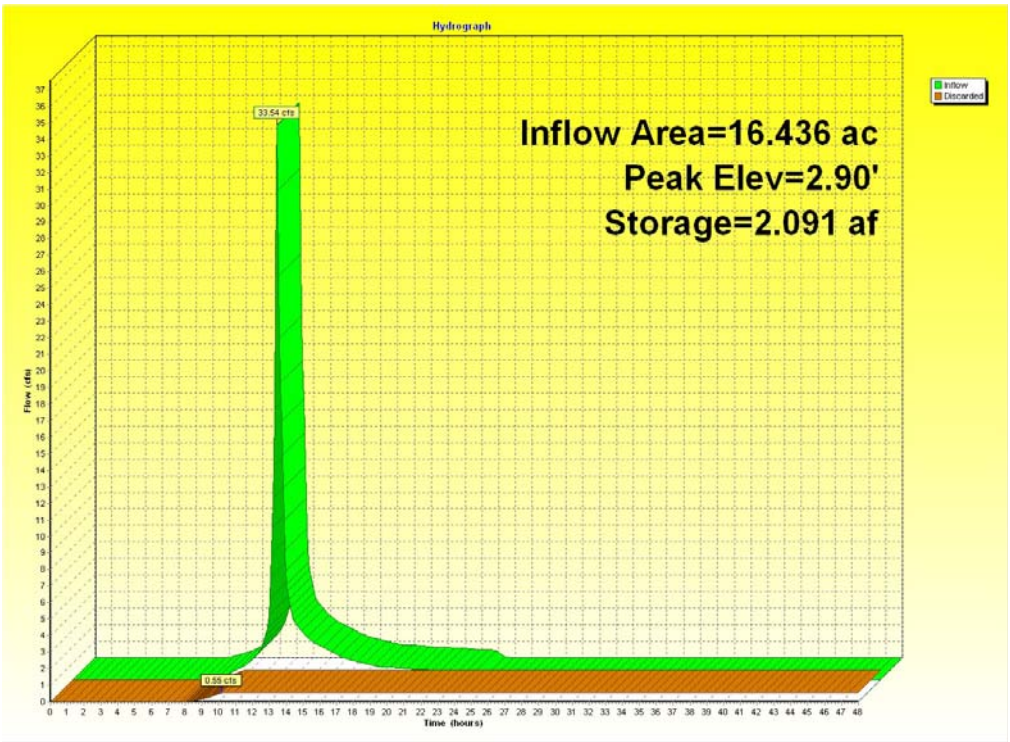
Hydrograph for Areas to be Disconnected in Basin 21 of the Township of Parsippany-Troy Hills



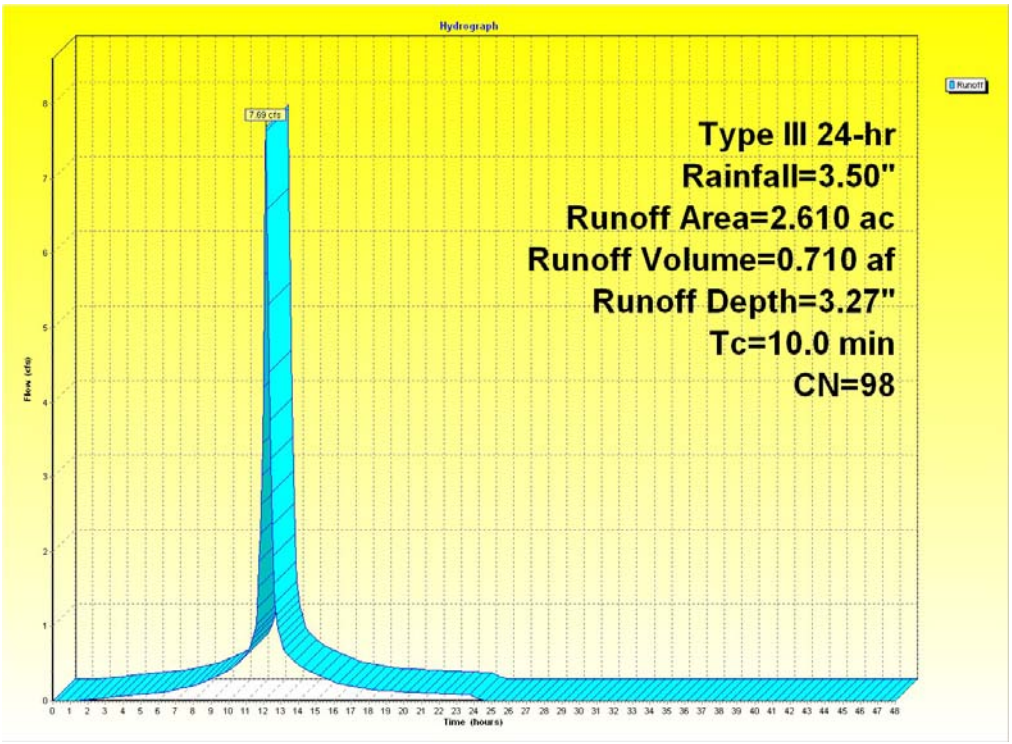
Routing of Hydrograph through Bioretention System (2ft. deep with 0.5 in/hr infiltration rate) (Existing Hydrograph and Routed Hydrograph are shown)



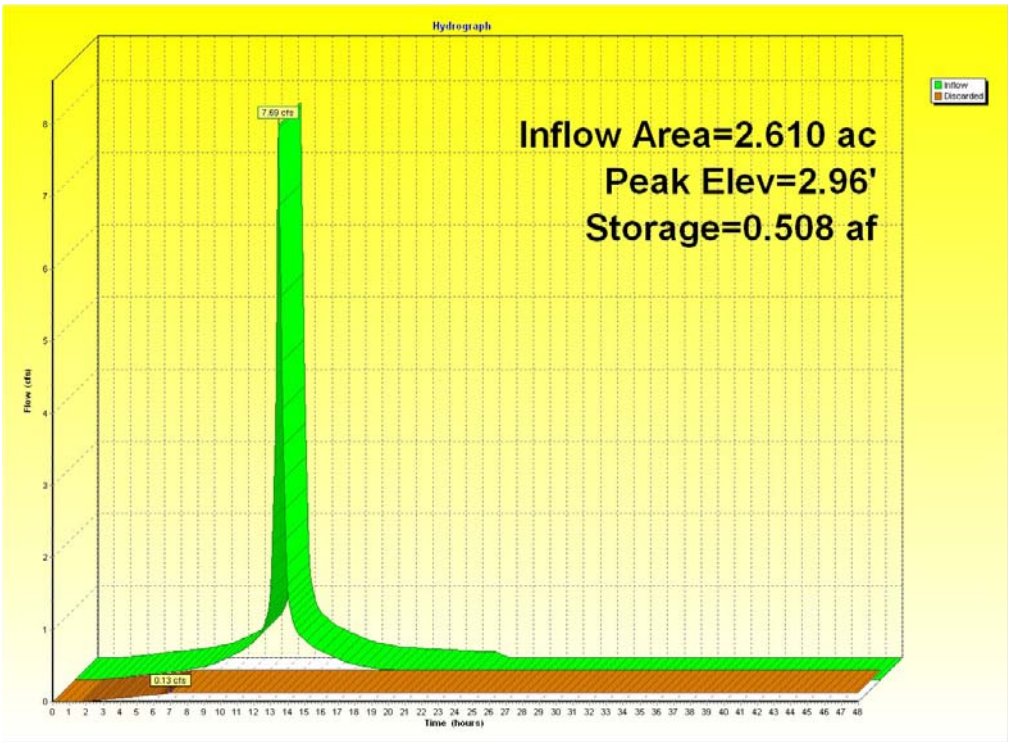
Hydrograph of Areas to be Disconnected in Basin 24 of the Township of Parsippany-Troy Hills



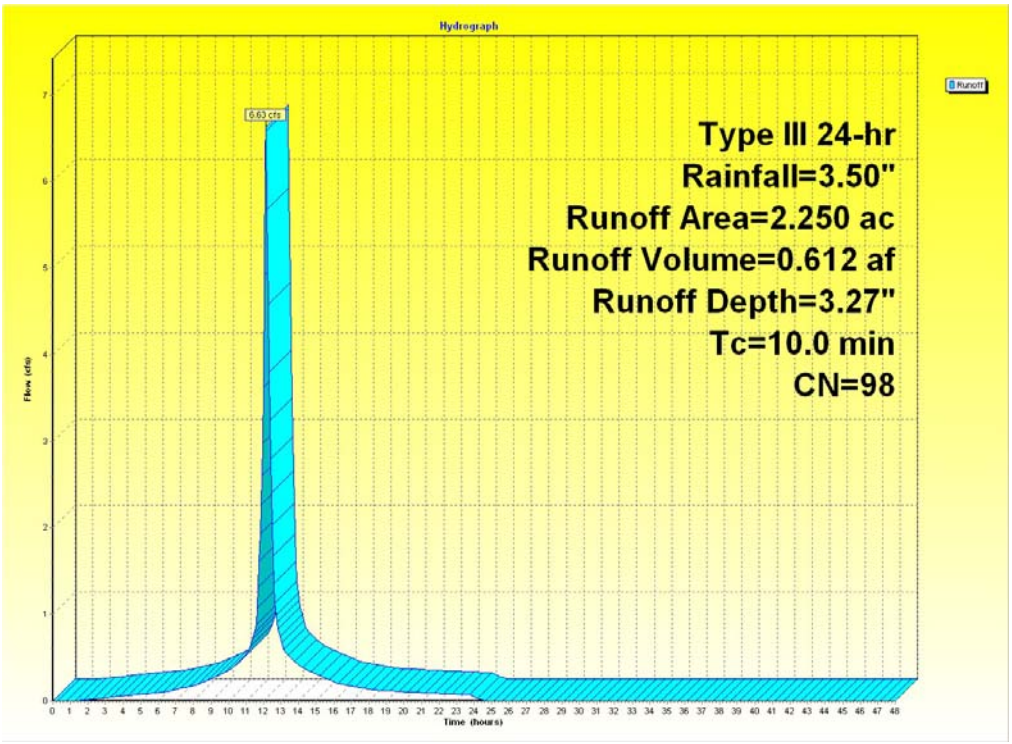
Routing of Hydrograph through Bioretention System (2ft. deep with 0.5 in/hr infiltration rate) (Existing Hydrograph and Routed Hydrograph are shown)



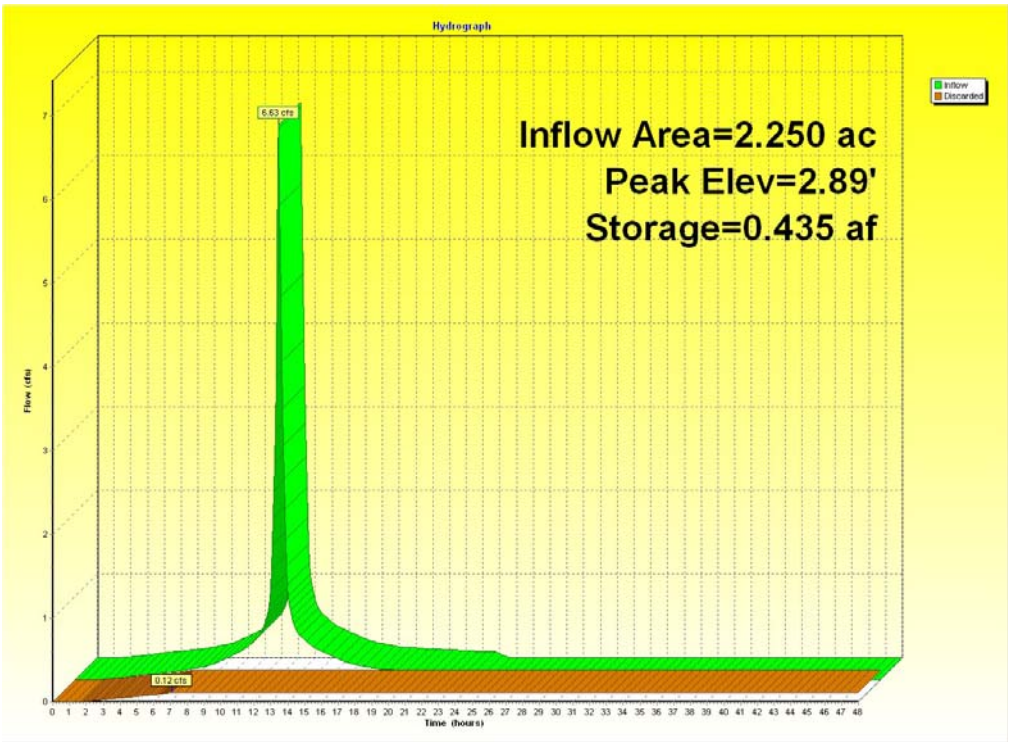
Hydrograph for Impervious Surfaces to be disconnected in Basin 25's Tivoli Gardens



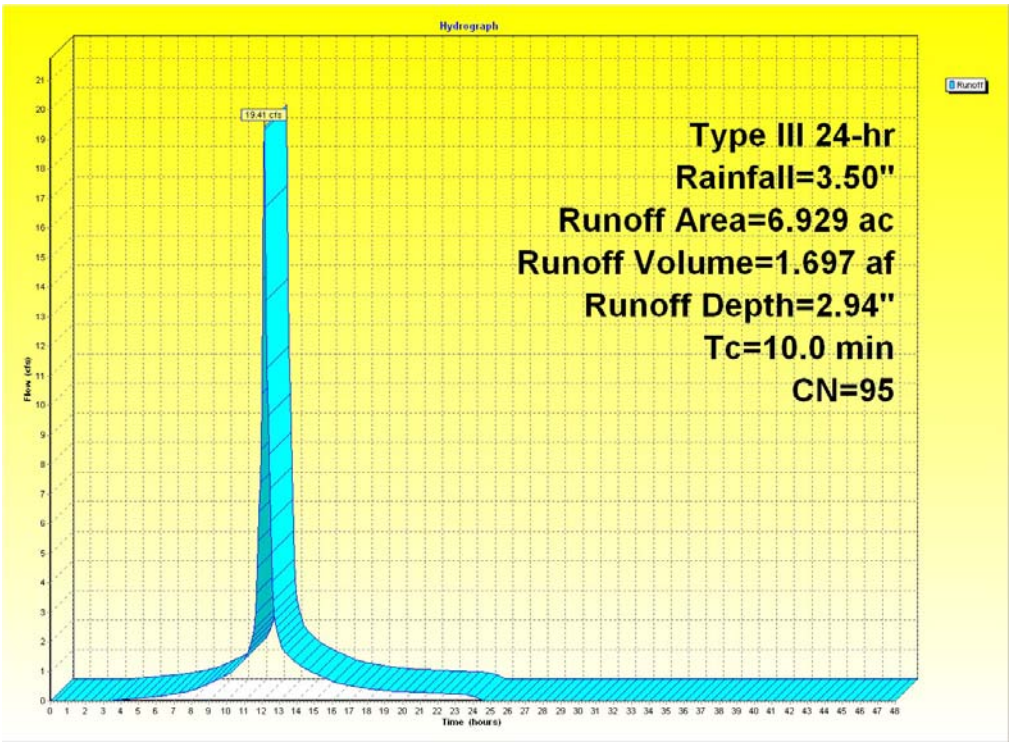
Routing of Hydrograph through Bioretention System (2ft. deep with 0.5 in/hr infiltration rate) (Existing Hydrograph and Routed Hydrograph are shown)



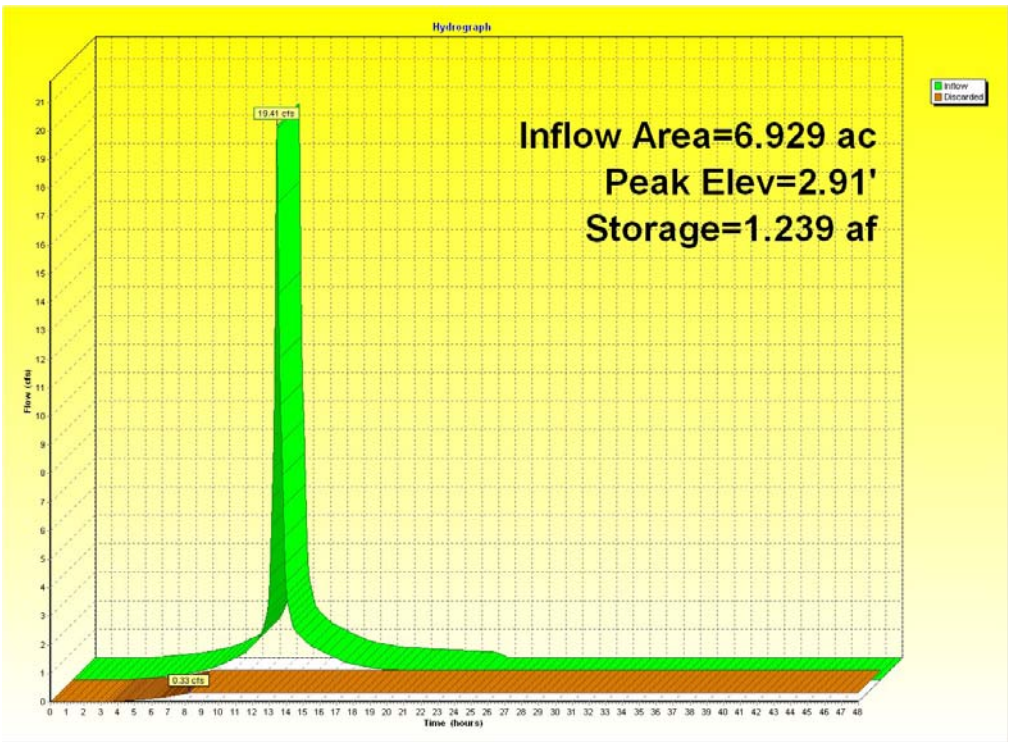
Hydrograph for Rt 202/Rt 46 Shopping Center in Basin 25 for the 20% of the Impervious Cover to be Disconnected



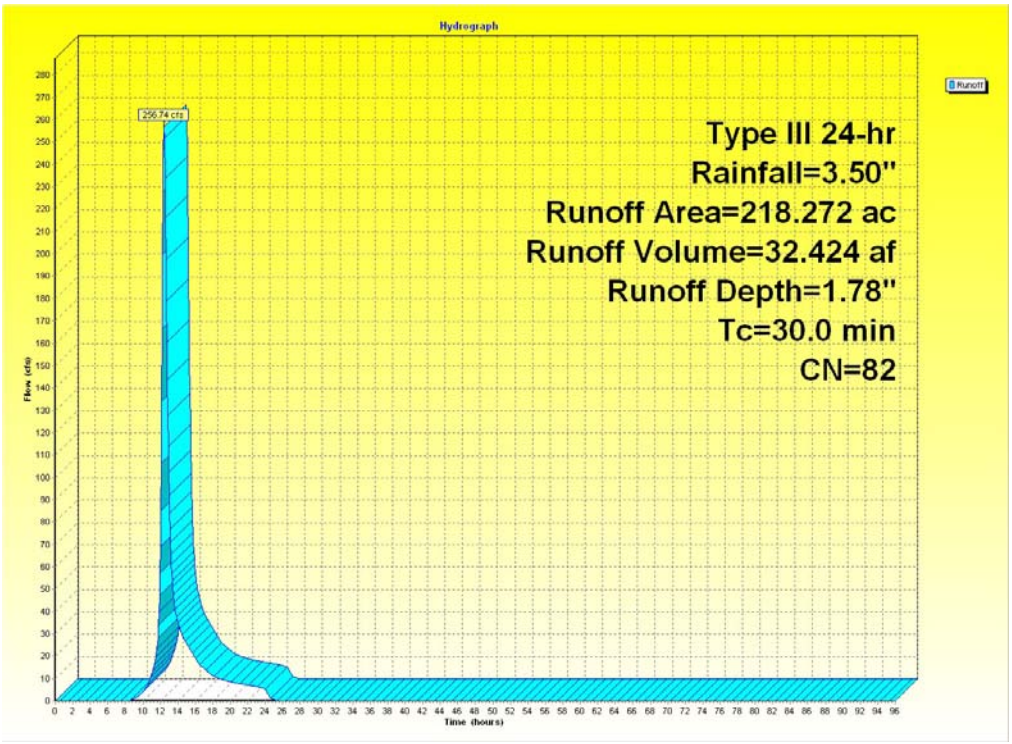
Routing of Hydrograph through Bioretention System (2ft. deep with 0.5 in/hr infiltration rate) (Existing Hydrograph and Routed Hydrograph are shown)



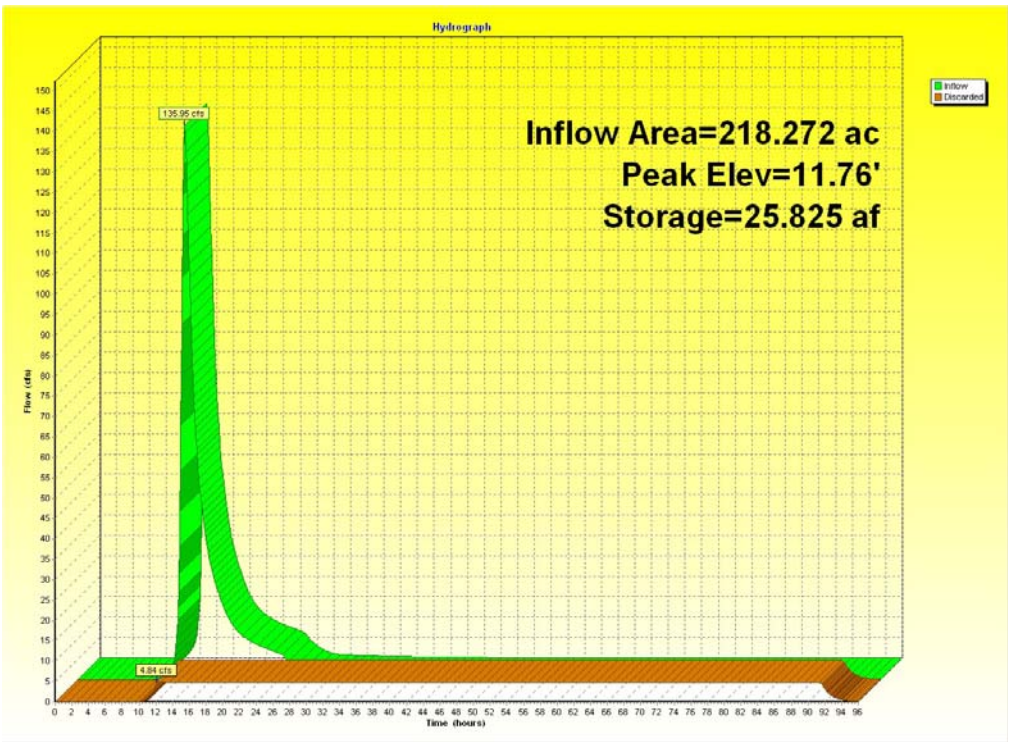
Hydrograph for Areas near Route 287 in Basin 25 of the Township of Parsippany-Troy Hills (2 Year Storm)



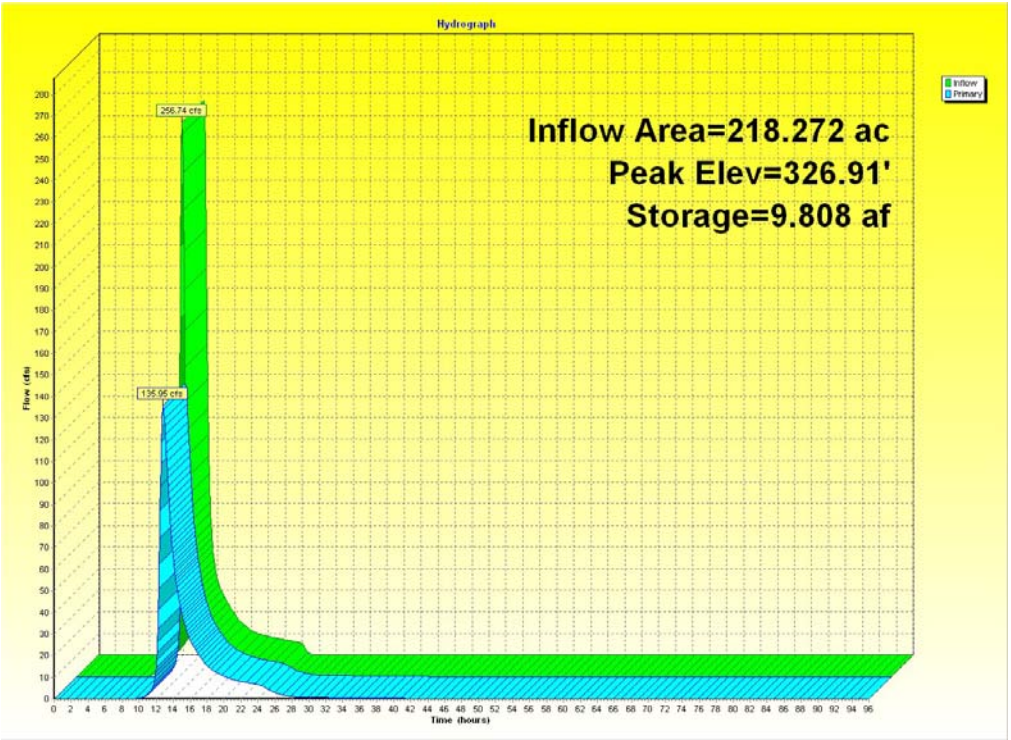
Routing of Hydrograph through Bioretention System (2ft. deep with 0.5 in/hr infiltration rate) (Existing Hydrograph and Routed Hydrograph are shown)



Hydrograph for Areas to be Disconnected in Basin 26 of the Township of Parsippany-Troy Hills



Routing through Pond 2



Routing through Pond 3