

**FLOOD MITIGATION FEASIBILITY STUDY  
FOR THE ROSE BROOK  
DELAWARE TOWNSHIP,  
HUNTERDON COUNTY, NEW JERSEY**

**PREPARED FOR:**

The Delaware Township Stormwater Committee and  
the Delaware Township Committee

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**Rose Brook Watershed Flood Mitigation Study  
Delaware Township, Hunterdon County**

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## **1.0 INTRODUCTION**

The Rose Brook, a tributary to the Wickecheoke Creek has experienced flash flooding (July 2006) and chronic stream bank erosion. The stream is much incised due to stream bed down-cutting and widening of the channel banks. Flooding of the wastewater treatment plant and adjacent channel erosion are other threats to local investments and stream water quality. The focus of this study was to identify ways to protect the Township infrastructure as well as private property by identifying potential flood mitigation measures and potential site locations.

While the primary emphasis of this effort is to manage flooding caused by the excessive volume and velocity of runoff generated in the developed headwaters of Rose Creek, the benefits go well beyond flooding mitigation. Because pollutants are carried on sediment, this effort is also directed at reducing contamination and sedimentation of the Delaware and Raritan Canal, a major source of water in New Jersey, even though Township residents are not dependent on that supply. Streambank stabilization cannot even be attempted until the velocity of runoff is better controlled. Erosion from headcutting throughout the watershed cannot be achieved until the streambed is restored. The objectives of this retrofit effort include restoration of the stream corridor habitats and maintenance of stream base flow through increased retention and recharge, as well as infrastructure and property protection. This project is the first Township effort to manage from a watershed-perspective, rather than just a project-by-project regulatory compliance, which has in the case of Rose Brook, failed. The Township hopes this serves as a demonstration for how to retrofit and shift management of a watershed that is out of control.

The Delaware Township Stormwater Committee greatly helped with the collecting of detailed information on the watershed.

## **2.0 CHARACTERISTICS OF THE WATERSHED**

Rose Brook, a Category One water, and its watershed are located in Delaware Township, Hunterdon County, NJ. The stream originates at its headwaters to the north and east of the intersection of Sergeantsville Road - Route 523 and Rosemont Ringoes Road - Route 604 in Sergeantsville. The stream flows in a southwest direction to the confluence with the Wickecheoke Creek. Most of the commercial area concentrated around the Route 523-604 intersection drains to this stream via storm sewer and drainage swales. The remaining residential development and preserved farmland drain to tributaries or the main stem of Rose Brook. There are a number of parcels that may be developed in the future, with an area of 147.88 acres or approximately 24% of the watershed. Various watershed maps are included in Appendix A that depict the watershed boundaries, drainage features, aerial photography, land use, topography, and potential flood mitigation sites. The Constraints Map included in Appendix A, depicts Rose Brook in its entirety, including the USGS blue line and its intermittent headwater tributaries that were digitized from the Hunterdon County Soil Survey. This Constraints Map also delineates the 300 foot riparian zone for the Category 1 stream that is regulated under the NJDEP Flood Hazard Area Control Rules (N.J.A.C. 7:13) and the Stormwater Rules (N.J.A.C. 7:8).

The Rose Brook watershed area to the confluence with Wickecheoke Creek is 0.97 square miles. HUC-14 02040105200060 Lokatong Creek/Wickecheoke Creek is located within WMA 11, the Central Delaware River drainage basin. The stream has a USGS "blue line" length of 1.2 miles (the blue line terminates to the west of Route 523) and falls 124 feet over this distance for an average stream slope of two (2) percent. The headwater drainage areas of Rose Brook are in Sergeantsville which has experienced increased development in recent years. Existing eroded streambanks are present and flooding routinely occurs in the headwater areas. As future watershed development is proposed, aggravation of these preexisting conditions may occur.

The Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) does not delineate Rose Brook's floodplain. The only indication on the FIRM of flooding potential is the backwater flooding from the Wickecheoke Creek, shown as the 500-yr floodplain (see Constraints Map).

Rose Brook was likely not studied due to the relatively small drainage area and sparse development at the time of the study. Despite the representation on the FIRM, four (4) residences at the western boundary of the watershed along Lower Creek Road have been impacted by the flash flooding of the Rose Brook three (3) times since June 2006. Residents completed flooding documentation, which was submitted to FEMA. The residents also mapped the floodplain for the event in July of 2006.

### **3.0 REGULATORY CONTEXT**

NJDEP developed Municipal Stormwater Regulations in response to U.S. Environmental Protection Agency's (USEPA) Phase II rules of 1999. NJDEP issued final stormwater rules in February 2004 and four New Jersey Pollution Discharge Elimination System (NJPDES) general permits authorizing stormwater discharges for all New Jersey municipalities, public complexes, and highway agencies that discharge stormwater from municipal separate storm sewers (MS4s). As part of the NJPDES general permit, each entity is required to adhere to a series of Statewide Basic Requirements (SBRs) that enforce a minimum standard and an implementation schedule.

As part of the SBRs program, municipalities were designated as either Tier A or B, depending on Population density. Delaware Township was designated Tier B due to the rural character of the municipality. The SBRs address stormwater quality issues related to development, redevelopment and existing development by requiring regulated standards to be implemented within a specified timeframe. The Township Stormwater Committee has recommended that the local stormwater ordinance will not sufficiently mitigate existing problems in the watershed, and is concerned that eroded banks and flooding could worsen. The Township Stormwater Committee has recommended that the local ordinance be revised to reduce the size of impacted area which triggers the ordinance- from disturbing one (1) acre to one quarter (1/4) acre of disturbance, and reducing the area of impervious cover from one quarter acre to two thousand (2000) square feet.

Category One status gives a waterbody the highest level of water quality protection under New Jersey State regulations as set forth by N.J.A.C. 7:9B-1.5(d). The regulations are designed as anti-degradation measures and protect waterbodies from measurable changes in water quality characteristics such as clarity and color. In addition, the NJDEP Stormwater Regulations (NJAC 7:8) provide that all Category One streams and their tributaries be protected by a 300 foot buffer. All streams within this watershed are designated as Category One and are therefore subject to the 300 foot buffer requirements, which are depicted on the Constraints Map.

### **4.0 POTENTIAL FLOOD MITIGATION**

The Stormwater Committee and Princeton Hydro performed several field walks to identify potential mitigation sites and actions. The Stormwater Committee researched ownership of potential properties for mitigation measures and learned of the interest of landowners in participating in a possible future volunteer mitigation program.

The Rose Brook watershed was broken down into three (3) subwatersheds: Upper, Middle and Lower, and potential retrofit sites were identified in the Upper and Middle subwatersheds.

## **Section One- Upper Watershed (along Routes 523 and 604)**

The upper watershed of Rose Brook includes the most heavily developed sections along Route 604 and 523, and much of the stormwater runoff is managed by storm sewers and drainage swales. The Hunterdon County Soil Survey mapping and USGS maps depict the Rose Brook headwaters as beginning just down gradient of the developed areas (see Constraints Map). The soil is predominately composed of silt and clay, and is naturally poorly drained. One main drainage swale or ditch extending from Bird Lane routinely floods. Excess runoff from the ditch has also cut a deep ravine across adjacent agricultural and natural areas on its way to the upper reaches of the creek.

A network of eight (8) flood mitigation sites have been identified in the upper watershed of Rose Brook along Routes 523 and 604 where partial flood mitigation can be achieved. To retrofit the watershed effectively, a combination of some of these eight potential mitigation sites should be considered. The Stormwater Committee will also encourage smaller voluntary projects on residential and commercial sites such as rain barrels, rain gardens, infiltration facilities, recharge beds and in-ground structures like small drywells. One volunteer project on private property has already been accomplished at the Methodist Church where an infiltration bed was included in a parking area paving project.

**Site 1 – Block 23, Lots 11 and 12, Commercial site**—Road runoff is diverted from Sergeantsville Road (Route 523) north of Rosemont Ringoes Road (Route 604) at the perimeter of Jim’s feed store property creating a depression across the gravel parking area before draining to the residential lot (Site 2) and discharging into a storm sewer in Rosemont Ringoes Road. The Stormwater Committee has discussed with the Hunterdon County Engineer how the runoff from Sergeantsville Road may be incorporated into the road improvement design. One approach is to direct the runoff to in a stable manner to the residential lot (Site 2) down slope where a detention system can be installed. A retrofit under the store’s parking lot to provide runoff storage would be prohibitively expensive for the storage volume required.

**Site 2 - Block 23, Lot 7, Residential lot on Route 604**— This lot is currently zoned V-1 Village residential/commercial and owned by Mr. Jim McCue. Runoff from the above store enters this property. The owner told the Stormwater Committee that there exists an open cistern on the site. A County inlet exists at Rosemont Ringoes Road that conveys the flows from the property downstream. It appears that there is enough area for a stormwater detention facility to be installed on the property.

**Site 3 - Block 36, Lot 14.11, Sergeantsville Park**—Much of the runoff collected along County Route 604 is conveyed down slope in a pipe that crosses Sergeantsville Park quite close to the surface before discharging to the Fire House where flooding is already a problem. Sergeantsville Park is the best option to capture floodwaters before they would reach the Fire House. Although the site is fairly large, there are other important demands on the site. The largest—which continues to grow annually—is the Farmers Market which is held on Saturdays from June through September. The lawn area could be graded to maximize infiltration and the infrequent parking demand might be met with open cell blocks paving. A portion of the site could provide detention and infiltration with a wet meadow landscape feature and educational exhibit

**Site 4 - Block 36, Lot 24, Fire House**—In the July 2006 downburst, the Fire House was cut off from County Route 523 by deep water and was effectively isolated temporarily. Once the current drainage improvements on County Route 604 in Delaware Township are completed, this flooding problem will likely be aggravated until one of the above projects is completed. The retrofit of the parking lot and landscape could accommodate additional storage and infiltration. See the Delaware Township Stormwater Mitigation Plan.

**Site 5 - Block 36, Lot 18, Residential lot**— A drainage swale (ditch) conveys large amounts of runoff from Rittenhouse Road and Bird Lane to Rose Brook, which is severely overloaded and regularly overtops its banks. It runs adjacent to a residential lot next to the Marescas Market and improvements to

stormwater management may be possible at this site. The Constraints Map included in Appendix A depicts a drainage swale (ditch) conveying stormwater to this site and Rose Brook from farm fields and Rittenhouse Road. Consider maximizing access to the floodplain and creating a wetland bioretention swale and controls on a portion of Site #5.

**Site 6 - Block 34, Lot 8, Preserved agricultural field and lowland forest**— A regional wetland retention complex may be possible near the Rose Brook crossing of County Route 523. The Hunterdon Soil Survey identifies the headwaters of Rose Brook as originating in this agricultural field. In addition, Rose Brook receives stormwater runoff from County Route 604 and 523 drainage swales. The field already mitigates the stormwater problem and that effect could be amplified. Several government programs would be possible sources of funding, including the USDA-NRCS programs. Through outreach to Mr. Eric Schradling of the US Fish and Wildlife Service, Private Lands Coordinator, this site has been identified as a potential restoration project that would qualify for partnership with the Fish and Wildlife Service Partnership grant program: although it is of low priority to the US Fish and Wildlife Service at this time.

**Site 7 - Block 34, Lot 24.01, Lowland forest site**— The USGS stream mapping identifies Rose Brook originating just before the sewage treatment plant. However, a ravine has been carved by the runoff from the Granary Road ditch and from the runoff ditch from Bird Lane which is also causing streambank erosion on Rose Brook. Reducing stormwater flows from upstream sources should be considered to reduce the impacts on the stream. Much of this area is delineated as forested wetlands and within the 300 foot protective riparian zone of the Rose Brook; and therefore disturbing these protected areas to address the flooding and stormwater concerns may not be prudent at this parcel. Again, Mr. Eric Shradling of the US Fish and Wildlife Service has identified this site, in addition to the agricultural field, as a potential restoration project that would qualify for partnership with the Fish and Wildlife Service, although it is also of low priority at this time.

Other retrofits in the Sergeantsville area may be possible including stormwater detention, modification of existing infrastructure, landscape changes or other methods that will be understood in the progression of the work.

**Site 8 - Rittenhouse Road drainage retrofit**—The runoff from the east side of Rittenhouse Road is not sufficiently accommodated by the roadside swale and concentrates and crosses the road. The regularly high volume of water shunted to the connecting swale routinely overflows the channel. Rutgers University has developed guidelines for roadside swales and ditches that will form the basis for the redesign of the stormwater management for Rittenhouse Road.

### **Section Two- Middle Watershed (along Route 523)**

The Rose Brook middle watershed is the focus of the second phase of this retrofit project. There are a number of developable properties remaining in the middle watershed, and future development could impact the watershed. The Township Stormwater Committee has proposed revisions to the stormwater ordinance that would regulate smaller areas of impervious cover and utilize easements to limit incremental increases in landscape impermeability. Long-term success in managing the middle watershed will be dependent upon better volume control going forward than is presently permissible under the State regulations. Proposed road widening of Route 523 by the County also presents additional stormwater management concerns.

**Site 9 - Block 34, Lot 12.03, Delaware Township Police and Public Works Yard** — A major stormwater outfall/discharge from County Route 523 occurs adjacent to the Delaware Township Public Works Yard where school buses are parked and maintained, and where the Township Police and Public Works Department offices are located. Retrofit of that site offers an opportunity to mediate runoff from the roadway and concentrated flows from upstream development. The retrofit of the yard is described in

the stormwater mitigation plan for the Township and includes the construction of storage bays for better sediment and pollutant management.

**Site 10 - Sergeantsville Road – Hunterdon County Route 523—Stormwater volume management-**

The current County plans for road improvements include consideration of water quality improvements at stormwater outlets. The Township however has requested that the County also address stormwater volume and quantity management due to the existing flooding problems. In addition, the Township also expressed concerns that road improvements ensure the preservation of the local historic features and character, as well as scenic areas. The Township expressed similar concerns for County Route 604 which is perceived as an important scenic and historic corridor in the Township with several designated historic sites along the route, and the Township has asked for traffic calming for both County Route 604 and 523.

**Section Three- Lower Watershed (to confluence with Wichecheoke)**

The lower watershed is comprised primarily of a single preserved farm. The projects here are intended to serve as a model for what farms can do to improve watershed management. Three wetland ponds, which are in the Rose Brook watershed, are scheduled for completion in the summer of 2008 with NRCS. In addition 30 acres are in the delayed mow LIP program and 10 acres were reseeded to native warm season grasses in 2007.

**Other opportunities**

Additional retrofits might be possible on already-developed and partially-developed properties, including the Bell Flower Farm and Meadow View developments (Block 39, Lot 19 and Block 38, Lots 3 and 26.01) and the parking area at Municipal Hall. The sewage treatment plant is another quasi-public facility but lacks opportunities for storage and infiltration of stormwater. Energy should be focused on stabilizing the stream banks.

Promoting modified farming practices that include contour farming can enhance natural recharge of stormwater runoff, as well as reduce soil erosion, enhance surface water quality, reducing potential impacts to stormwater infrastructure, and reduce stream degradation, such as channel scour or sediment deposition.

Existing stormwater infrastructure, such as detention basins, can also be evaluated to determine if modifications and retrofits can be readily designed and implemented to increase stormwater retention and or recharge within these existing features.

**5.0 RANKING SYSTEM**

The stormwater mitigation measures recommended above are ranked in terms of (1) anticipated mitigation effectiveness, (2) environmental benefits given the magnitude of the flooding concerns, (3) a benefit-cost valuation, and (4) site constraints. Overall, the mitigation measures proposed in the upper watershed should receive priority, as their implementation will be more effective in addressing stormwater runoff and flood mitigation for the Rose Brook watershed, than the mitigation measures proposed in the lower watershed.

**6.0 CONSTRAINTS**

The project constraints that are considered include the following:

- Physical constraints for the different technologies (topography, soil permeability, depth to groundwater, aquifer hydraulic conductivity, encroachments of wetlands, riparian zone, or critical habitat areas, etc.);
- Institutional and public Interest;
- Community support;
- Time to implement;
- Utility management cooperation;
- Land owner cooperation, access, and viable partnership for implementation, as well as long term maintenance and management;
- Permitting requirements;
- Anticipated costs and funding means; and
- Ability to implement long-term monitoring and assess progress.

## **7.0 POTENTIAL FUNDING MECHANISMS**

The Township Stormwater Committee will investigate a variety of possible funding sources that include, but are not limited to:

### **Federal 319(h) Watershed Program**

The NJDEP CWA 319(h) grant funds are available for implementation projects on public lands or private lands under a Conservation Easement restriction. This funding limitation may help prioritize demonstration projects on municipal, county or state owned lands such as the Firehouse, Public Works Yard, school sites, and parklands.

The New Jersey Water Supply Authority (NJWSA) is completing a 319(h) Watershed Protection Plan for the Lockatong and Wickecheoke Creek Watersheds. The Stormwater Committee will coordinate with the NJWSA to see that the results from this study are incorporated into the plan, adding to the potential sources of grant funding from the 319(h) program.

### **Lower Delaware River Wild and Scenic Management Committee ~ 2009 Management Grant Program**

The Lower Delaware River Wild and Scenic Management Committee has set forth the criteria for their 2009 Management Grant Program. Municipalities that provide clearly stated objectives, clearly describe their need for assistance and support stormwater or watershed management will have the potential for selection of a grant. A short—maximum five (5) page—application will be accepted on a rolling basis as long as information about the applicant’s organization, areas of need, project descriptions and anticipated outcomes, and the proposed allocation of funds are fully described. The grant period must conclude by September 30, 2009.

The proposals must address the Management Plan Goals of water quality, natural and historic resources, recreation, economic development and open space preservation. Specifically, the proposals should address how the proposed project will realize one or more of the goals of the Management Plan, display the sharing of resources and information with other members of the Lower Delaware Wild and Scenic River region, inform of any threats to the watershed, visibly state achievable goals and prove an increase in quality of life in the region, and lastly, specify how the project will help complete the goals of the Management Plan.

### **Center for Watershed Protection ~ Technical Capacity Mini-Grants**

The Center for Watershed Protection (CWP) released a Request for Proposals on September 2, 2008 for their Technical Capacity Mini-Grants. Funding is awarded from the EPA Targeted Watershed Initiative Grant (Cooperative Agreement No. WS-83362101). Grants will be awarded to groups who want to strengthen their knowledge of stormwater and watershed management. These grants would be awarded in both technical assistance and cash. Proposals which contain at least one of the following three criteria will be considered: implement Best Management Practices (BMP) to reduce pollution such as rain gardens or bioretention basins; adding stormwater BMPs in areas lacking such projects; or requests for capacity-building support in the matter of stormwater and watershed management. Such projects could include designing and constructing a bioretention facility, best management practices and watershed restoration techniques. The project should be described fully incorporating objectives, work elements and subtasks.

Similar to the above mentioned Lower Delaware River Wild and Scenic Management Committee ~ 2009 Management Grant Program the CWP grant application must describe how the project meets at least two (2) of the Management Plan Goals. Further information should be included to state additional activities that are being or have been done to support the Management Plan and well as other grants currently underway.

Two (2) letters of support for the project, a detailed project budget (including total costs, in-kind funding and in-kind volunteer/professional hours), and a description of how the proposed project(s) will enhance the goals of the Management Committee Plan must be included in the application.

### **USDA – NRCS Grant Programs**

In other watersheds throughout New Jersey Natural Resources Conservation Service (NRCS) funding for landowners has been utilized to implement best management practices on private lands and agricultural lands. Grant funding is also available from the NRCS for restoration projects for public and private landowners through programs sponsored by the NRCS, in partnership with the North Jersey Resource Conservation & Development Council (North Jersey RC&D), Rutgers Cooperative Extension, the County Soil Conservation Districts, and the NJ Department of Agriculture. Some of these programs are highlighted below and can be reviewed at: <http://www.nj.nrcs.usda.gov/programs/>

- Conservation Reserve Enhancement Program (CREP)
- Conservation Reserve Program (CRP)
- Environmental Quality Incentives Program (EQIP)
- Farm and Ranch Land Protection Program (FRPP)
- Grassland Reserve Program (GRP)
- Wetlands Reserve Program (WRP)
- Wildlife Habitat Incentives Program (WHIP)

### **New Jersey Environmental Infrastructure Financing Program**

The New Jersey Environmental Infrastructure Financing Program, which includes New Jersey's State Revolving Fund, provides low interest loans to assist in correction of water quality problems related to stormwater and wastewater management. Other funding mechanisms may include the New Jersey Environmental Infrastructure Trust (for protection to the wastewater treatment plant) and the NJDEP Wetland Mitigation Council (for the regional wetland retention complex).

**Table 1: Potential Flood Mitigation Sites**

<b>Site No.</b>	<b>Site Name</b>	<b>Block</b>	<b>Lot(s)</b>	<b>Lot Area (Acres)</b>	<b>Opportunities</b>	<b>Constraints</b>	<b>Priority Ranking</b>
1	Commercial site	23	11 & 12	1.695	Owner is willing to help.		Med
2	Residential Lot on Route 604	23	7	0.374	Owner is willing to help.		Med
3	Sergeantsville Park	36	14.11	1.498	Township owned. Ample space. Central location.		High
4	Fire House	36	24	1.555	Delaware Township owned.	C-1 buffer on property.	High
5	Residential lot/	36	18	0.415		C-1 buffer on property. Privately owned.	High
6	Preserved agricultural field	34	8	20.248	Ample space. Central location.	C-1 buffer, wetlands and wood turtle habitat. Privately owned.	High
7	Lowland Forest	34	24.01	7.772	Ample space. Central location.	C-1 buffer, wetlands and wood turtle habitat.	Low
8	Rittenhouse Road drainage retrofit			1.373			Med
9	Delaware Twp Police and Public Works Yard	34	12.03	6.468	Delaware Township owned.	C-1 buffer, wetlands and wood turtle on property.	Med
10	Sergeantsville Road - Route 523			5.379	County Roadway	C-1 buffer and wood turtle on property.	High

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## **APPENDICES**

***Appendix A – Maps***

***Appendix B***

***Delaware Township Stormwater Management Plan  
Excerpts From the  
Recommended Stormwater Mitigation Projects***

## The Delaware Township Stormwater Mitigation Plan

The Delaware Township Stormwater Mitigation Plan is set in the context of a larger vision of managing the watersheds of the Township. While the Township is still rural, almost all of the streams exhibit signs of the impact of mismanaged or uncontrolled stormwater runoff, including streambeds incised to bedrock, streambank collapse and instability, and localized flooding. The primary goal of this mitigation plan is to provide several options to applicants who cannot meet one or more of the requirements of the Stormwater Management Plan including soil erosion, water quantity, water quality, or groundwater recharge. The projects identified below represent a sample of the types of projects may be implemented on public and quasi-public lands, starting on Township-owned properties and roadways. Before an applicant selects a project from this list for mitigation, the applicant must meet with the Township, Hunterdon County, Hunterdon Soil Conservation District, and others to determine whether the selected project will satisfy the mitigation requirements. This Plan will continue to evolve over time as data becomes available about the Township's watersheds during this compliance process.

The following is a preliminary list of mitigation options:

- Retrofit of the Delaware Township School Detention Basin
- Retrofit of Dilts Park Drainage
- Retrofit of the Township Maintenance Area
- Retrofit of the Sergeantsville Firehouse Site
- Riparian Forest Replanting Program
- Lower Creek Road Wetland Impoundment
- Pine Hill Road Culvert Retrofit
- Roadside Forest Buffer Protection Program

### **Option #1 – Retrofit of the Delaware Township School Stormwater Detention Basin and Installation of Rain Barrels and Water Gardens**

**Problem:** The existing detention structure at the School does not provide water quality treatment or infiltration. Both of these elements are emphasized in the new stormwater management rules. Although the current basin is functioning properly, retrofits might be considered to serve as a demonstration project for the Township that meets the current stormwater guidelines. The detention structure at the school is located in the Headquarters Tributary of the Third Neshanic River HUC14.

**Solution:** The existing basin could be converted to a bioretention basin or wet pond to provide water quality improvements to meet the current regulations as well as additional infiltration. Rain barrels and water gardens could also be used to meet infiltration requirements immediately around the existing building.

**Opportunities:** This site is highly visible and will serve as an excellent demonstration of both water quality improvement and habitat management. The students can be involved in the design as well as the implementation for a very interactive learning program that helps meets the education requirements of the NJPDES permit.

**Constraints:** Minimal. The Township of Buckingham in Pennsylvania recently retrofitted a retention basin behind the municipal building off Route 413 in order to provide habitat as well as improve water quality. The conversion has been very successful and has sparked further efforts on adjacent Township land.

### **Option #2 – Retrofit of Dilts Park Stormwater Drainage with Rain Gardens and the Implementation of Native Landscape BMPs**

**Problem:** Dilts Park is located at the vulnerable headwaters of several tributaries to Alexauken Creek. The site is presently managed conventionally with turf grass. The turf grass is being mowed to control the deer tick population for the public health of those who use the park. Conventional use of fertilizers, lime, and pesticides may lead to long-term water quality problems in the Alexauken Creek. Dilts Park is located in the Alexauken Creek HUC14.

**Solution:** A study may be undertaken into the implementation of riparian forest corridors to manage the runoff generated by the play fields of the Park. Planting grasslands and forest where turf is not essential for playing and walking should be considered.

**Opportunities:** The site is a highly visible area for demonstration projects. It's position, at the headwaters of two tributaries to the Alexauken, although not mapped on the USGS Quadrangle maps is ideal for retrofits.

**Constraints:** The most significant constraint is the limited availability of local expertise and information on managing native landscapes in Delaware Township. Invasive exotic species as well as deer overgrazing require adequate management in order for this type of project to be successful. Further, public health must be carefully considered, as it is a concern to those who utilize the Park.

### **Option #3 – Retrofit the Township Maintenance Yard**

**Problem:** Overall there are several existing measures in place to minimize the potential for spills and leaks at the Township maintenance yard. The fuel tanks have double walls to minimize the likelihood for leaks. Further, road salt is stored in a protected area. However, there are still additional measures that could be implemented to further reduce the likelihood of spills and contamination entering the tributary to the Wickecheoke Creek. This site is within the Wickecheoke Creek below Locktown HUC14.

**Solution:** Potential areas for retrofits should be investigated throughout the maintenance yard. A vegetated swale could be established along the entire downslope perimeter to reduce potential contamination of the creek from stormwater runoff. A bioretention area or a sand filter might intercept and treat the runoff that drains directly from the building. Further, an evaluation of the benefits of spill pads with filtration systems for bus and vehicle fueling may be an option.

**Opportunities:** The likelihood of some potential accidental contamination would be reduced. Sediment management could also be improved.

**Constraints:** The site is heavily used in all seasons making any retrofits difficult to install.

### **Option #4 – Retrofit of the Sergeantsville Fire House**

**Problem:** The Sergeantsville Fire House has a very large and continuous parking area that generates a large volume of runoff. Runoff from the parking area is discharged directly to the storm drain with minimal water quality treatment. A large roof area also contributes to the runoff volume, as does the adjacent open field area. The Fire House is located in the Wickecheoke below Locktown HUC14.

**Solution:** The Fire House is an excellent place to demonstrate the use of rain barrels to collect runoff from the roof. The use of infiltration devices to minimize surface runoff to the road from the parking area should be considered. Field drainage might be better managed before reaching the inlets below the parking lot. The existing planting box could be reconfigured as a rain garden bio-retention area. Similarly, the planting beds on the upper tier of the parking lot can be reconfigured to accommodate runoff if the gravel area is reworked. Potentially underground basins might serve to provide additional water quantity control from the parking lot.

**Opportunities:** The area of parking and impervious cover is large so the reduction in runoff discharged could be significant. The site is highly visible and could include permanent educational exhibits.

**Constraints:** The functional uses of the Fire House require both expansive parking and relatively unconstrained movement of vehicles. The existing grading and paving are not conducive to a simple retrofit. The sites uses are unpredictable and vary from day to day making site work phasing difficult.

### **Option #5 – Establishment of Riparian Corridor Forests on Various Public and Quasi-Public Lands**

**Problem:** Historic farming practices typically cropped as close to the banks of the streams as feasible eliminating many riparian forests. These farming patterns have been carried over to farms now converted to residential subdivision. As such, lawns sometimes exist right up to the stream banks, which can lead to problems with water quality, water quantity, soil erosion and groundwater recharge.

**Solution:** A study of the Township's streams to identify potential locations for replanting riparian forest buffers where they have been eliminated may be beneficial. It has been shown that riparian forests can serve to reduce nutrients and sediments as well as rates and volumes of stormwater runoff. Vegetated buffers can also support infiltration and provide beneficial groundwater recharge.

**Opportunities:** Sites can be prioritized for reforestation. Potentially the reforestation may require cooperation with private landowners. Land conservancies may be able to provide assistance.

**Constraints:** The biggest impediment to riparian planting is the general lack of local expertise in establishing and managing native vegetation; however, this is changing rapidly. Currently, there is one County contractor who specializes in this field, Paul Steinbeiser. Several area institutions such as Bowman's Hill Wildlife Preserve and Rutgers also offer training programs in planting native landscapes.

### **Option # 6 – Lower Creek Road Wetland Impoundment**

**Problem:** The Wickecheoke Creek, like most others in the Township, is already receiving significant quantities of stormwater runoff. As a result, some Township infrastructure, such as Lower Creek Road, and habitat for threatened and endangered species has been damaged.

**Solution:** Beyond limiting future increases in runoff, however, some effort should go to reducing the quantity of stormwater runoff. One potential pilot project is a diversion and impoundment on Lower Creek Road. An investigation into creating a temporary impoundment on property owned by the NJCF upstream of the roadway bottleneck in order to reduce the volume of floodwater in the Wickecheoke would be conducted. During periods of high flow water would be diverted from just upstream to the field across Lower Creek Road. A portion of the former cropland could be converted to either grassland or riparian forest using a combination of berms and shallow excavations to create the temporary impoundment.

**Opportunities:** Due to the porosity of the soil and its location above and adjacent to the stream, this upper floodplain land may provide opportunities for both infiltration as well as flood storage. The area should be partially regraded to increase storage capacity and improve opportunities to create desirable wildlife habitat.

**Constraints:** The cooperation of the NJCF is required, however the habitat opportunities increase that likelihood. It is also in their interest to start to address the roadway problem further downstream as a complete collapse would impact that habitat as well as the road. This solution is only helpful if there are no further increases in runoff diverted to the Wickecheoke Creek, in fact, as well as by regulation. All of

the elements of the Stormwater Management Plan must be in place for this solution to have more than temporary benefits to the stream.

### **Option #7 – Pine Hill Road Culvert Retrofit and Demonstration**

**Problem:** Runoff discharged directly through road culverts onto steep slopes can destabilize the slopes and deliver sediment and contaminants directly to streams. Pine Hill Road lies within the Wickecheoke Creek below Locktown HUC14.

**Solution:** Some modification to the existing culverts at Pine Hill Road may be necessary to ensure slope stability at the outfall. Investigation into alternatives for the existing culverts could be undertaken in an effort to develop a cost effective and environmentally effective solution in steep rocky areas. All solutions, however, are dependent on effectively preventing further increases in stormwater runoff directed to the roadside swales.

**Opportunities:** Acquiring easements and pursuing reforestation may be an option, especially where a change in cover type might alleviate existing problems.

**Constraints:** There are no demonstrated successful solutions to this problem in the area. Some research is necessary beforehand. Good solutions may be difficult to implement within the right-of-way.

### **Option #8 – Roadside Buffer Protection Program**

**Problem:** Road rights-of-way are not always large enough to accommodate alternatives to eventually discharging stormwater runoff via a storm sewer network. Even when the right-of-way is wide enough, historic structures such as stone walls and established vegetation may inhibit right-of-way or road widening for swales.

**Solution:** The Township may consider investigating the possibility of a roadside buffer protection program. In some instances drainage from large unforested agricultural fields could be reduced significantly before reaching the roadway by establishing a vegetated buffer strip. Where successful, this alternative may be substantially less costly than installing a storm sewer system. A forest buffer also would foster infiltration and pollutant and sediment reduction. Because of the long-term investment inherent in planting forest, this program should be considered only where the farmland has been preserved from future development. A temporary program for tall, delayed mow grasslands as buffers should also be considered and evaluated.

**Opportunities:** Considering this program provides an opportunity of looking to solutions beyond the limitation of Township-owned land. The cost might include establishment and monitoring as well as payments for land acquisition.

**Constraints:** Constraints for this program will be determined if the Township decides to implement this mitigation plan at a later date.

***Appendix C – Photos  
Rose Brook Watershed***