

Appendix B

Proposed Implementation Projects

The following projects are proposed to provide reductions in stormwater runoff and pollutant loadings. Each strategy is applicable to the specified location(s) and site-remediation activities to reduce runoff flows and the associated water quality constituent loads. The techniques are conceptual with estimated costs, and require further site assessments for design and implementation details. Italicized projects have immediate watershed-wide applications. Road-Drainage Retrofit projects are listed under Roadside Drainage Design/Retrofit Training as site-specific field demonstrations for each municipality.

- *Roadside Drainage Design/Retrofit Training*
 - Road-Drainage Retrofit, Delaware Township
 - Road-Drainage Retrofit, Franklin Township
 - Road-Drainage Retrofit, Raritan Township
 - Road-Drainage Retrofit, Kingwood Township
- *Targeted Agricultural Assistance Program*
- *Update Stormwater BMP Manual for Soils and Bedrock Conditions in Hunterdon County*
- *Hydrogeologic Study of the Copper, Lockatong, and Wickecheoke Watersheds*
- *River-Friendly Farms Certification*
- **Preservation/Conservation-Land Stormwater Control**
- **Agricultural Runoff Remediation**
- **Bioretention Applications – Recreational Areas and Private/Public Lawns**
- **Delaware Township Municipal-Garage Retrofit**
- **Vehicle Maintenance and Storage Retrofit**
- **Sergeantsville Firehouse Parking-Lot and Municipal Park Retrofits**

Other possible remediation strategies include: public education and outreach through Community-Day presentations, mailings (e.g., flyers or brochures), website information, and other municipal and county programs; restrictions on all-terrain vehicle access to riparian areas; supplementing school curriculums and projects with classroom and in-stream water quality and hydrology classes and presentations; and initiating “Clean-Stream Teams” for creating responsible groups of students and landowners to maintain specific sections of the streams, similar to the “Adopt-A-Highway Program.” Nearly all implementation projects can be initiated during the first year of funding with the exception of the Agricultural Runoff Remediation and the Road-Drainage Retrofit of Pine Hill Road projects that may be cost-prohibitive. The two projects that may have reduced emphasis due to cost could be partitioned to several smaller projects, reducing the up-front cost. Once initiated, each project could be completed within three to four years. The specific funding source(s) for each project needs to be identified and committed prior to initiating the projects.

Cost estimates were derived from similar project designs by Omni Environmental, Inc. for various BMPs proposed in the *Mulhockaway Creek Stormwater Management and Watershed Restoration Plan* (NJWSA, 2007), from the Natural Resources Conservation Service (NRCS), the Hunterdon County

Soil Conservation District (HCSCD), the US Geological Survey (USGS), and the New Jersey Water Supply Authority (NJWSA). Prioritization of the projects was dependent on three factors: Flow/Load-Reduction (or flow protection); Implementation Potential, ability to have the project initiated during the first year of implementation; and Municipal Priority, interest by municipality for project support.

Microsoft Virtual Earth™ and Word™ programs were used to develop illustrations of the aerial extent and conceptual design of each potential remediation project.

Project Name:	Preservation/Conservation Land Stormwater Control	Date: 04/14/2009	Flow/Load-Reduction Priority: High
Location:	Delaware Twp, Block 30, Lot 1, and Kingwood Twp, Block 20, Lot 1	Parcel Size: 147.5 acres, and 71.7 acres	Implementation Potential: High
Remediation Type:	Subsoiling and microtopography		Municipal Priority: High
Issues and Concerns:			
<p>Greater runoff flows from compacted soils, increased impervious cover, and greater intensity storm events have enhanced overland flow. Soils in the watershed are somewhat poorly drained. This situation is exacerbated by decades of agricultural production involving extensive tillage and other field operations. Over time, the soils have become compacted and have lost much of the inherent ability to retain and infiltrate rainwater. Much of the agricultural and former agricultural lands are in grass or grass/forb/brush cover, which controls most soil erosion. However, evidence in the stream corridor suggests that the flow regime is increasing in volume and erosive velocities.</p>			
Existing Condition Based on Field Evaluation:			
<p>Assessments of active croplands throughout the watersheds revealed mostly crop production practices that stabilize soils and prevent erosion. There were, however, erosion problems in the drainage channels along the perimeter of many active, as well as preserved, agricultural fields. Overland flow drains from the fields into these channels, concentrating the flow in the narrow channels and increasing the stream-bank erosion, ultimately depositing the sediment in the main channel. Soils are somewhat poorly drained and compacted from decades of agricultural operations. Block 30, Lot 1 in Delaware Township is a 147.5 acre property in the Lockatong watershed that had been an active crop farm, but sections are now inactive and undergoing succession. This parcel has been preserved through efforts by Delaware Township, NJDEP Green Acres Program, NJ Conservation Foundation, Hunterdon Land Trust Alliance, and NJ Water Supply Authority. Approximately 21 acres of the inactive areas could be retrofitted, as an innovative pilot project, to retain additional stormwater and the associated water quality constituents through vegetative and micro-topographic modifications (Figure A1). Block 20, Lot 1 in Kingwood Township is a 71.7 acre, active crop farm in the Lockatong watershed that has been preserved solely through efforts by Kingwood Township (Figure A2). This parcel could be used to illustrate increased stormwater infiltration through innovations of farming practices to include the periodic fracturing of any plowpan or fragipan.</p>			

Proposed Solutions:

The Delaware Township parcel will incorporate very innovative techniques for decreasing runoff and increasing ground water recharge. Rehabilitation of approximately 21 acres of Conservation Lands (preserved land, formerly agriculture) will improve infiltration, retain stormwater, and improve soil quality through subsoiling (deep single chisel plow), and with the creation of micro-topography and establishment of warm season grasses and woody vegetation. (Includes US Geological Survey (USGS) rainfall and runoff monitoring). Generally, micro-topography is the establishment of random uneven areas within the field in roughly ‘crescent’ shapes, on the contour. The broad intent is to mimic the natural conditions on the surface that may have existed prior to conversion to agriculture.

The Kingwood Township parcel would be used to determine the effectiveness of a subsoiling technique, similar to that used for the micro-topography project, for fracturing the plowpan and any fragipan whereby increasing infiltration and reducing runoff, while mixing organics into the soil. The available project area is approximately 8 acres.

The work should be done using common farm equipment such as moldboard plow, offset disk, or front end loader in order to make the technology economically transferable to other lands, both public and private, in the future. Township DPW, and NJWSA equipment could be used for subsoiling, and for establishing small, temporary berms and weirs to direct and retain runoff for monitoring purposes. Information acquired from this project would be applicable to thousands of acres of preserved lands state-wide.

Anticipated Benefits:

An estimated 40 to 50 percent decrease in runoff, up to 400,000 gallons/acre/yr, with an associated increase in ground water recharge. Up to 0.65 lb/acre/yr and 150 lb/acre/yr reduction in total phosphorus (TP) and total suspended solids (TSS), respectively, could be achieved based on the *NJSW BMP Manual, Appendix C, Sample Municipal Stormwater Management Plan*’s expected loadings of 1.3 lb/acre/year TP and 300 lb/acre/yr TSS for Agricultural. The sediment and flow reductions will increase proportionately as the technique is applied to other Conservation Lands throughout these watersheds and ultimately throughout the State. This technique could also be adapted to commercial lands having the typical condition of smoothed, compacted, high maintenance turf.

Major Implementation Issues:

The project will be applied to a total of 29 acres of public and preserved lands that are in agriculture or recently abandoned from crop production. The host municipality and the preservation partners will have to approve the site locations. This work is anticipated to be completed using common farm equipment, rather than excavating equipment. Soils in the watershed may have some limitations for the tillage and shaping of the land.

Possible Funding Sources: EPA 319(h) through NJDEP, NJWSA, NRCS, USGS, Kingwood Township, Delaware Township

Partners/Stakeholders: Municipal officials, NJDEP, NRCS, USGS, NJCF, Hunterdon County SCD, NJWSA

Task	Description	Estimated Cost ¹
1	Prepare and present concept plan for each site to NJDEP, HCSCD, and municipal officials	\$5,000
2	Site topographic survey, and soils boring and testing (2 sites)	\$52,000
3	Preparation of design plans, permits, and Administrative Report	\$13,000

4	Preparation of Stormwater BMP Maintenance Plan (NJDEP requirement)			\$3,000
5	Installation of BMP retrofits			
	Activity	Unit Cost	Quantity	
	Equipment mobilization/erosion control ²	\$35/foot	1,000	\$35,000
	Installation of 4 continuous-recording discharge measurement stations (2 per site) O&M for 3 years	\$27,800 \$47,400	4	\$300,800
	Installation of precipitation monitors (1 per site) O&M for 3 years	\$2,300 \$6,930	2	\$18,400
	Installation of automatic water sampler (2 per site) O&M for 3 years	\$7,600 \$13,740	4	\$30,400
	Active farm plowing and installation of crescents on inactive farm fields	6,000		\$6,000
	NRCS Technical and Administrative Costs	41,000		\$41,000
	NJWSA Technical and Administrative Costs	22,400		\$22,400
	Vegetative Planting	\$2,500	2	\$5,000
	Closeout and Contingency	7%		\$32,100
Total Installation and Operation Cost				\$491,100
Total Project Cost (50% per site)				\$564,100

¹ Costs were based on estimates by the NRCS and USGS and represent the total for both project sites. USGS will supply automated water quality samplers at no cost. Municipal DPW and/or NJWSA will supply heavy equipment at no cost. NRCS and USGS will seek matching funds, and NJWSA will provide in-kind services up to 50 percent of staff charges.

² Soil disturbance in existing agricultural areas may be partially exempt from the NJ Soil Erosion and Sediment Control Standards.

Figure A1. Delaware Township Block 30, Lot 1. Potential remediation site for runoff controls on preserved inactive farmland.

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Runoff-control crescent locations and orientation for illustrative purposes only

“Control” field

Runoff flow direction

USGS temporary weir and runoff-monitoring station

USGS temporary weir and runoff-monitoring station

50 yds

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Figure A2. Kingwood Township Block 20, Lot 1. Potential remediation site for runoff controls on preserved active farmland.



Project Name:	Agricultural Runoff Remediation	Date: 04/14/2009	Flow/Load-Reduction Priority: High
Location:	Franklin Twp, Block 37, Lots 35, 42, 31.0004	Parcel Size: Approximately 160 acres	Implementation Potential: May be cost-prohibited
Remediation Type:	Bioretention swales, and/or constructed wetland		Municipal Priority: Moderate

Issues and Concerns:

Stormwater runoff from the site is routed to a C1 tributary to Lockatong Creek. Large areas of impervious cover quickly convey stormwater off the site, creating very flashy and increased flows in the Lockatong Creek during storm events. The flow in this tributary contributes a large portion of the total baseflow during dry-weather conditions in the summertime. Loss of recharge, or increased water use may alter the flow regime of the Lockatong Creek. Bacterial and nitrogen levels were more elevated in this section of the project area than any other watershed areas.

Existing Condition Based on Field Evaluation:

The commercial plant production includes more than 118 acres, with a large portion of impervious ground cover: greenhouses, plastic-sheet weed control, and operations buildings. Runoff during storms exits the western edge of the property and flows into a tributary of Lockatong Creek, possibly heated from the dark plastic weed-control sheeting, and carrying nutrients, solids, and any pesticides from routine operations. Neighboring parcels were also active in commercial plant production operations. The total potential runoff from 1.25 inch storms, or less, for the combined parcel areas is approximately 56 million gallons per year. Historically, extreme runoff events have washed potted plants downstream. An estimated total suspended solids (TSS) and total phosphorus (TP) loads are 48,000 and 208 pounds per year, respectively, using the criteria from the *NJSW BMP Manual, Appendix C, Sample Municipal Stormwater Management Plan*. Although water quality data collected during this project had only 6 samples from a site downstream of these activities (L9b, Old Franklin School Road), 3 of the fecal coliform and 4 of the E. coliform values exceeded the 10 percent limits for exceedences. The E. coliform geometric average also exceeded the Surface Water Quality Standard (SWQS). Nitrate was elevated for each of the 4 samples that were collected, with an average concentration of 7.5 mg/l and a maximum loading of approximately 68 lb/day. Two of the 6 samples analyzed for total phosphorus exceeded the 0.1 mg/l SWQS with a maximum loading of approximately 4.5 lb/day. Further sampling should be conducted to identify specific source(s) of contamination.

Proposed Solutions:

Bioretention swales (Option A), 20 feet wide, could be constructed along the side and down-gradient perimeter of each plant-production area to collect stormwater runoff from the impervious areas while providing solids and nutrient retention, as well as reduction of the flow volume through evapotranspiration and infiltration. The design will be dependent on the available area along the perimeter of each impervious area, soil depth and depth to ground water, and topography. Design and maintenance criteria are presented in *New Jersey Stormwater Best Management Practices Manual, Chapter 9.1, Bioretention Systems*. Wetlands (Option B) could be constructed to retain direct and piped runoff at a selected location(s). Design and maintenance criteria are presented in *New Jersey Stormwater Best Management Practices Manual, Chapter 9.2, Standard for Constructed Stormwater Wetlands*. A combination of Plan A and Plan B would provide a more versatile design for siting the stormwater controls (**Figures B1, B2, and B3**). As a third option, an innovative system could be installed to capture, route for irrigation, and reuse stormwater. This type of system would be designed for the specific site and is therefore not included in this proposal. Combinations of the remediation strategies, in addition to assistance from NJRC&DC for River-Friendly Farms, would provide a versatile design for the site characteristics.

Anticipated Benefits:

The NJDEP BMP Design Manual provides pollutant loading values for agricultural areas of 1.3 lbs/acre/year total phosphorus (TP) and 300 lbs/acre/year total suspended solids (TSS). This is equivalent to 208 lbs/yr TP and 48,000 lb/yr TSS for a 160 acre agricultural area. A bioretention swale will retain up to 90 percent of TSS and up to 60 percent of TP, while a constructed wetland will retain up to 90 percent of TSS and 50 percent of TP. The remediation strategy, in available areas between and along the perimeter of each impervious area, should retain runoff from the 1.25 inch rain event, ultimately reducing flashy runoff flows and the associated increase in scour velocity to the Lockatong Creek.

Major Implementation Issues:

Success of this remediation project would require landowner approval of the remediation strategy and maintenance program. A qualified contractor would be selected to construct and maintain the retrofit according to the manufacturer's recommended maintenance program. Costs could inhibit implementation, but could be reduced through prioritization and remediation of critical runoff areas. The potential implementation sites require field inspection to determine appropriate use, other locations may also provide favorable conditions for runoff control(s).

Possible Funding Sources: EPA 319(h) through NJDEP, Private, Conservation Reserve Enhancement Program (CREP), Environmental Quality Incentive Program (EQIP), NJ Environmental Infrastructure Financing Program

Partners/Stakeholders: Franklin Township officials, Hunterdon County SCD, NJDEP, Hunterdon County Agriculture Development Board, NJRC&DC

Task	Description	Estimated Cost ¹
1	Prepare and present concept plan to Hunterdon County SCD, NJDEP, and municipal officials	\$5,000
2	Site topographic survey and soils testing	\$5,000
3	Pre-application meeting with Hunterdon County SCD, NJDEP, and municipal officials. Preparation of design plans and permits.	\$10,000
4	Preparation of Stormwater BMP Maintenance Plan (NJDEP requirement)	\$2,000

5	Installation of BMP retrofits			
	Activity	Unit Cost	Quantity	
	Equipment mobilization/erosion control ²	\$35/foot	4,500	\$157,500
Option A	Construction of bioretention swales/check dams	\$8/foot ²	100,000	\$800,000
	Vegetative Planting	\$2,500	20	\$50,000
	Closeout and Contingency	20%		\$201,500
Total Construction Cost:				\$1,209,000
Total Project Cost:				\$1,231,000
Annual O&M Cost:				\$2,000
Option B	Construction of wetland/bioretention	\$6/foot ²	100,000	\$600,000
	Vegetative Planting	\$2,500	20	\$50,000
	Closeout and Contingency	20%		\$161,500
Total Construction Cost				\$969,000
Total Project Cost				\$991,000
Annual O&M Cost				\$2,000

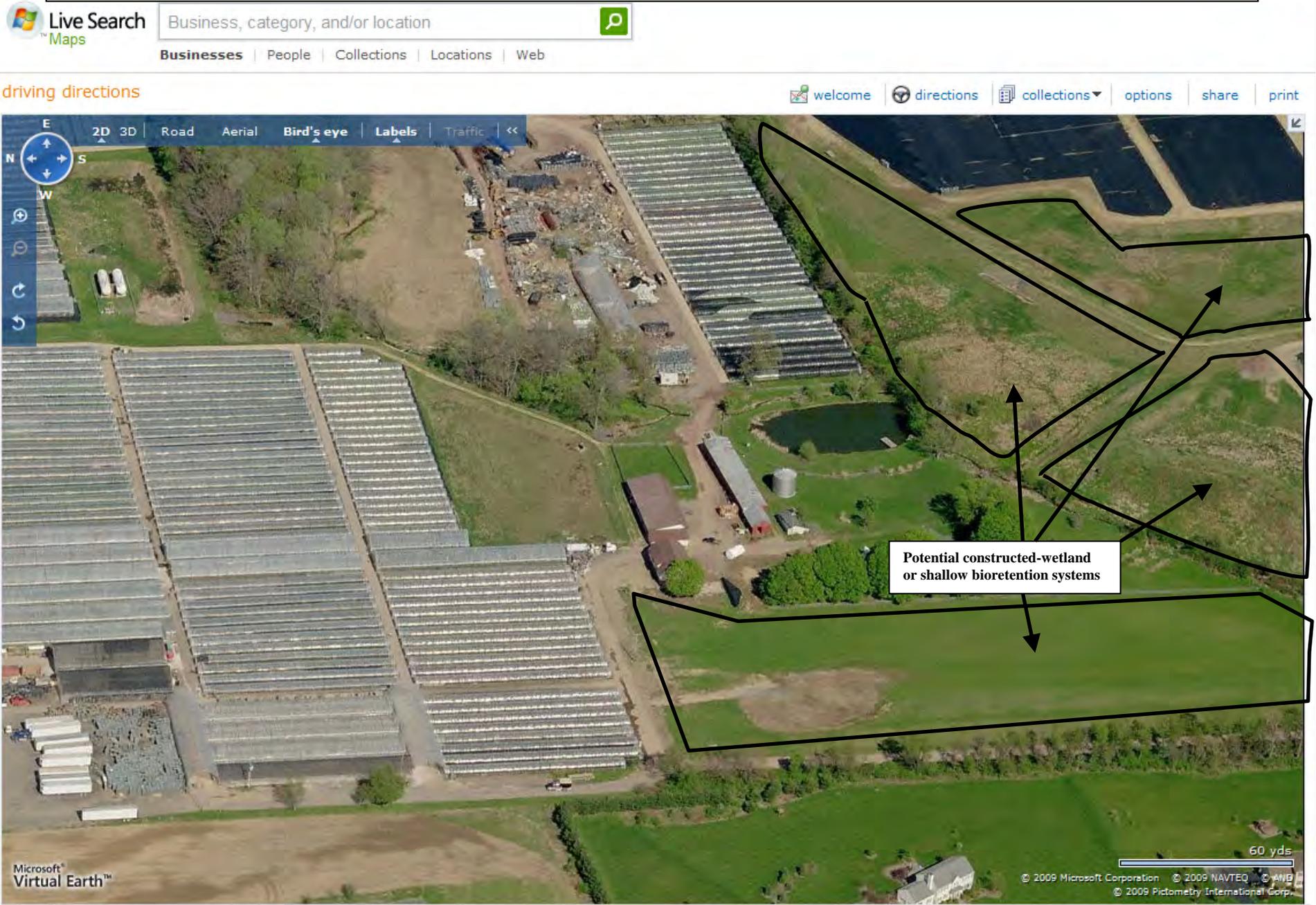
¹ Costs were estimated based on similar designs by Omni Environmental, Inc. for various BMPs proposed in the *Mulhockaway Creek Stormwater Management and Watershed Restoration Plan* (NJWSA, 2007). The project could be partitioned into several smaller projects to offset the overall cost .

² Soil disturbance in existing agricultural areas may be partially exempt from the NJ Soil Erosion and Sediment Control Standards.

Figure B1. Franklin Township Block 37, Lot 42 (southern section). Potential stormwater runoff remediation for agricultural facility.

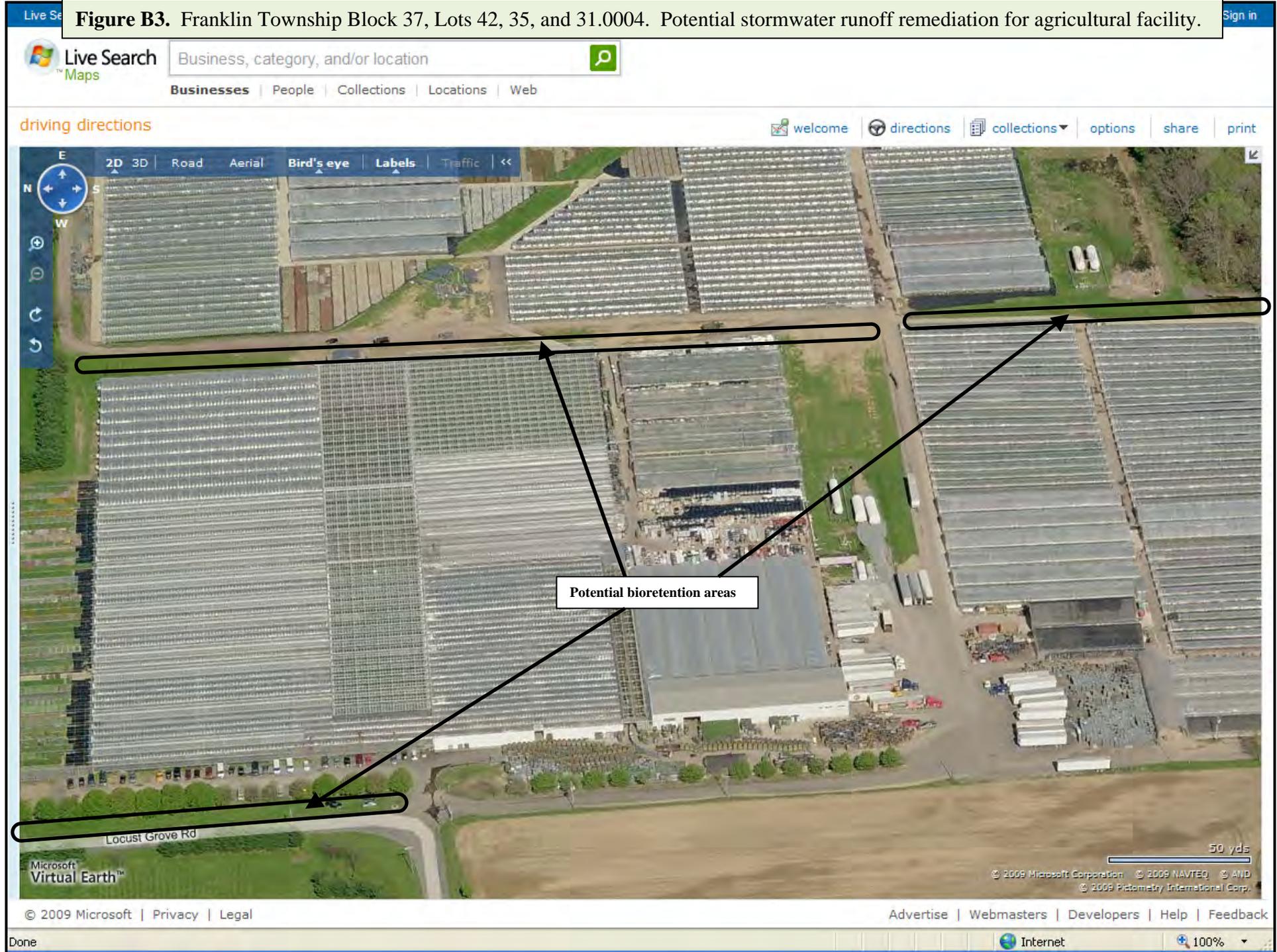


Figure B2. Franklin Township Block 37, Lot 42 (central section). Potential stormwater runoff remediation for agricultural facility.



Potential constructed-wetland or shallow bioretention systems

Figure B3. Franklin Township Block 37, Lots 42, 35, and 31.0004. Potential stormwater runoff remediation for agricultural facility.



Project Name:	Roadside Drainage Design/Retrofit Training	Date: 04/14/2009	Flow/Load-Reduction Priority: High
Location:	Franklin, Kingwood, Delaware, and Raritan Townships, Hunterdon County	Watershed-wide remediation strategy	Implementation Potential: Moderate
Remediation Type:	Bioretention swale, check dam, and subsurface storage/infiltration		Municipal Priority: High

Issues and Concerns:

Incised, steep-sided roadway drainage channels, contribute up to 3,700 tons/year of sediment, via direct erosion and washoff from the road surfaces, to the Lockatong and Wickecheoke creeks. The majority of roads throughout Franklin, Kingwood, Delaware, and Raritan Townships exhibit eroding drainage channels.

Existing Condition Based on Field Evaluation:

Roadside drainage ditches contributing sediment, via erosion, are prevalent throughout both watersheds. Annual clearing of sediment and debris from these channels, by dredging, further destabilizes the channel banks from loss of vegetation, and deepens the ravines causing more confined flow and increased erosive energy. Approximately 139 miles of roads traverse the watersheds, that contribute on an average annual basis 28.8 tons of sediment per mile of paved roads and 93.9 tons of sediment per mile of unpaved roads.

Proposed Solutions:

This proposed project provides innovative road-drainage design and maintenance training for municipal DPW officials and road crews, through classroom and field training, as part of the DPW Manager certification and recertification programs. The Department of Public Works Manager position requires an initial nine courses of training be completed prior to taking the New Jersey State Certified Public Works exam (N.J.S.A.40A:9-154.6b). These courses are all offered through Rutgers University. Courses in the Technical Unit for Operations Resource Management include operations in road maintenance. This course should present the “operations” for installation and maintenance of stable roadway drainage to retain stormwater flow, reduce erosion, and improve water quality, as required by each Municipal Stormwater Management Plan. Every three years the certification must be renewed, requiring 20 contract hours, equivalent to 2 units of continuing education (N.J.S.A.40A:9-154.6h). This would provide another opportunity for reiterating the NJDEP requirements for proper stormwater management and the options for retrofitting roadway drainage designs and existing installations. An annual roadway design and maintenance workshop would be required, as part of the 20 contract hours of continuing education for each Township Department of Public Works Manager, and include the Township Engineer, and road crews. The training would include classroom and hands-on field instruction for drainage-design options, construction and maintenance techniques, and retrofits of existing eroding swales. Proper equipment, frequency of drainage-ravine clearing, and stormwater-storage designs would also be emphasized as part of this training. Hunterdon County Engineering and the Soil Conservation District, and Rutgers University could provide annual training workshops as part of the 20 contract hours of

continuing education, and as a mandatory requirement of the Stormwater Management Rule. Existing stable, and eroding drainage ditches would be used as examples to highlight design criteria for new projects and retrofits to the existing installations. Annual field assessments, guided by the instructors, would be followed by physical remediation of short sections of failing drainage channels. Field training would be presented to each municipality to provide a retrofitted-drainage model in each locality for future reference. The next four proposals are for “Road Drainage Retrofit” projects, one for each municipality, that could be used as potential candidates for field training.

Anticipated Benefits:

This type of training program could be used state-wide, and provide an annual resolve to sections of deteriorating or failing road-drainage channels. The Road-Drainage Retrofit projects that are proposed for each municipality in the following sections could be implemented in conjunction with the training.

Major Implementation Issues:

Implementation is dependent on the available funding to provide on-going annual training, and acceptance by Rutgers and State to modify curriculum to include emphasis on roadway drainage design retrofits. ROW must be available, purchase or easement, from neighboring landowners to provide adequate area for drainage retrofits.

Possible Funding Sources: EPA 319(h) through NJDEP; Hunterdon County; NJ Environmental Infrastructure Financing Program; Franklin, Delaware, Kingwood, and Raritan Townships

Partners/Stakeholders: Franklin, Delaware, Kingwood, and Raritan Townships, Hunterdon County SCD, NJDEP, NJWSA, NJ Environmental Infrastructure Financing Program, Hunterdon County Engineering

Task	Description	Estimated Cost ¹
1	Planning meeting with Rutgers University, HC Engineering, municipal DPW managers, and HCSCD	\$5,000
2	Develop modifications to curriculum and training manual	\$30,000
3	Training-manual publication	\$4,000
	Contingency (20%)	\$7,800
Total Project Cost		\$46,800
Annual Operations Cost		\$2,000

¹ Cost estimates were provided by the Hunterdon County Soil Conservation District.

Existing eroded roadside drain.



Potential retrofit to roadside drain.



Project Name:	Road-Drainage Retrofit, Delaware Township	Date: 04/14/2009	Flow/Load-Reduction Priority: High
Location:	Pine Hill Road, Delaware Township	Roadside drainage length: 400 feet	Implementation Potential: May be cost-prohibited
Remediation Type:	Bioretention swale, enhanced lateral drainage, and wetland		Municipal Priority: Lower (due to cost)
Issues and Concerns:			
<p>Eroded County and municipal roadway drainage channels, contribute up to 3,700 tons/year of sediment, via direct erosion and washoff from the road surfaces, to the Lockatong and Wickecheoke creeks. Pine Hill Road is the largest dirt/gravel road with the steepest grade in the Wickecheoke watershed.</p>			
Existing Condition Based on Field Evaluation:			
<p>Approximately 1.4 miles of this dirt/gravel roadway traverses the steepest road gradients in the Wickecheoke watershed (Figure C1). Some sections of the road approach a slope of 40 percent. Much of the upgradient lawns, fields, and driveways drain to the roadside ditches, supplementing the stormwater runoff from the road. The outflow from the drainage ditches either discharges from elevated outflow pipes onto steep hill slopes, up to 61 percent grade, that convey the runoff directly to Wickecheoke Creek; or it flows along the road and discharges directly to one of two tributaries of Wickecheoke Creek: Plum Brook in the northern section or Cold Run in the southern section. The volume of runoff combined with the erosive velocity from the steep gradients destabilizes the drainage channels and the roadway, increasing loads from sediment, nutrients, and contaminants from vehicles to the streams.</p>			
Proposed Solutions:			
<p>Stormwater piping with inlets, as necessary at roadway intersections, would be installed in road sections that exceed 5 percent slope to minimize, or eliminate, erosion of the drainage channels. The piping would discharge to constructed stormwater wetlands with energy dissipaters in the forebay, or at a minimum, the discharge could terminate at energy dissipaters before entering the stream. Design and maintenance criteria are presented in <i>New Jersey Stormwater Best Management Practices Manual, Chapter 9.2, Standard for Constructed Stormwater Wetlands</i>. Drainage ravines less than 5 percent would be armored with rock and vegetation, and retrofitted where applicable with vegetated swales and gravel check-dams. Swales would be constructed according to design requirements in the <i>NJ Soil Erosion and Sediment Control Standards</i>, wider bottom widths and maximum side slopes of 3:1. Road segments draining laterally through pipes and discharging onto the steep drop to the Wickecheoke Creek, could have additional lateral drainage pipes installed between the existing pipes to disconnect the large volume of flow currently routed to the existing discharge locations. All outflow pipes would be installed or retrofitted to be even with the natural ground surface to eliminate the added force associated with falling water. All existing drainage being routed to the roadside swales should be reduced through public education and installation of bioretention systems (i.e., rain gardens, vegetated swales, and other shallow basins) upgradient of Pine Hill Road. Design and maintenance criteria are presented in <i>New Jersey Stormwater Best Management Practices Manual, Chapter 7, Landscaping</i>; and <i>Rain Garden Manual for New Jersey</i>, by the Native Plant Society of New</p>			

Jersey. Driveway curbing should be eliminated or sequenced with cuts to allow stormwater to flow onto and into the adjacent lawn or woods. These designs are contingent upon width of the ROW easement; soil depth; depth to ground water; and gradient.

Anticipated Benefits:

Although the NJDEP BMP Design Manual does not provide pollutant loading values for roadway or roadside drainage ravines, the NRCS has determined that approximately 105.5 tons/mile/year of sediment is lost from unpaved roads in Delaware Township, or 148 tons/year from an unpaved roadway length of 1.4 miles. Using 30 feet as the road width, this section of roadway would contribute approximately 10.7 lb/year of TP, based on an estimated unit areal load (UAL) of 2.1 lb TP/acre/year for Commercial land use in the *NJSW BMP Manual, Appendix C, Sample Municipal Stormwater Management Plan*. With an assumed 20 percent retention of flow, suspended and dissolved pollutants should also be reduced by 20 percent. For this road section, a reduction of up to 29.6 tons/year and 2.1 lbs/year of sediment and TP loadings, respectively, could be obtained.

Major Implementation Issues:

Implementation is dependent on the width of the available roadway ROW, and the willingness of adjacent landowners to volunteer or sell land, where necessary, for construction of energy dissipaters and/or wetlands. The Delaware Township Committee would have to approve the retrofit. The Township Department of Public Works could perform and/or contract the retrofit, necessary, with a qualified consultant. A Letter-Of-Interpretation (LOI) should be prepared to determine the status of linear wetlands. Permits need to be acquired from the NJDEP for any anticipated land disturbance within 300 feet of any of these C1 streams.

Possible Funding Sources:

EPA 319(h) grant through NJDEP, Delaware Township, NJ Environmental Infrastructure Financing Program

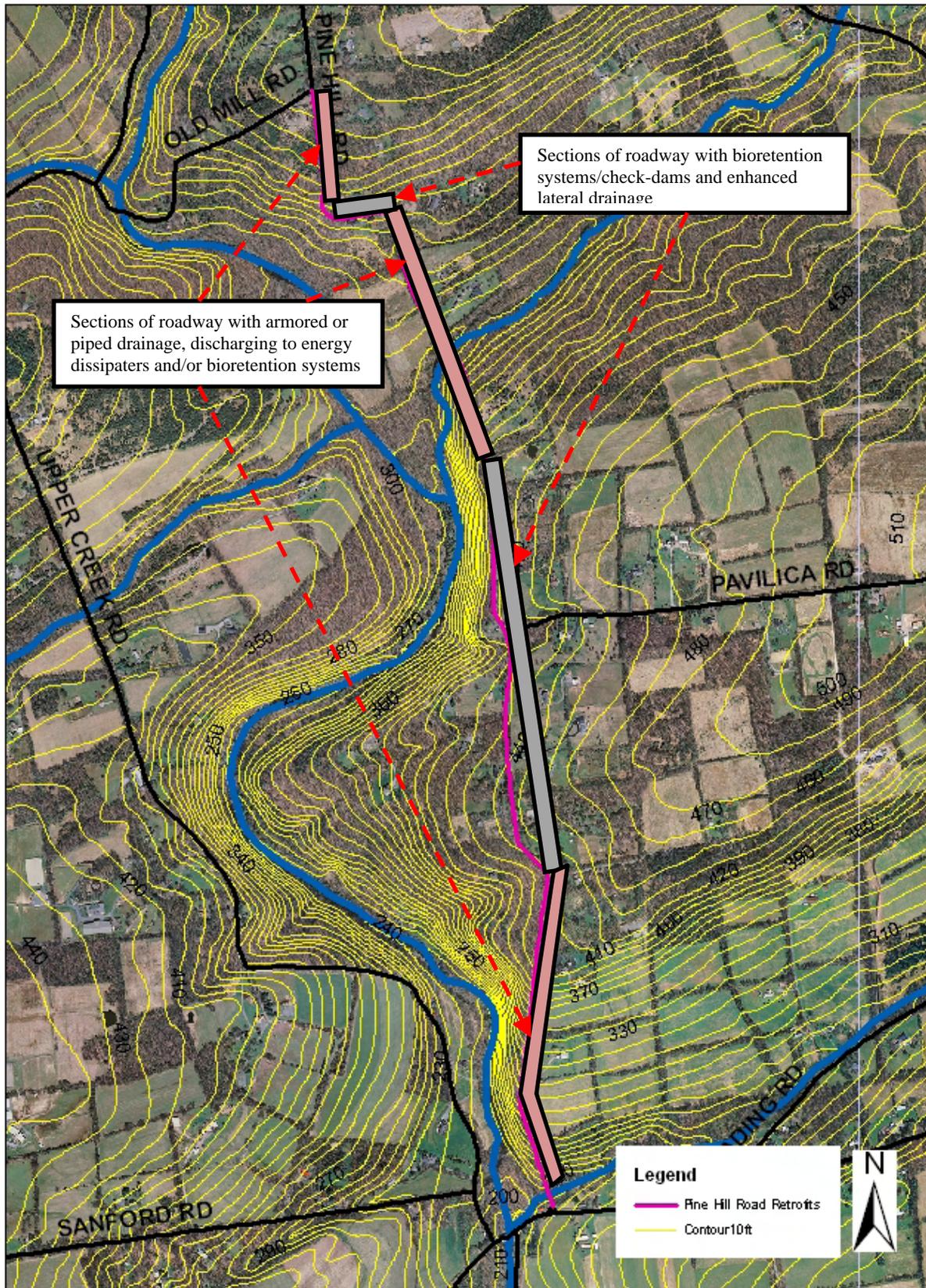
Partners/Stakeholders: Delaware Township DPW and municipal officials, Hunterdon County SCD, NJDEP, Hunterdon County Engineering

Task	Description			Estimated Cost¹
1	Prepare concept plan and present to property management/ownership			\$5,000
2	Pre-application meeting with Hunterdon County SCD and NJDEP. Preparation of design plans and permits.			\$15,000
3	Site topographic survey and soils testing			\$6,000
4	Prepare final design plans			\$5,000
5	Preparation of Stormwater BMP Maintenance Plan (NJDEP requirement)			\$2,000
6	Preparation of construction documents, and solicitation of quotes for contractors and review			\$3,500
7	Installation of BMP retrofits			
	Activity	Unit Cost	Quantity	
	Equipment mobilization/erosion control	\$35/foot	7,000	\$245,000
	Repair of existing drainage pipes	\$50/foot	150	\$7,500
	Construction of bioengineered swales/stone check-dams	\$100/foot	1,250	\$125,000
	Installation of drainage pipe and inlets	\$100/foot	6,300	\$630,000

	Wetland/Bioretenention construction	\$10/foot ²	2,000	\$20,000
	Vegetation Plantings	\$4,000	1	\$4,000
	Closeout and Contingency	20%		\$206,300
Total Construction Cost				\$1,237,800
Total Project Cost				\$1,274,300
Annual O&M Cost				\$1,000

¹ Costs were estimated based on designs by Omni Environmental, Inc. for various BMPs proposed in the *Mulhockaway Creek Stormwater Management and Watershed Restoration Plan* (NJWSA, 2007). Efforts and costs for this project could be divided into separate roadway segments to offset the overall cost.

Figure C1. Delaware Township, Pine Hill Road Potential Roadway Drainage Retrofit

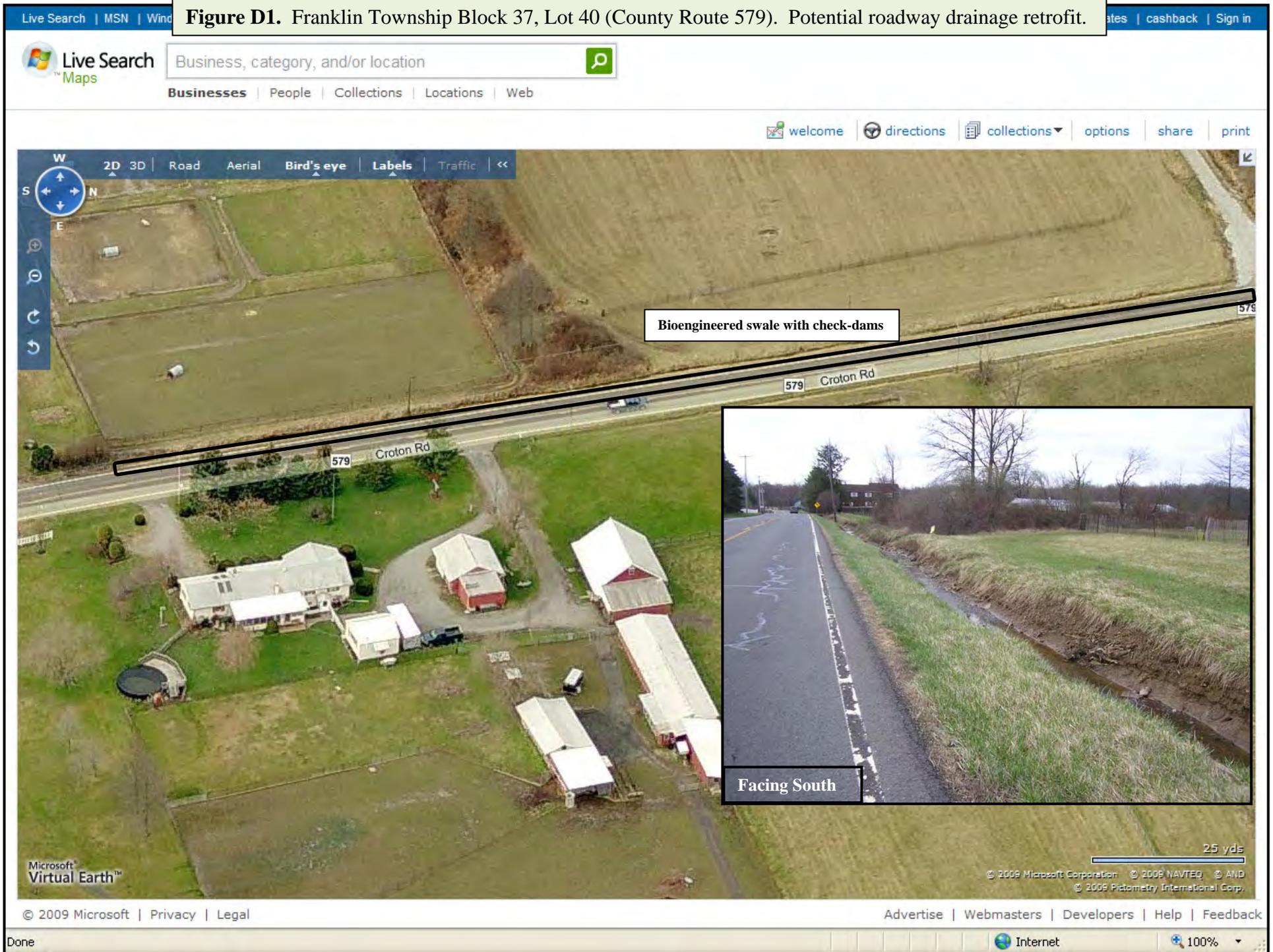


Project Name:	Road-Drainage Retrofit, Franklin Township	Date: 04/14/2009	Flow/Load-Reduction Priority: Moderate
Location:	County Route 579, Franklin Township, Block 49, Lot 40	Roadside drainage length: 500 feet	Implementation Potential: Moderate
Remediation Type:	Bioretention swale and check dams		Municipal Priority: Moderate
Issues and Concerns: Incised, steep-sided roadway drainage channels, contribute up to 3,700 tons/year of sediment, via direct erosion and washoff from the road surfaces, to the Lockatong and Wickecheoke creeks.			
Existing Condition Based on Field Evaluation: Roadside drainage ditches contributing sediment, via erosion, are prevalent throughout both watersheds. Annual clearing of sediment and debris from these channels by dredging further destabilizes the channel banks from loss of vegetation, and deepens the ravines causing more confined flow and increased erosive energy. This proposed project targets approximately 400 feet of roadside drainage along the west side of County Route 579, just south of Oak Grove Road, that is severely eroded and incised.			
Proposed Solutions: A vegetated bioretention swale with intermittently-spaced check-dams would be constructed along the west side of this road section (Figure D1). Design and maintenance criteria are presented in <i>New Jersey Stormwater Best Management Practices Manual, Chapter 9.1, Bioretention Systems</i> . Retrofitting the drainage channel with a crescent shaped cross-section and vegetative cover (additional stone armor where necessary), in addition to check dams, would lessen the scour velocity, retain an estimated 20 percent or more of the flow, and provide shallower water depths to promote evapotranspiration. Swales should be constructed according to design requirements in the <i>NJ Soil Erosion and Sediment Control Standards</i> , wider bottom widths and maximum side slopes of 3:1. Stormwater storage/infiltration could be enhanced by deepening the channel, where possible, and filling the lower section with gravel, and covering with geotextile material, as demonstrated by Hunterdon County Engineering on road drainage swales along Pittstown Road. The design will be dependent on the width of the easement, soil depth, depth to ground water, and gradient.			
Anticipated Benefits: Although the NJDEP BMP Design Manual does not provide pollutant loading values for roadway or roadside drainage ravines, the NRCS has determined that approximately 37.6 tons/mile/year of sediment is lost from paved roads in Franklin Township, or 3.6 tons/year from a paved roadway length of 500 feet. Using 50 feet as the road width, this section of roadway would contribute approximately 1.2 lb/year of TP, based on the NJSW BMP Manual. With a 20 percent retention of flow, suspended and dissolved pollutants should also be reduced by 20 percent. For this road section, up to 0.7 tons/year and 0.2 lbs/year of sediment and TP loadings, respectively, could be reduced.			
Major Implementation Issues: Implementation is dependent on the width of the available roadway ROW. An additional ROW easement would require the neighboring landowners' approval for an easement, or land purchase. The retrofit would require approval from Hunterdon County Engineering. A Letter-Of-Interpretation (LOI) should be prepared to determine wetlands status.			

Possible Funding Sources: Hunterdon County Engineering, NJ Environmental Infrastructure Financing Program				
Partners/Stakeholders: Hunterdon County Engineering, Franklin Township, Hunterdon County SCD, NJDEP				
Task	Description			Estimated Cost¹
1	Pre-application meeting with Hunterdon County SCD. Preparation of design plans and permits.			\$5,000
2	Preparation of Stormwater BMP Maintenance Plan (NJDEP requirement)			\$2,000
3	Preparation of construction documents, and solicitation of quotes for contractors and review			\$2,500
4	Installation of BMP retrofits			
	Activity	Unit Cost	Quantity	
	Equipment mobilization/erosion control	\$35/foot	500	\$17,500
	Repair of existing drainage pipes	\$50/foot	100	\$5,000
	Construction of bioengineered swales/stone check dams	\$100/foot	500	\$50,000
	Vegetation Plantings	\$4,000	1	\$4,000
	Closeout and Contingency	20%		\$15,300
Total Construction Cost				\$91,800
Total Project Cost				\$101,300
Annual O&M Cost				\$1,000

¹ Costs were estimated based on designs by Omni Environmental, Inc. for various BMPs proposed in the *Mulhockaway Creek Stormwater Management and Watershed Restoration Plan* (NJWSA, 2007).

Figure D1. Franklin Township Block 37, Lot 40 (County Route 579). Potential roadway drainage retrofit.



Project Name:	Road-Drainage Retrofit, Raritan Township	Date: 04/14/2009	Flow/Load-Reduction Priority: Moderate
Location:	Goose Island Road, just east of County Route 579, Raritan Township, Block 21, Lots 2.0001 and 2.0002	Roadside drainage length: 650 feet	Implementation Potential: Moderate
Remediation Type:	Bioretention swale and check-dams		Municipal Priority: Moderate
Issues and Concerns: Incised and eroded roadway drainage channels, contribute up to 3,700 tons/year of sediment, via direct erosion and washoff from the road surfaces, to the Lockatong and Wickecheoke creeks.			
Existing Condition Based on Field Evaluation: Annual clearing of sediment and debris from this roadside channel by dredging further destabilizes the channel from loss of vegetation, and increases the depth of the ditch causing more confined flow and increased erosive energy. This proposed project targets approximately 400 feet of roadside drainage along the south side of Goose Island Road, just east of County Route 579, that contributes sediment loads to a tributary of Wickecheoke Creek, designated as C1.			
Proposed Solutions: A vegetated bioretention swale with intermittently-spaced check-dams (if warranted) would be constructed along the west side of this road section (Figure E1). Design and maintenance criteria are presented in <i>New Jersey Stormwater Best Management Practices Manual, Chapter 9.1, Bioretention Systems</i> . Retrofitting the channel with a crescent-shaped cross-section and vegetative cover (additional stone armor where necessary), in addition to check dams, would lessen the scour velocity, retain an estimated 20 percent or more of the flow, and provide shallower water depths to promote evapotranspiration. Swales should be constructed according to design requirements in the <i>NJ Soil Erosion and Sediment Control Standards</i> , wider bottom widths and maximum side slopes of 3:1. Stormwater storage/infiltration can be enhanced by deepening the channel, where possible, and filling the lower section with gravel, and covering with geotextile material, as demonstrated by Hunterdon County Engineering on road drainage swales along Pittstown Road. The design will be dependent on the width of the ROW easement, soil depth, depth to ground water, and gradient.			
Anticipated Benefits: Although the NJDEP BMP Design Manual does not provide pollutant loading values for roadway or roadside drainage ravines, the NRCS has determined that approximately 27.4 tons/mile/year of sediment is lost from paved roads in Raritan Township, or 3.4 tons/year from a paved roadway length of 650 feet. Using 30 feet as the road width, this section of roadway would contribute approximately 0.9 lb/year of TP, based on an estimated unit areal load (UAL) of 2.1 lb TP/acre/year for Commercial land use in the NJSW BMP Manual. With a 20 percent retention of flow, suspended and dissolved pollutants should also be reduced by 20 percent. For this road section, up to 0.7 tons/year and 0.2 lbs/year of sediment and TP loadings, respectively, could be reduced.			

Major Implementation Issues:				
Implementation is dependent on the width of the available roadway ROW. An additional ROW easement would require the neighboring landowners' approval, or land purchase. The Raritan Township Committee would have to approve the retrofit. The Township Department of Public Works would perform the retrofit with assistance, as required, from a qualified consultant. A Letter-Of-Interpretation (LOI) should be processed to determine the status of linear wetlands.				
Possible Funding Sources:				
EPA 319(h) grant through NJDEP, Raritan Township, NJ Environmental Infrastructure Financing Program				
Partners/Stakeholders: Raritan Township DPW and municipal officials, Hunterdon County SCD, NJDEP				
Task	Description			Estimated Cost¹
1	Pre-application meeting with Hunterdon County SCD. Preparation of design plans and permits.			\$5,000
2	Preparation of Stormwater BMP Maintenance Plan (NJDEP requirement)			\$2,000
3	Preparation of construction documents, and solicitation of quotes for contractors and review			\$2,500
4	Installation of BMP retrofits			
	Activity	Unit Cost	Quantity	
	Equipment mobilization/erosion control	\$35/foot	650	\$22,750
	Repair of existing drainage pipes	\$50/foot	50	\$2,500
	Construction of bioengineered swales and stone check-dams	\$100/foot	650	\$65,000
	Closeout and Contingency	20%		\$18,050
Total Construction Cost				\$108,300
Total Project Cost				\$117,800
Annual O&M Cost				\$1,000

¹ Costs were estimated based on designs by Omni Environmental, Inc. for various BMPs proposed in the *Mulhockaway Creek Stormwater Management and Watershed Restoration Plan* (NJWSA, 2007).

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Figure E1. Raritan Township Block 21, Lots 2.0001 and 2.0002 (Goose Island Road). Potential roadway drainage retrofit.

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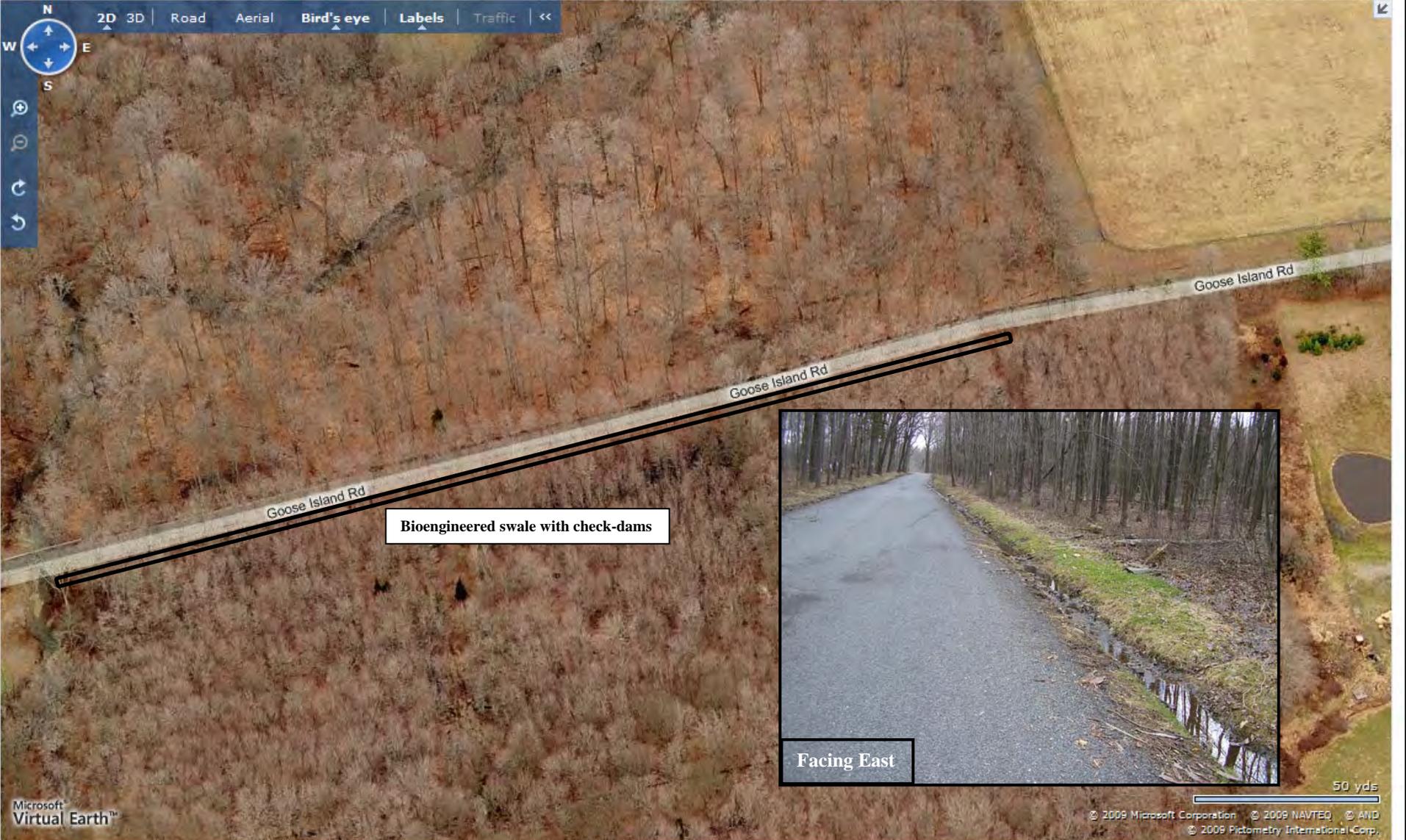


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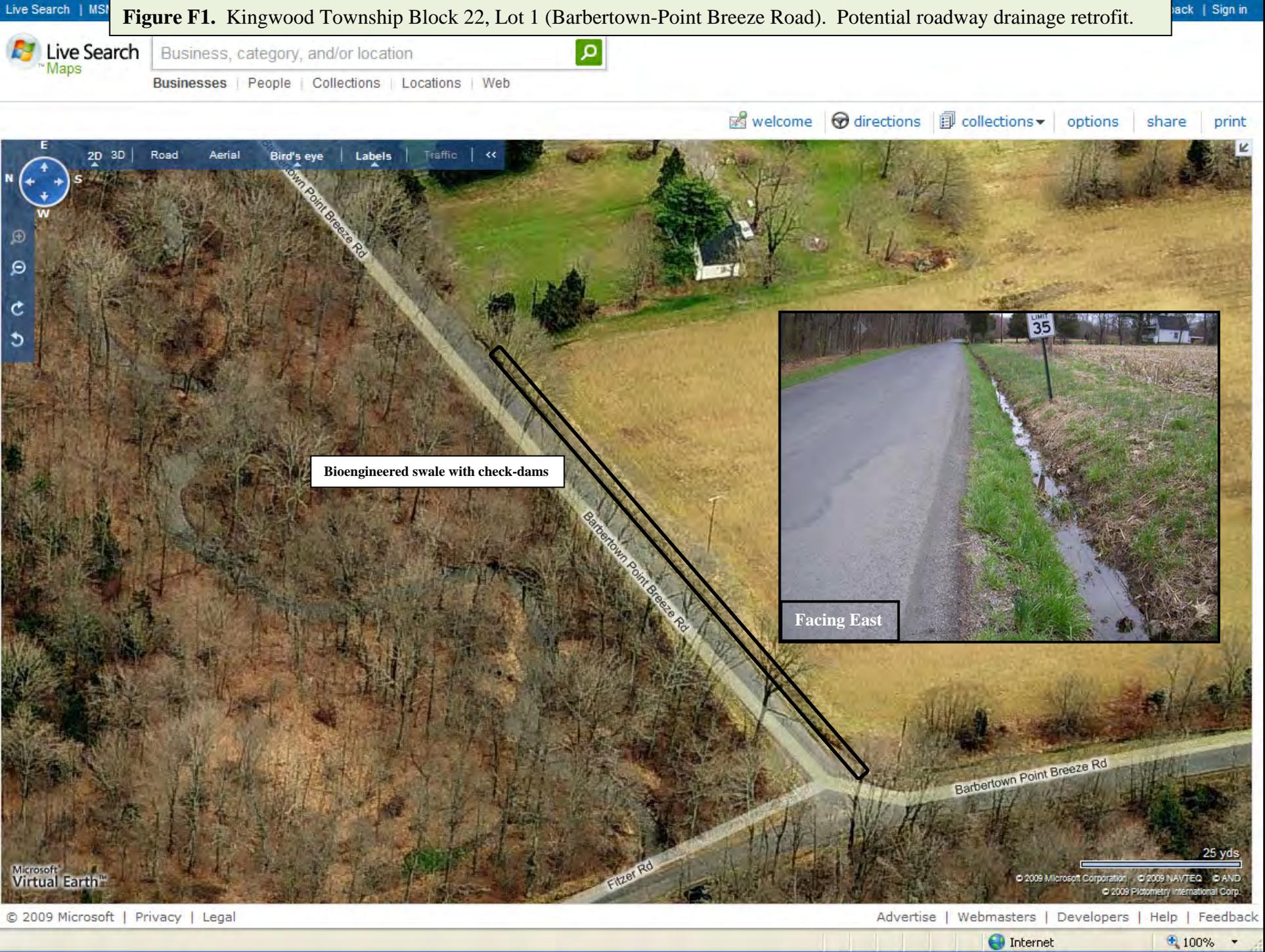
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Project Name:	Road-Drainage Retrofit, Kingwood Township	Date: 04/14/2009	Flow/Load-Reduction Priority: Moderate
Location:	Barbertown-Point Breeze Road, just east of Fitzer Road intersection, Kingwood Township, Block 22, Lot 1	Roadside drainage length: 350 feet	Implementation Potential: Moderate
Remediation Type:	Bioretention swale and check-dams		Municipal Priority: Moderate
Issues and Concerns: The Natural Resources Conservation Service has reported that incised and eroded roadway drainage channels contribute up to 3,700 tons/year of sediment, via direct erosion and washoff from the road surfaces, to the Lockatong and Wickecheoke creeks.			
Existing Condition Based on Field Evaluation: Annual clearing of sediment and debris from this roadside channel by dredging further destabilizes the channel from loss of vegetation, and increases the depth of the ditch causing more confined flow and increased erosive energy. This proposed project targets approximately 350 feet of roadside drainage along the south side of Barbertown-Point Breeze Road, just east of the Fitzer Road intersection, that contributes sediment loads to Muddy Run, a tributary of Lockatong Creek, designated as C1.			
Proposed Solutions: A vegetated bioretention swale with intermittently-spaced check-dams (if needed) would be constructed along the south side of this road section (Figure F1). Design and maintenance criteria are presented in <i>New Jersey Stormwater Best Management Practices Manual, Chapter 9.1, Bioretention Systems</i> . Retrofitting the channel with a crescent shaped cross-section and vegetative cover (additional stone armor where necessary), in addition to check dams, would lessen the scour velocity, retain an estimated 20 percent or more of the flow, and provide shallower water depths to promote evapotranspiration. Swales should be constructed according to design requirements in the <i>NJ Soil Erosion and Sediment Control Standards</i> , wider bottom widths and maximum side slopes of 3:1. Stormwater storage/infiltration could be enhanced by deepening the channel and filling the lower section with gravel, and capping with geotextile material. The design will be dependent on the width of the ROW easement, soil depth, depth to ground water, and gradient.			
Anticipated Benefits: Although the NJDEP BMP Design Manual does not provide pollutant loading values for roadway or roadside drainage ravines, the NRCS has determined that approximately 28 tons/mile/year of sediment is lost from paved roads in Kingwood Township, or 1.9 tons/year from a paved roadway length of 350 feet. Using 30 feet as the road width, this section of roadway would contribute approximately 0.5 lb/year of TP, based on an estimated unit areal load (UAL) of 2.1 lb TP/acre/year for Commercial land use (NJ BMP Manual). With a 20 percent retention of flow, suspended and dissolved pollutants should also be reduced by 20 percent. For this road section, a reduction of up to 0.4 tons/year and 0.1 lbs/year of sediment and TP loadings, respectively, could be obtained.			

Major Implementation Issues: Implementation is dependent on the width of the available roadway ROW. Expansion of the ROW easement would require the neighboring landowners' approval, or land purchase. The Kingwood Township Committee would have to approve the retrofit. The Township Department of Public Works would perform the retrofit with assistance, as required, from a qualified consultant. A Letter-Of-Interpretation (LOI) should be processed to determine the status of linear wetlands.				
Possible Funding Sources: EPA 319(h) grant through NJDEP, Kingwood Township, NJ Environmental Infrastructure Financing Program				
Partners/Stakeholders: Kingwood Township DPW and municipal officials, Hunterdon County SCD, NJDEP				
Task	Description			Estimated Cost¹
1	Pre-application meeting with Hunterdon County SCD. Preparation of design plans and permits.			\$5,000
2	Preparation of Stormwater BMP Maintenance Plan (NJDEP requirement)			\$2,000
3	Preparation of construction documents, and solicitation of quotes for contractors and review			\$2,500
4	Installation of BMP retrofits			
	Activity	Unit Cost	Quantity	
	Equipment mobilization/erosion control	\$35/foot	350	\$12,250
	Repair of existing drainage pipes	\$50/foot	100	\$5,000
	Construction of bioengineered swales/stone check-dams	\$100/foot	350	\$35,000
	Closeout and Contingency	20%		\$10,450
Total Construction Cost				\$62,700
Total Project Cost				\$72,200
Annual O&M Cost				\$1,000

¹ Costs were estimated based on designs by Omni Environmental, Inc. for various BMPs proposed in the *Mulhockaway Creek Stormwater Management and Watershed Restoration Plan* (NJWSA, 2007).

Figure F1. Kingwood Township Block 22, Lot 1 (Barbertown-Point Breeze Road). Potential roadway drainage retrofit.



Project Name:	Targeted Agricultural Assistance Program	Date: 04/14/2009	Flow/Load-Reduction Priority: High
Location:	Franklin, Kingwood, Delaware, and Raritan Townships, Hunterdon County	Watershed-wide remediation strategy	Implementation Potential: High
Remediation Type:	Nutrient management plans and integrated-pest management services		Municipal Priority: High

Issues and Concerns:

Agriculture operations will continue to be a significant portion of the land use in the Lockatong and Wickecheoke Creek Watersheds and serve to maintain the rural character of the communities. However, these operations can contribute to the problems in the watersheds, including erosion, bacterial contamination, localized nutrient enrichment and increased stream temperatures. Erosion from agricultural operations results from non-conservation plowing, lack of riparian buffers, animals with direct access to the stream and/or over-grazing of pastures. Bacterial contamination is commonly caused by animal feces directly deposited in the stream, or poor manure management (storage or use as fertilizer). Nutrient enrichment can occur from poorly applied manure or over-application of fertilizers. Increased stream temperatures from agricultural areas are typically the result of poor riparian buffers and exposure of the stream to sunlight. The New Jersey Water Supply Authority (NJWSA) and Hunterdon County Soil Conservation District (HCSCD) have identified locations where animals have direct access to the stream and the riparian buffer is too narrow, in poor condition, or non-existent.

Existing Condition Based on Field Evaluation:

The Lockatong and Wickecheoke Creeks have violations of water quality standards for total phosphorus, pH, temperature, and bacteria. Animals have direct access to the stream in many locations and the riparian buffer is sparse in places. Since 2000, the streams have consistently had violations of the total phosphorus water quality standard. While the turbidity and total suspended solids concentrations are well below water quality standards during low to moderate flow conditions, they exceed water quality standards during wet-weather runoff events. Visual inspection of the streams demonstrate the significant sediment and erosion processes occurring in stream channels throughout the watershed.

Through provision of Integrated Crop Management (ICM) Services, HCSCD has uncovered several prevalent trends in the County. Many continually farmed tracts are over limed with pH levels above optimum while others required lime, indicating that lime is applied without evaluation of its necessity for crop production. Optimizing pH levels maximizes nutrient availability and crop growth, while reducing the amount of nutrients in runoff. Balanced nutrient levels reduce nutrient runoff by maximizing crop growth. Phosphorus is usually found at or above optimal levels, but farmers still apply fertilizers that contain it. Manure is often applied without a soil test and without knowledge of the soil's and/or crop's ability to incorporate the nutrients. Use of pesticides is typically based on the presence of a pest or weed rather than the economic and biological damage thresholds.

Proposed Solutions:

A comprehensive Targeted Agricultural Assistance Program is recommended to address agricultural issues in the watershed, particularly those related to erosion management. The program would be implemented by the Hunterdon County Soil Conservation District and voluntary for landowners but provide funding to initiate planning and implementation of efforts to minimize the impacts of agricultural practices on water bodies. The targeted program includes: nutrient management plans, integrated crop management (ICM) services, and an implementation coordinator, using existing farm bill assistance programs. Integration with the “River Friendly Farms” certification program could be possible. Details for each of the programs components are explained below.

- **Nutrient Management Plans:** Hunterdon County Soil Conservation District would be developed for all agricultural operations with two or more animal equivalent units (AEUs). An AEU is 1,000 pounds of live weight of any animal on an annualized basis, meaning the weight can be normalized by the amount of time the animal is present on the property. Nutrient management plans would also be developed for smaller operations where animals (livestock, poultry, canine) are kept within 300 feet of a water body or wetland and a water quality benefit could be realized by such management. Plans would be developed at no cost to the landowner/agricultural operation. Implementation funding would be sought through EQIP and other Farm Bill assistance programs.
- **Integrated Crop Management (ICM) Services:** Hunterdon County Soil Conservation District would work with the agricultural operation to develop an ICM approach to agricultural production on that farm which would include the establishment of thresholds for nutrients, pesticides and herbicides based on soil tests, pest infestation and pest threats. ICM benefits the agricultural operation by optimizing production and eliminating the overuse of fertilizers and pesticides based on scientific and economic principals and proven agronomic practices.
- **Implementation Coordinator:** Hunterdon County Soil Conservation District would develop an outreach, education and monitoring coordinator position to identify and target high impact operations or locations where water quality benefits can be cooperatively achieved. The coordinator would also publicize the project, elicit participation and document implementation.

Anticipated Benefits:

The ICM Services provided by the HCSCD will educate landowners and tenant farmers about the appropriate amount of manure and/or chemicals to use to maximize their benefit and reduce production costs associated with over-application. Optimizing chemical use will result in better crop uptake and fewer nutrients migrating to the stream. The HCSCD program has already resulted in elimination and reduction of lime, fertilizer and pesticide applications.

Major Implementation Issues:

The success of the Targeted Agricultural Assistance Program will depend largely on the receptiveness of landowners and agricultural operations to participate in the program. In particular, this program will be open to smaller operations, which are not typically the focus of similar programs due to their smaller size. Finding funds to support the program and implementation may also be difficult.

Possible Funding Sources:

EPA 319(h) grant through NJDEP, NJWSA, EQIP and other Farm Bill assistance programs

Partners/Stakeholders:		
Delaware, Kingwood, Raritan, and Franklin Townships; NJDEP; HCSCD; NRCS; NJWSA		
Task	Description	Estimated Cost¹
1	Program management/coordination	\$48,000
2	Preparation of Nutrient Management Plans for 40 farms, or 1,000 acres	\$44,800
3	Integrated Crop Management services (farmer training, and soil assessments for 1,500 acres)	\$112,500
	Contingency (10%)	\$20,500
Total Project Cost		\$225,800
Annual Operation Cost		\$48,000

¹ Proposal and cost estimates were provided by the Hunterdon County Soil Conservation District.

Project Name:	Update Stormwater BMP Manual For Soils and Bedrock Conditions in Hunterdon County	Date: 04/14/2009	Flow/Load-Reduction Priority: High
Location:	Franklin, Kingwood, Delaware, and Raritan Townships, Hunterdon County	Watershed-wide remediation strategy	Implementation Potential: High
Remediation Type:	Increased Stormwater-Control Effectiveness		Municipal Priority: High
Issues and Concerns: Natural soil and bedrock conditions in Hunterdon County, including the Lockatong and Wickecheoke Creek watersheds, create unresolved design and construction limitations for stormwater controls. Seasonally high ground water levels, shallow bedrock with limited and non-homogenous secondary porosity, and clay soils, create conditions that can be inappropriate for many of the recommended BMP designs.			
Existing Condition Based on Field Evaluation: Presently, approximately half of the constructed stormwater basins in the watersheds are seasonally ponded, and can contain water for weeks when underlain with clayey subsoils and shallow bedrock, even during dry summertime conditions.			
Proposed Solutions: Addition of design and structural modifications, and site limitations/requirements, to the recommended stormwater-control techniques to provide more effective stormwater containment and infiltration/evapotranspiration for both residential and commercial properties. Off-site stormwater-routing design requirements should be included in site plans to ensure continuous soil stability enroute to the adjacent stream(s). On-site stormwater controls, such as rain gardens, subsurface storage/infiltration, rain barrels, and others, should be required to minimize the runoff volume from rooftops, parking lots, and driveways that is frequently routed to roadside drainage ravines and streams. Rain-barrel effectiveness is reviewed in: <i>Combined Sewer Overflow Rooftop Type Analysis and Rain Barrel Demonstration Project</i> , Department of Environmental Programs Metropolitan Washington Council of Governments, December 2001. Other watersheds with similar soils and geology would benefit from the BMP amendments.			
Anticipated Benefits: Anticipated benefits include: additional ground water recharge, reduced erosion potential, and reduced mosquito and geese populations by reducing the number and volume of wet stormwater basins. Storm-runoff would be more effectively captured on-site and infiltrated, reducing the downstream runoff volume ultimately associated with higher stream flow volume and contaminant loadings, while increasing baseflows proportionately.			
Major Implementation Issues: Although the revised BMP techniques would be applicable to new development, existing development may require volunteer BMP installations and retrofits. The amended techniques will require acceptance by the NJDEP prior to implementation in municipal site-plan reviews for new development.			

Possible Funding Sources: EPA 319(h) grant through NJDEP, NJ Environmental Infrastructure Financing Program, NJWSA, Municipalities		
Partners/Stakeholders: Delaware, Kingwood, Raritan, and Franklin Townships; HCSCD; NRCS; NJWSA		
Task	Description	Estimated Cost¹
1	Program management/coordination	\$26,000
2	Publication and materials	\$4,000
	Contingency (10%)	\$3,000
Total Project Cost		\$33,000

¹ Proposal and cost estimates were provided by the Hunterdon County Soil Conservation District.

Project Name:	Hydrogeologic Study of the Copper, Lockatong, and Wickecheoke Watersheds	Date: 04/14/2009	Flow Protection Priority: High
Location:	Franklin, Kingwood, Delaware, and Raritan Townships, Hunterdon County	Watershed-wide remediation strategy	Implementation Potential: High
Remediation Type:	Identification of Seasonal Ground Water Flow Characteristics, Recharge Areas, and Potential Sources of Aquifer and Surface Water Contamination		Municipal Priority: High
Issues and Concerns:			
<p>Franklin, Kingwood, and Delaware Townships are entirely dependent on ground water as the sole source of residential drinking water supply as well as a commercial, industrial, institutional and agricultural water supply. Ground water discharge (baseflow) to stream systems in the townships also provides a very significant ecological function particularly during dry-flow/drought periods. Two of the principal stream systems that drain through these three townships (Lockatong and Wickecheoke Creeks) also contribute flow to the Delaware and Raritan Canal which is a significant water supply source in central New Jersey. Fractured bedrock provides an interconnection between the surface and ground water, potentially providing a fast transport of water quality contaminants to wells and streams. The aquifer system has not been studied to identify the magnitude and direction of flow nor the quantity or quality of the water supply. Overuse and contamination of the ground water is known to be influencing the quantity and quality of the stream flow.</p>			
Existing Condition Based on Field Evaluation:			
<p>Boron, which has commonly been associated with pesticides in agricultural practices, has been located in very high concentrations at springs within the Lockatong headwaters. High levels of nitrate concentrations in the streams may also be originating from contaminated ground water from historical livestock operations. Ground water uses, of less than 100,000 gallons per day, in the watersheds do not have limitations on effects to wetland and stream ecology, or potable water supply. Many segments of the Lockatong and Wickechoeke mainstem are dry or losing flow during the dry summertime conditions. Future increases in water uses, without knowledge of the water-supply limitations, would continue to decrease stream baseflows, dilution for point-source pollution, and potable water supplies.</p>			

Proposed Solutions:**Task 1: Well records compilation by watershed and GIS Mapping.**

Well records for the individual watersheds will be compiled and entered into GIS layers for mapping. This will be a very useful resource for individual, commercial and other use applicants for new wells, well replacements, increased water uses, and subdivision applications; consultants; and information for individual residents as well as for Township officials. It will provide a supportive database/tool for the Townships' planning efforts and implementation of ground water protection provisions.

Analyses of the collected data by watershed and geologic units will provide a reference for ground water use in comparison to recharge (GSR 32 and baseflow methods); identify areas and portions of watersheds where ground water use may be in excess of or approaching the threshold of 20% of recharge; and provide a platform for future planning of ground water use in these three watersheds and portions thereof.

Task 2: Groundwater-Level Monitoring Network Development

Ground water level monitoring networks will be developed for the Copper, Lockatong, and Wickecheoke Creek Watersheds. Copper Creek is included in this study to determine the extent of subsurface flow that may be outflowing from the Lockatong Creek watershed into the Copper Creek watershed through a network of fractures. The continuous monitoring of water levels over time will provide an understanding of water-level responses seasonally; during extended wet and dry periods; significant droughts, and long-term trends. A drought-warning target system, based on static water level, can be produced with continuous monitoring. This could initiate voluntary water conservation measures when aquifer levels reach designated elevations.

Task 3: Development of water-level contour maps for the three principal watersheds in the Townships**Task 4: GIS Mapping of geology; principal aquifers; areas of ground water depletion; outflow and inflow to streams; and areas of ground water quality concerns****Task 5: Updated required recharge area using Nitrate Dilution Modeling with the 2.0 mg/l nitrate planning standard****Anticipated Benefits:**

Collectively, these project outputs will fulfill basic data needs and provide a powerful technical support/planning tool that will greatly assist the Townships in pursuing planning and implementing their missions/responsibilities to safeguard and use water resources wisely, optimally, and appropriately for the public benefit. This will provide long-term assurance for protection of stream baseflow and quality.

Major Implementation Issues:			
UBR-M2 Associates Project Team developed this project proposal and do not anticipate any implementation issues. The UBR-M2 Associates Project Team has significant experience in ground water resources development, planning, management, and protection. The Townships have the capacity and ability to provide significant in-kind assistance during the project and there are many water resources professionals residing in the subject Townships.			
Possible Funding Sources: EPA 319(h) through NJDEP, Municipal, NJWSA			
Partners/Stakeholders: Delaware, Kingwood, Franklin, and Raritan Townships; NJWSA; Hunterdon County Health Department; Hunterdon County Planning; Hunterdon County SCD; NJDEP; Contractor			
Task	Description		Estimated Cost¹
1	Data compilation/GIS mapping for Task 1		\$20,000
2	Establish water-level monitoring network for Task 2		\$40,000
3	Development of ground water levels mapping for Task 3		\$40,000
4	GIS mapping for Task 4		\$20,000
5	Nitrate dilution modeling for Task 5		\$20,000
	Closeout and Contingency	20%	\$28,000
Total Project Cost			\$168,000
Annual O&M Cost			\$3,000

¹ Proposal and cost estimates were provided by the URB-M2 Associates Project Team (professional hydrogeologists for the Townships of Kingwood and Delaware).

Project Name:	River-Friendly Farms Certification	Date: 04/14/2009	Flow/Load-Reduction Priority: High
Location:	Franklin, Kingwood, Delaware, and Raritan Townships, Hunterdon County	Watershed-wide remediation strategy	Implementation Potential: Moderate
Remediation Type:	Agricultural Stormwater Controls Education and Implementation		Municipal Priority: High
Issues and Concerns:			
<p>Although agricultural field erosion in the Lockatong and Wickecheoke watersheds is minimal for the existing crop production, sheet flow leaving farm fields becomes concentrated along the perimeter and causes the perimeter drainage ravines to become unstable and erode. In addition, fields next to roads concentrate the runoff flow into roadside drains, increasing erosion. Livestock with access to the streams introduce large quantities of sediment, nutrients, and bacteria.</p>			
Existing Condition Based on Field Evaluation:			
<p>Large volumes of sediment have eroded from stormwater drainage channels along the perimeter of agricultural crop and livestock fields. Livestock have unconstrained egress to the streams at locations in both watersheds for drinking water and wading. Most often, livestock excrement is directly deposited into the stream.</p>			
Proposed Solutions:			
<p>The New Jersey River-Friendly Farms program, administered by the North Jersey Resource Conservation and Development Council (NJRC&DC), helps to protect water resources by promoting good farm management practices. This program would be introduced to those farms that may be contributing large volumes of runoff flow and/or have livestock access to the streams, to educate and promote the protection of stream water quality and flow while maintaining productive farmland.</p>			
Anticipated Benefits:			
<p>The erosion from stream channels was estimated by the NRCS to contribute up to 12,300 tons of sediment per year for the combined watersheds. Approximately 10 percent of this load (1,230 tons/year) could be originating from erosion along the perimeter of the fields and livestock-access areas. The associated in-stream annual total phosphorus load could potentially approach 6.8 tons/year. Education gained from certification will provide conservation options for the farmers for stream corridor and stormwater controls. Once certified, signage placed along the road frontage to the farm would promote conservation to other farmers and residents. The program may be adopted by municipal Environmental Commissions to provide additional resources for agricultural- conservation education. Figures G1 and G2 show locations of potential candidates for this program based on field observations in the Lockatong and Wickecheoke watersheds, respectively.</p>			

Major Implementation Issues:		
Farmers must be contacted and agree to adopt the management measures for certification. Although the NJRC&DC River-Friendly Farms Program currently targets the Raritan River basin, it could be expanded to provide certification to farms in the Lockatong and Wickecheoke Creek watershed areas.		
Possible Funding Sources: EPA 319(h) through NJDEP, NJRC&DC, NJWSA, EQIP, Private		
Partners/Stakeholders: Delaware, Kingwood, Franklin, and Raritan Townships; Hunterdon County SCD, NJDEP, NJWSA, NJRC&DC		
Task	Description	Estimated Cost¹
1	Certification of an initial 16 farms (identified in Figures G1 and G2)	\$24,000
2	Certification of 30 additional farms	\$45,000
3	Outreach	\$4,400
Total Project Cost		\$73,400

¹ Costs were derived from previous projects by NJWSA and NJRC&DC.

Figure G1. Potential sites for “River Friendly Farm” certifications in the Lockatong watershed.

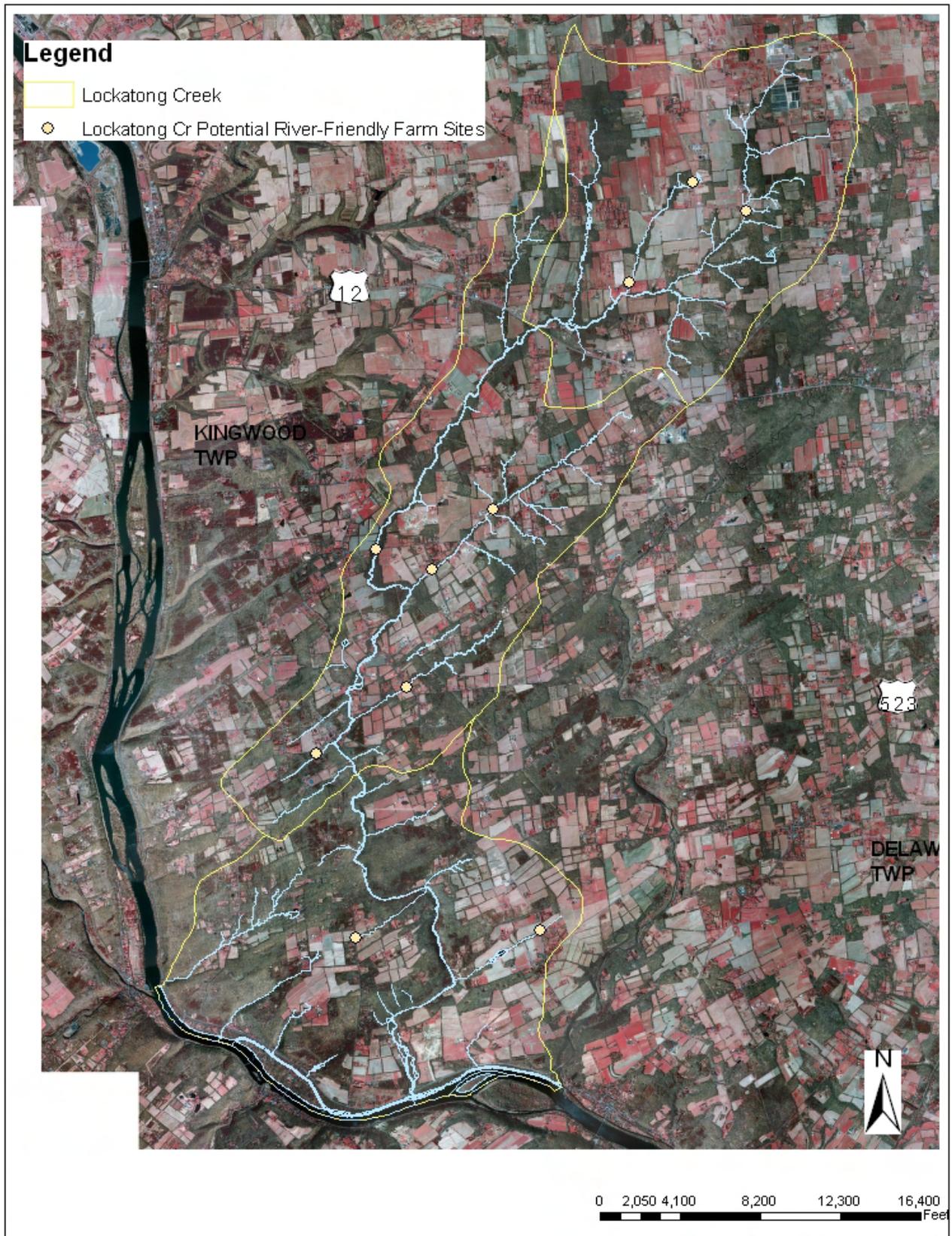
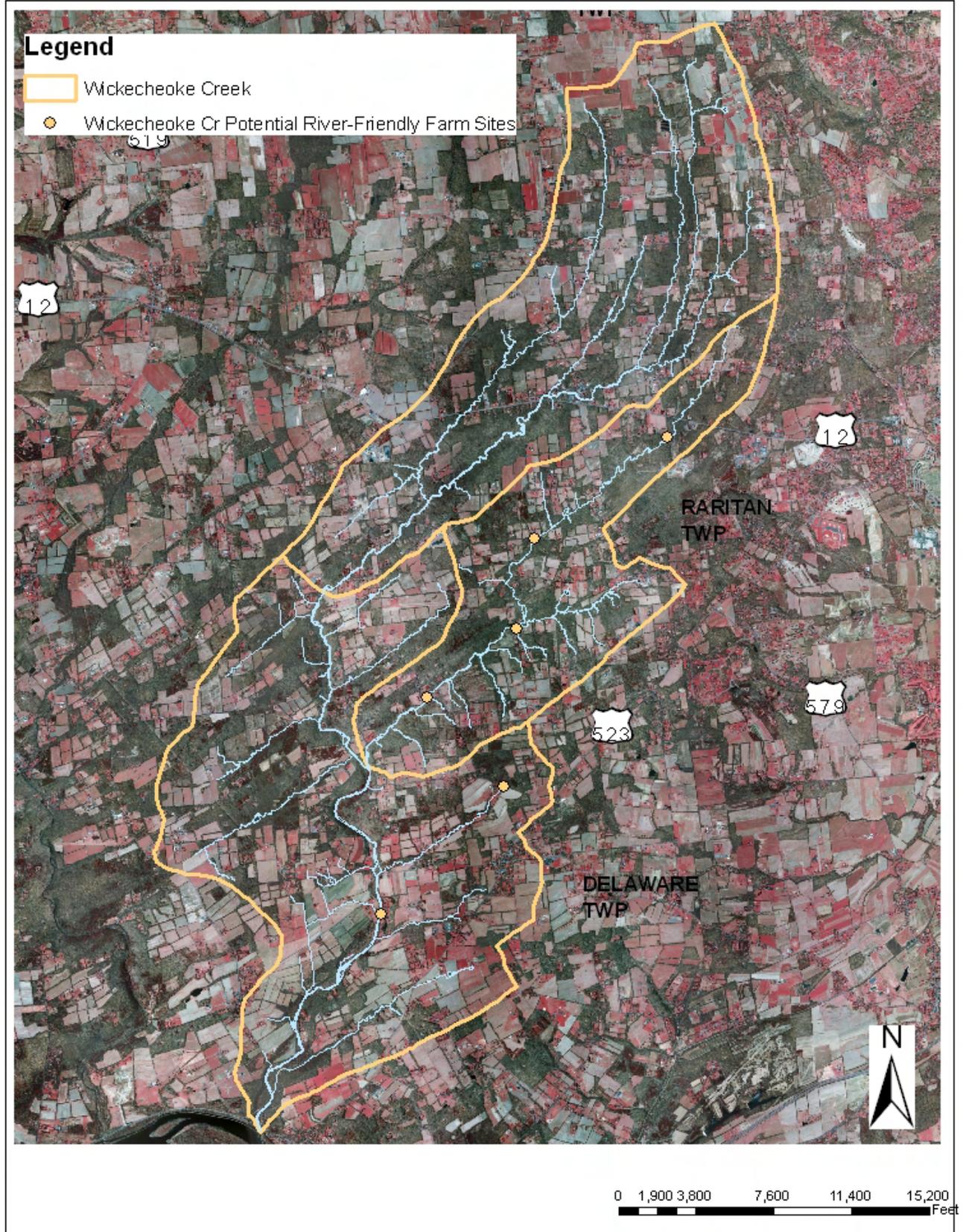


Figure G2. Potential sites for “River Friendly Farm” certifications in the Wickecheoke watershed.



Project Name:	Bioretention Applications - Recreational Areas and Private/ Public Lawns	Date: 04/14/2009	Flow/Load- Reduction Priority: High
Location:	Kingwood Twp Park, Block 19, Lot 8	Parcel Size: 51.5 acres	Implementation Potential: High
Remediation Type:	Bioretention using rain gardens, wetlands, and swales; and streambank revegetation		Municipal Priority: High
Issues and Concerns:			
<p>Greater runoff flows are created from compacted soils, increased impervious cover, and greater intensity storm events. Soils in the watershed are somewhat poorly drained. Turf and lawn areas become compacted from seasonal maintenance, particularly in the spring when the soil is moist. The soils in athletic fields become compacted from continuous use and maintenance. Over time, the soils lose much of the inherent ability to retain and infiltrate rainwater.</p>			
Existing Condition Based on Field Evaluation:			
<p>Kingwood Township purchased and designated an open-space area as a community park in 1998. The Park was developed on preserved agricultural lands, some of which had previously been classified as agricultural wetlands. Most of the area was transformed into athletic fields for soccer, baseball, and community events. Large crowds of spectators and recreationists from Kingwood and neighboring municipalities frequent the Park. The original drainage system was part of the agricultural crop production activities. Over time, the use of parking areas, athletic fields, and walking paths has increased soil compaction and subsequently increased the volume and velocity of stormwater runoff. The drainage for the parking lots was piped directly to the Lockatong Creek. None of the Park area was designed for retaining runoff flows, including pesticides and fertilizer used for maintaining the fields. Of the total 51.5 acres, approximately 19 acres can be retrofitted with stormwater controls as a first phase of other potential future retrofits. A narrow and entrenched, grassed stormwater swale borders the northern edge of the athletic fields, draining into a forested wetland next to the Lockatong Creek. The increased runoff has severely eroded the swales, and formed deep conveyance ditches through the forested wetland at the western edge of the Park.</p>			

<p>Proposed Solutions: Core aeration of entire athletic field complex according to accepted athletic field protocols developed by land grant universities. Retrofit of Kingwood Park (athletic fields) for wetland/rain-garden stormwater controls to eliminate sediment loading to the stream (Figure H1). Streambank revegetation would be performed on both sides of the channel to restabilize the streambanks (Figure H2). Wider, crescent-shaped, bioretention swales with check-dams would be installed along the northern edge of the Park. Rain gardens would have shallow water depths, one foot or less, and consist of excavation and berming in appropriate areas to retain stormwater runoff for less than 72 hours. Additional information for the design of rain gardens is presented in: <i>Rain Garden Manual for New Jersey</i>, The Native Plant Society of New Jersey, Office of Continuing Professional Education, Cook College, April 2005. All project areas will be landscaped with appropriate native vegetation. The bioretention gardens will be done in a manner that is intended to encourage homeowners and corporations to mimic these techniques on their own lawns in different scales. The orientation and size of bioretention systems will be based on site evaluations during the planning and design tasks. Educational materials, via signage and brochures, will be available for people attending athletic and other social events at the site.</p>		
<p>Anticipated Benefits: Stormwater will be retained from approximately 19 acres of the parcel, and from adjoining lands upgradient. Potential annual runoff from this section of the parcel is estimated at 6.7 million gallons. A 20-foot wide bioretention swale, with check-dams, along the northern edge of the Park could retain approximately 69 percent of the runoff volume, or 25 percent of the volume from the entire parcel. An area of 50’ by 200’ for bioretention (a selection of rain gardens), at a maximum depth of 1 foot, should retain the remaining stormwater runoff from up to the 1.25 inch storm and the associated water quality constituents. Using a Commercial land use for annual TP and TSS loading estimates from the <i>NJSW BMP Manual, Appendix C, Sample Municipal Stormwater Management Plan</i>, a reduction of up to 90 percent TSS and 60 percent TP can be achieved, or 23.9 lb/year TP and 1.7 tons/yr TSS. Up to 90 tons/yr of sediment load that is currently being eroded from the existing drainage channels would also be reduced. The sediment and flow reductions will increase proportionately as this technique is applied to other public Conservation Lands throughout these watersheds and ultimately throughout the State. This technique could also be adapted to private and commercial lawns (as rain gardens and grassed swales) having the typical condition of smoothed, compacted, high maintenance turf.</p>		
<p>Major Implementation Issues: The project will require approval by Kingwood Township and New Jersey Green Acres. There may be occasional opposition to the increased maintenance at the site, since uneven microtopography could mean that field mowing and maintenance may become more labor intensive. Some may object to the more natural appearance and wetter conditions compared to the existing close-mowed turfgrass in the western section of the Park.</p>		
<p>Possible Funding Sources: EPA 319(h) through NJDEP, NJWSA, NRCS, USGS, Kingwood Township</p>		
<p>Partners/Stakeholders: Kingwood Township, NJDEP, NRCS, USGS, Hunterdon County SCD, NJWSA</p>		
Task	Description	Estimated Cost¹

1	Prepare and present concept plan to Kingwood Township officials			\$5,000
2	Site topographic survey and soils testing			\$9,000
3	Pre-application meeting with Hunterdon County SCD and municipal officials. Preparation of design plans and permits.			\$15,000
4	Preparation of Stormwater BMP Maintenance Plan (NJDEP requirement)			\$2,000
5	Installation of BMP retrofits			
	Activity	Unit Cost	Quantity	
	Equipment mobilization/erosion control	\$35/foot	1,200	\$42,000
	Installation of project/sponsor sign	\$4,000	1	\$4,000
Option A	Construction of bioretention swale/check dams	\$6.5/foot ²	16,000	\$104,000
	Bioretention swale vegetation management/planting	\$2,500	3	\$7,500
	Construction of rain garden(s)	\$5.5/foot ²	10,000	\$55,000
	Rain garden vegetation management/planting	\$2,500	2	\$5,000
	Streambank revegetation	\$2,500	2	\$5,000
	Closeout/Contingency	20%		\$44,500
	Total Construction Cost			\$267,000
	Total Project Cost			\$298,000
	Annual O&M Cost			\$2,000
Option B²	Construction of rain garden(s)	\$5.5/foot ²	10,000	\$55,000
	Rain garden vegetation management/planting	\$2,500	2	\$5,000
	Streambank revegetation	\$2,500	2	\$5,000
	Closeout/Contingency	20%		\$22,200
	Total Construction Cost			\$133,200
	Total Project Cost			\$164,200
	Annual O&M Cost			\$2,000

¹ Costs were estimated based on designs by Omni Environmental, Inc. for various BMPs proposed in the *Mulhockaway Creek Stormwater Management and Watershed Restoration Plan* (NJWSA, 2007). Municipal DPW or NJWSA could supply heavy equipment at no cost. Municipal staff and residents could provide volunteer services for plantings. NRCS will seek matching funds.

² If general repairs (some widening and check-dams) to the existing bioretention swales are possible, a complete retrofit may not be necessary.

Figure H1. Kingwood Township Block 19, Lot 8 (Township Park – Athletic Fields). Potential site for stormwater runoff remediation.

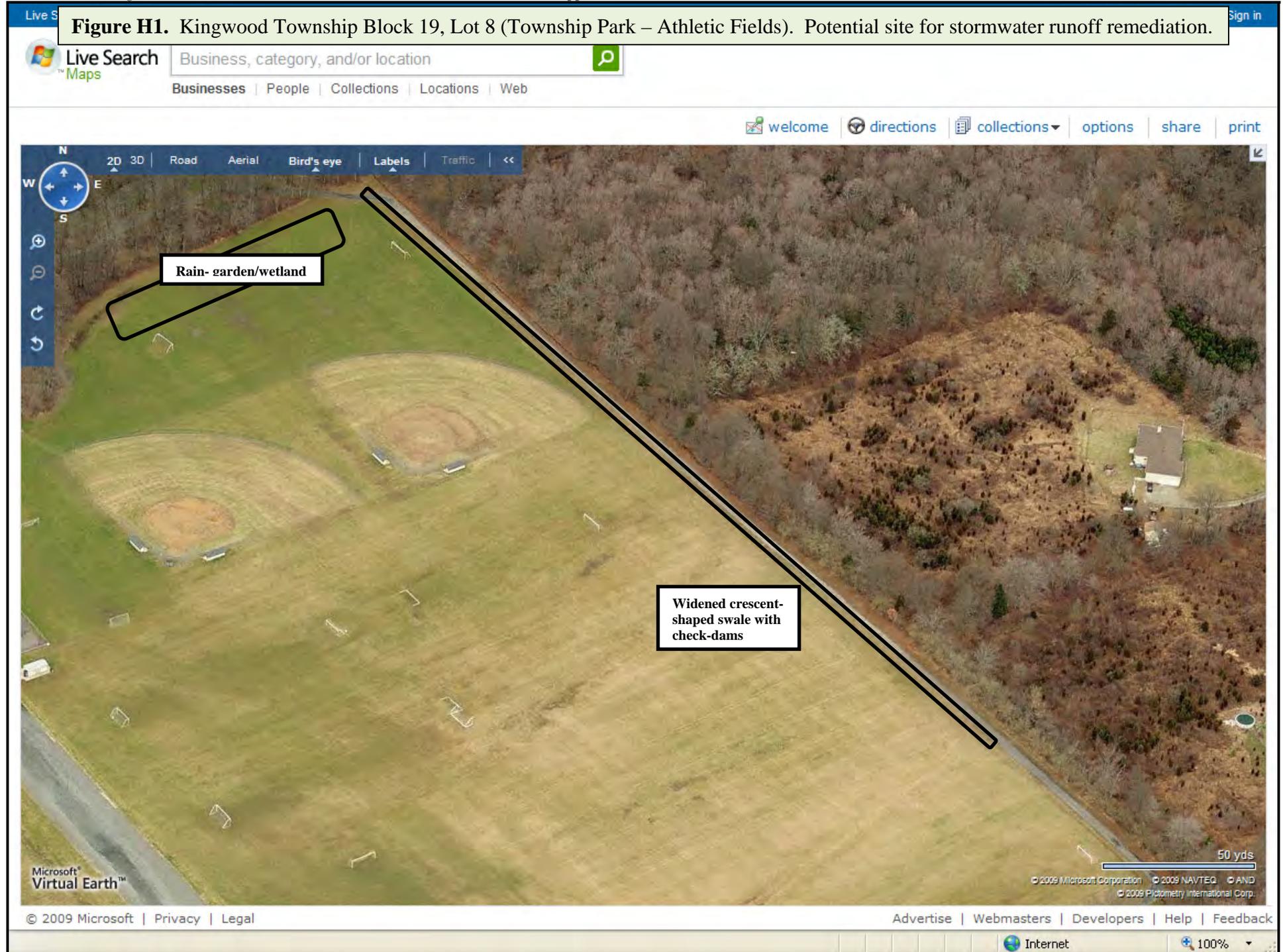
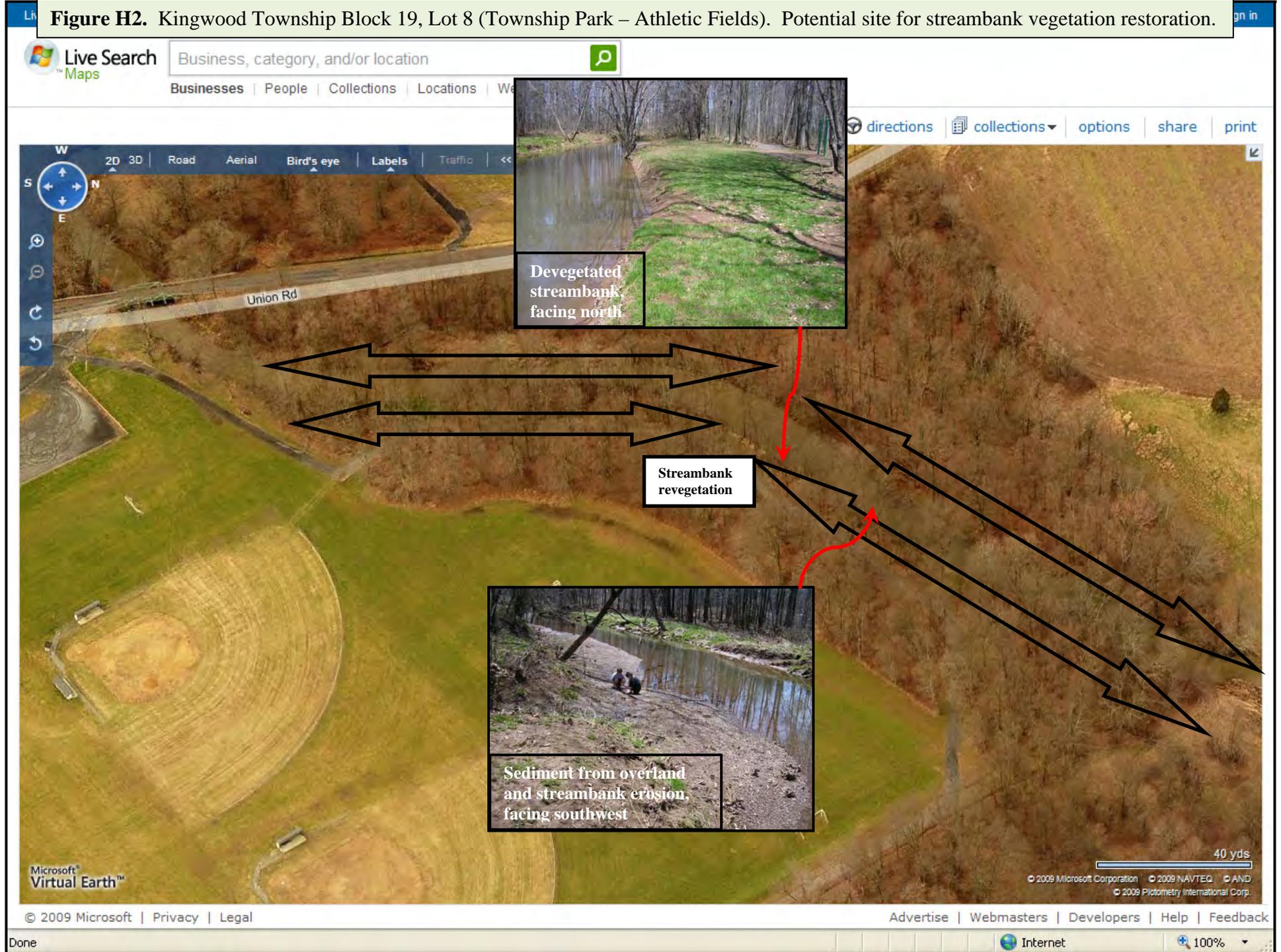


Figure H2. Kingwood Township Block 19, Lot 8 (Township Park – Athletic Fields). Potential site for streambank vegetation restoration.



Project Name:	Delaware Township Municipal-Garage Retrofit	Date: 04/14/2009	Flow/Load- Reduction Priority: High
Location:	Delaware Twp, Block 34, Lot 12.0003	Parcel Size: 6.5 acres	Implementation Potential: High
Remediation Type:	Bioretention swales and check dams		Municipal Priority: High
Issues and Concerns: Vehicular traffic, in combination with sand, gravel, and soil storage piles creates sediment-laden runoff during storm events. Runoff carries sediments containing pollution constituents from the automobiles, such as metals, asbestos, battery acid, and other solutes. Rose Brook, a C1 tributary to the Wickecheoke Creek flows along the northern end of the property.			
Existing Condition Based on Field Evaluation: The site is 6.5 acres, with approximately 80 percent impervious: paved and buildings. School buses, police vehicles, and some heavy equipment are based at this location. Storage piles of sand, gravel and soil are located at the northern end of the property, abutting Rose Brook. Runoff during storms exits the northern end and flows directly into Rose Brook. Dirt tracks are visible throughout the parking lot from vehicle traffic. There exists a perimeter woodland buffer of approximately 50 feet where a vegetative swale may be installed.			
Proposed Solutions: A vegetated bioretention swale would be constructed along the down-gradient perimeter to collect runoff from the site and provide solids and nutrient removal, as well as reduction of the flow volume through evapotranspiration and infiltration (Figure II). Shallow, stone check-dams could be located near the center of the swale length to further slow the flow velocity and provide additional retention volume up-gradient from the dam. The design will be dependent on the width of the perimeter buffer, soil depth and depth to ground water, and topography. Design and maintenance criteria are presented in <i>New Jersey Stormwater Best Management Practices Manual, Chapter 9.1, Bioretention Systems</i> . Using an average depth of 1 foot, an area of approximately 22,000 ft ² could retain the site runoff and eliminate approximately 165,000 gallons of stormwater (93 percent) per 1.25 inch rain event through evapotranspiration and infiltration. Sand filters would be installed to remove metals, hydrocarbons, and other toxic materials, pending results of preliminary soil and water quality analyses. The filters must have a maintenance plan and be protected by easement, deed restriction, ordinance, or other legal measures to prevent neglect, alteration, and removal. Design and maintenance criteria are presented in <i>New Jersey Stormwater Best Management Practices Manual, Chapter 9.9, Standard for Sand Filters</i> . Stocked soil, gravel, etc. would be housed in bins or shelters to reduce direct contact with precipitation and runoff.			
Anticipated Benefits: Although the NJDEP BMP Design Manual does not provide pollutant loading values for parking lots or storage of construction materials, the design can assume similar loading rates to those of commercial areas. Commercial areas generate approximately 2.1 lbs/acre/year total phosphorus (TP) and 200 lbs/acre/year total suspended solids (TSS). Vegetative swales, preceding a sand filter, will retain up to 98 percent of TSS and up to 60 and 35 percent of TP and total nitrogen (TN), respectively. The remediation strategy would retain runoff from the 1.25 inch rain event while reducing erodible flow velocities.			

Major Implementation Issues:				
Success of this remediation project would require the Delaware Township Department of Public Works, and/or a qualified contractor, to construct the retrofit and maintain any sand filters that may be installed, according to the manufacturer's recommended maintenance program. Installation of swales and filters must be performed within the existing footprint of disturbance, since Rose Brook is a C1 stream.				
Possible Funding Sources: EPA 319(h) through NJDEP, NJ Environmental Infrastructure Financing Program, Delaware Township				
Partners/Stakeholders: Delaware Township DPW and officials, NJDEP				
Task	Description			Estimated Cost¹
1	Prepare and present concept plan to Delaware Township officials			\$5,000
2	Site topographic survey and soils testing			\$5,000
3	Pre-application meeting with Hunterdon County SCD and municipal officials. Preparation of design plans and permits.			\$10,000
4	Preparation of Stormwater BMP Maintenance Plan (NJDEP requirement)			\$2,000
5	Installation of BMP retrofits			
	Activity	Unit Cost	Quantity	
	Equipment mobilization/erosion control	\$35/foot	800	\$28,000
	Construction of bioretention swales/check dams	\$6.5/foot ²	22,000	\$143,000
	Vegetative Planting	\$2,500	4	\$10,000
	Sand Filter Installation ²	\$8/foot ²	2,700	\$21,600
	Closeout and Contingency	20%		\$40,500
Total Construction Cost				\$243,100
Total Project Cost				\$265,100
Annual O&M Cost				\$1,000

¹ Except for the installation costs for the sand filter system, costs were estimated based on similar designs by Omni Environmental, Inc. for various BMPs proposed in the *Mulhockaway Creek Stormwater Management and Watershed Restoration Plan* (NJWSA, 2007).

² Size estimated from *NJ Stormwater Best Management Practices Manual, Chapter 9.9, Standard for Sand Filters*.

Figure II. Delaware Township Block 34, Lot 120003. Potential remediation for municipal garage facility.



Project Name:	Vehicle Maintenance and Storage Retrofit	Date: 04/14/2009	Flow/Load-Reduction Priority: Moderate
Location:	Delaware Twp, Block 18, Lot 1	Parcel Size: 1.8 acres	Implementation Potential: May be cost restricted (private)
Remediation Type:	Bioretention swales/check-dams and sand filter		Municipal Priority: Lower
Issues and Concerns: Vehicles contain pollution constituents such as metals, asbestos, and hydrocarbons. The site is located approximately 800 feet from the mainstem Wickecheoke Creek, a C1 stream.			
Existing Condition Based on Field Evaluation: The site is 1.8 acres, with approximately 80 percent impervious: paved and structures. School buses, trucks, cars, and other vehicles are on site. Runoff during storms exits the southwest corner and flows approximately 800 feet overland and into the Wickecheoke Creek. There exists a perimeter woodland buffer of approximately 20 feet where a vegetative swale may be installed.			
Proposed Solutions: A vegetated bioretention swale would be constructed along the down-gradient perimeter to collect runoff from the site and provide solids and nutrient removal, as well as reduction of the flow volume through evapotranspiration and infiltration (Figure J1). Design and maintenance criteria are presented in <i>New Jersey Stormwater Best Management Practices Manual, Chapter 9.1, Bioretention Systems</i> . A shallow gravel check-dam would be located near the center of the swale length to further slow the flow velocity and provide additional retention volume up-gradient from the dam. The design will be dependent on the width of the perimeter buffer, soil depth and depth to ground water, and topography. Using an average depth of 1 foot, an area of approximately 6,550 ft ² could retain the site runoff and eliminate approximately 48,900 gallons of stormwater per 1.25 inch rain event through evapotranspiration and infiltration. Sand filters would be installed to remove metals, hydrocarbons, and other toxic materials, pending results of preliminary soil and water quality analyses. The filters must have a maintenance plan and be protected by easement, deed restriction, ordinance, or other legal measures to prevent neglect, alteration, and removal. Design and maintenance criteria are presented in <i>New Jersey Stormwater Best Management Practices Manual, Chapter 9.9, Standard for Sand Filters</i> .			
Anticipated Benefits: Although the NJDEP BMP Design Manual does not provide pollutant loading values for parking lots or storage of vehicles, the design can assume similar loading rates to those of commercial areas. Commercial areas generate approximately 2.1 lbs/acre/year total phosphorus (TP) and 200 lbs/acre/year total suspended solids (TSS). Vegetative swales, preceding a sand filter, will retain up to 98 percent of TSS and up to 60 and 35 percent of TP and total nitrogen (TN), respectively. The remediation strategy should retain runoff from the 1.25 inch rain event while reducing erodible flow velocities.			

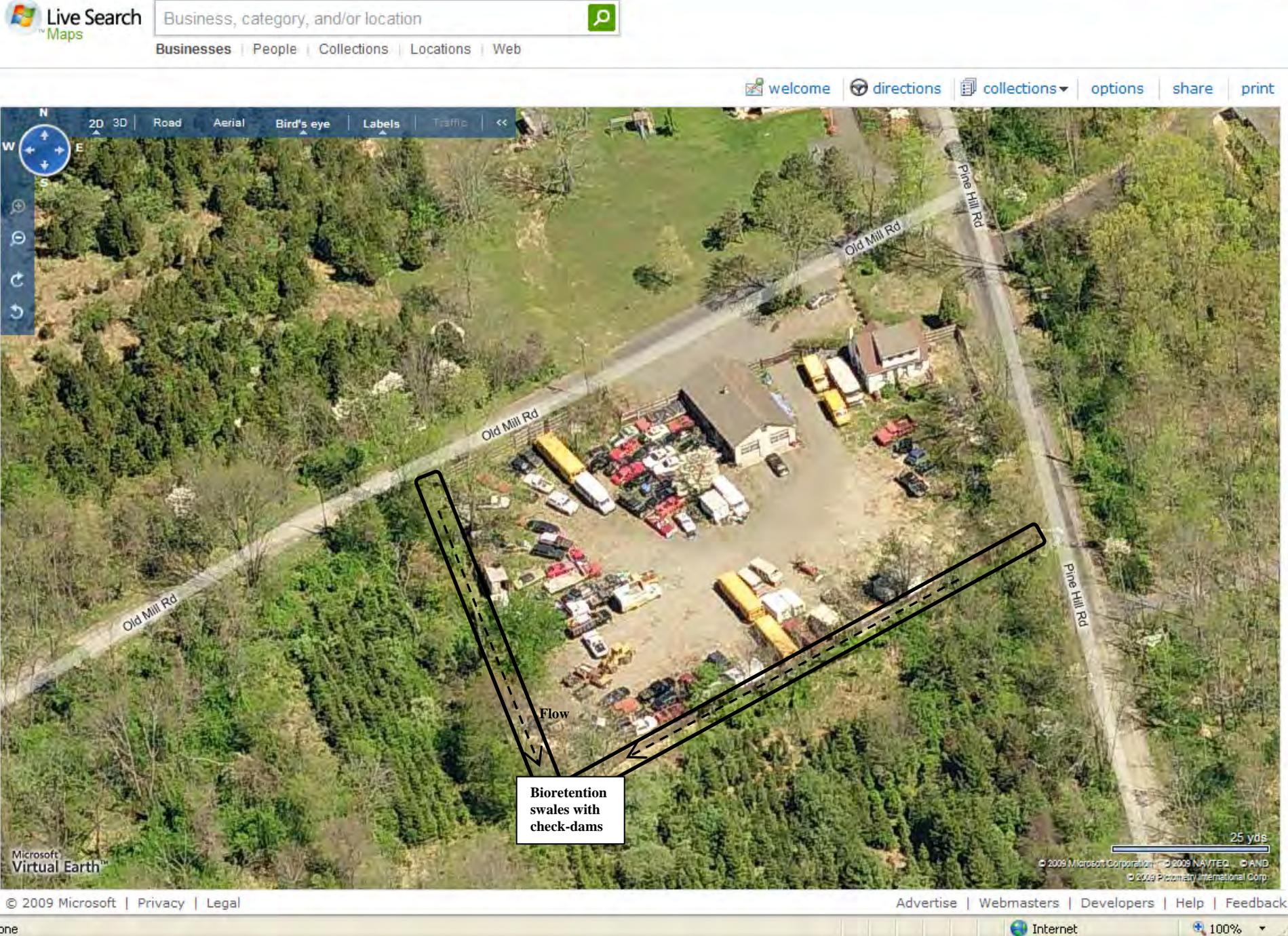
Major Implementation Issues:				
Success of this remediation project would require landowner approval of the remediation strategy and maintenance program. If a wooded perimeter buffer is not available, sand filters (or other water purification measures) may need to be installed in the paved area. A qualified contractor would be selected to construct the retrofit and maintain any stormwater purification filters that are installed according to the manufacturer's recommended maintenance program.				
Possible Funding Sources: EPA 319(h) through NJDEP, Private				
Partners/Stakeholders: Delaware Township, Hunterdon County SCD, NJDEP				
Task	Description			Estimated Cost¹
1	Prepare and present concept plan to Delaware Township officials			\$5,000
2	Site topographic survey and soils testing			\$5,000
3	Pre-application meeting with Hunterdon County SCD and municipal officials. Preparation of design plans and permits.			\$15,000
4	Preparation of Stormwater BMP Maintenance Plan (NJDEP requirement)			\$2,000
5	Installation of BMP retrofits			
	Activity	Unit Cost	Quantity	
	Equipment mobilization/erosion control ²	\$35/foot	500	\$17,500
	Construction of bioretention swales/check dams	\$6.5/foot ²	6,550	\$42,600
	Vegetative Planting	\$2,500	2	\$5,000
	Sand Filter Installation ³	\$8/foot ²	725	\$5,800
	Closeout and Contingency	20%		\$14,200
Total Construction Cost				\$85,100
Total Project Cost				\$112,100
Annual O&M Cost				\$1,000

¹ With an exception for the installation costs for the sand filter system, costs were estimated based on similar designs by Omni Environmental, Inc. for various BMPs proposed in the *Mulhockaway Creek Stormwater Management and Watershed Restoration Plan* (NJWSA, 2007).

² Municipal DPW could provide heavy equipment.

³ Size estimated from *NJ Stormwater Best Management Practices Manual, Chapter 9.9, Standard for Sand Filters*.

Figure J1. Delaware Township Block 18, Lot 1 (Pine Hill and Old Mill Road intersection). Potential remediation site for stormwater runoff.



Project Name:	Sergeantsville Firehouse Parking-Lot and Municipal Park Retrofits	Date: 04/14/2009	Flow/Load-Reduction Priority: Moderate
Location:	Delaware Twp, Block 36, Lots 24 and 14.11	Parcel Size: 3.1 acres	Implementation Potential: High
Remediation Type:	Rain Garden, and Bioretention swale with check-dam		Municipal Priority: High
Issues and Concerns:			
<p>Stormwater runoff from the firehouse parking lot and the municipal park is routed to roadside drainage along Stockton-Flemington Road (County Route 523), supplementing urban and roadway drainage to Rose Brook, a C1 tributary to Wickecheoke Creek. Since the parking lot is not in continuous use, some of the runoff contaminants may be sediment and nutrients from adjoining residential properties, including the park.</p>			
Existing Condition Based on Field Evaluation:			
<p>The site is 3.1 acres, with approximately 50 percent impervious: paved parking lot and buildings. Runoff during storms exits the western end of the firehouse property and flows along Route 523 to Rose Brook. There exists a grassed area along the northern edge where a vegetative swale and shallow basin may be installed.</p>			
Proposed Solutions:			
<p>Two bioretention systems would be constructed: one along the western edge of the park and another along the northern edge of the parking lot to collect runoff and provide solids and nutrient removal, as well as reduction of the flow volume through evapotranspiration and infiltration (Figure K1). A shallow, gravel check-dam would be located near the center of the parking lot swale length to further slow the flow velocity and provide additional retention volume up-gradient from the dam. The designs will be dependent on the available area along the western edge of the park and along the northern perimeter of the parking lot, soil depth and depth to ground water, and topography. Design and maintenance criteria are presented in <i>New Jersey Stormwater Best Management Practices Manual, Chapter 9.1, Bioretention Systems</i>. Additional information for the design of rain gardens is presented in: <i>Rain Garden Manual for New Jersey</i>, The Native Plant Society of New Jersey, Office of Continuing Professional Education, Cook College, April 2005. Using an average depth of 1 foot to facilitate evapotranspiration, an area of approximately 9,000 ft² could retain the site runoff and eliminate approximately 66,700 gallons of water per 1.25 inch rain event through evapotranspiration and infiltration. Sand filters would be installed to remove metals, hydrocarbons, and other toxic materials, pending results of preliminary soil and water quality analyses from the parking lot. The filters must have a maintenance plan and be protected by easement, deed restriction, ordinance, or other legal measures to prevent neglect, alteration, and removal. Design and maintenance criteria are presented in <i>New Jersey Stormwater Best Management Practices Manual, Chapter 9.9, Standard for Sand Filters</i>. Rain barrels attached to the downspouts of the firehouse would provide additional stormwater retention, up to 75 gallons per barrel (<i>Combined Sewer Overflow Rooftop Type Analysis and Rain Barrel Demonstration Project</i>, Department of Environmental Programs Metropolitan Washington Council of Governments, December 2001).</p>			

Anticipated Benefits:				
Total phosphorus and total suspended solids loadings for medium to high density residential land cover is 1.4 and 140 lb/acre/year, respectively, according to the NJSW BMP Manual. Although the BMP Manual does not provide pollutant loading values for parking lots, the design can assume similar loading rates to those of commercial areas. Commercial areas generate approximately 2.1 lbs/acre/year total phosphorus (TP) and 200 lbs/acre/year total suspended solids (TSS). A rain garden, vegetative swale and basin, preceding a sand filter, will retain up to 98 percent of TSS and up to 60 and 35 percent of TP and total nitrogen (TN), respectively. The remediation strategy should retain runoff from the 1.25 inch rain event, ultimately reducing runoff flow and the associated increase in scour velocity as the flow reaches Rose Brook.				
Major Implementation Issues:				
Implementation of this remediation project requires Delaware Township and the Sergeantsville Fire Company to approve the retrofits. A qualified contractor, with possible assistance from the Sergeantsville Department of Public Works, would be required to construct the retrofit and maintain any sand filters that are installed according to the manufacturer's recommended maintenance program.				
Possible Funding Sources: EPA 319(h) through NJDEP, NJ Environmental Infrastructure Financing Program, Borough of Sergeantsville, Fire Company dues and contributions, service-area municipalities				
Partners/Stakeholders: Sergeantsville Fire Company members, municipal officials, NJDEP				
Task	Description			Estimated Cost¹
1	Prepare and present concept plan to Fire Company and municipal officials			\$5,000
2	Site topographic survey and soils testing			\$5,000
3	Pre-application meeting with Hunterdon SCD, Fire Company officials, and municipal officials. Preparation of design plans and permits.			\$10,000
4	Preparation of Stormwater BMP Maintenance Plan (NJDEP requirement)			\$2,000
5	Installation of BMP retrofits			
	Activity	Unit Cost	Quantity	
	Equipment mobilization/erosion control ²	\$35/foot	350	\$12,250
	Rain-barrel installation	\$200	5	\$1,000
	Construction of rain garden	\$5.50/ foot ²	7,000	\$38,500
	Vegetative Planting of rain garden	\$2,500	1	\$2,500
	Construction of bioretention swale/check dam	\$8/foot ²	2,000	\$16,000
	Vegetative Planting of swale	\$2,500	1	\$2,500
	Sand Filter Installation ³	\$8/foot ²	725	\$5,800
	Closeout and Contingency	20%		\$15,700
Total Construction Cost				\$94,250
Total Project Cost				\$116,250
Annual O&M Cost				\$1,500

¹ Except for the installation costs for the sand filter system, costs were derived from similar designs by Omni Environmental, Inc. for various BMPs proposed in the *Mulhockaway Creek Stormwater Management and Watershed Restoration Plan* (NJWSA, 2007).

² Municipal DPW could provide heavy equipment.

³ Size estimated from *NJ Stormwater Best Management Practices Manual, Chapter 9.9, Standard for Sand Filters*.

Figure K1. Delaware Township Block 36, Lot 24. Potential remediation site for runoff controls at Sergeantsville Firehouse.



Other interests by Delaware Township for remediation projects include:

- Road-bank stabilization, via reseeded, along the west side of County Route 519, approximately 0.5 mile north of Stockton.
- Disconnection of roadway drainage along County Route 604, approximately 0.5 mile west of the covered bridge. Increased drainage has apparently increased erosion of a tributary to Wickecheoke Creek.
- Mowing of the roadway right-of-way along County Route 604, between Sergeantsville and the covered bridge has frequently exposed soil from “bottoming out” that is prone to erosion. Mowers should use caution to prevent the exposure of soil.
- Roadway drainage ditches are normally cleaned by backhoes and/or road-graders that deepen and expand the ditches creating destabilized banks from vertical angles and loss of vegetation. Road maintenance crews should retrofit drainage ditches to stabilize the channels and reduce erosion.
- Eliminate roadway widening and install bioretention swales along County Route 523, approximately 0.5 mile south of Sergeantsville, to reduce stormwater runoff.
- Implement care during roadway snow plowing to prevent the removal of roadside vegetation.
- Delaware Township emphasizes the need for options in roadway maintenance for reducing erosion from mowing, devegetation, and destabilized drainage channels.