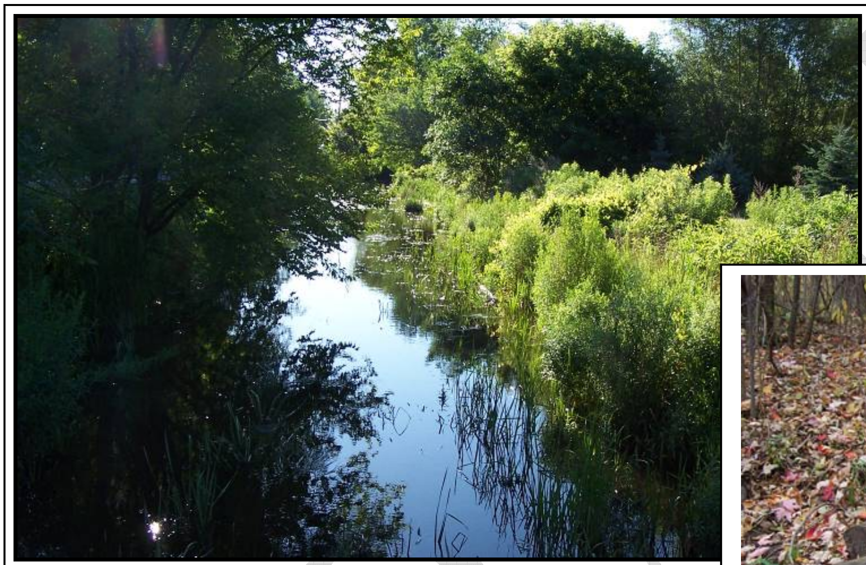
Little Black Creek Stormwater Assessment and Action Plan



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Little Black Creek Stormwater Assessment and Action Plan is a
Pilot plan of the Monroe County Stormwater Master Plan

Special acknowledgement needs to be given to the Center for Watershed Protection. Staff conducting this Report relied heavily on the concepts and strategies provided by the Center in its Urban Subwatershed Restoration Manual Series (CWP, 2004) and other reports and studies conducted by the Center Also, this work would not have been possible without the support and cooperation of the Towns of Chili, Gates and Ogden NY who provided important local knowledge and collaboration throughout the assessment process.

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List of Abbreviations

cfs	cubic feet per second (rate of water flowing)
CWP	Center for Watershed Protection
EMC	Event Mean Concentration
EPA	US Environmental Protection Agency
GIS	Geographic Information System
GPS	Global Positioning System
H.S.	High School
ICM	Impervious Cover Model
LBC	Little Black Creek
LiDAR	Light Detecting And Ranging
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
POC	Pollutant of Concern
SWAAP	Stormwater Assessment and Action Plan
TMDL	Total Maximum Daily Load
USGS	US Geological Survey
WS	Watershed
WTM	Watershed Treatment Model

Executive Summary

Similar to many developing areas, Monroe County has undergone rapid growth with unfortunate consequences to water quality. One consequence is that pollutants are so easily washed off impervious surfaces (roads, buildings and parking lots) and into streams. A second consequence is that streams more frequently overflow their banks. Out of bank flow causes flooding and erosion that enlarge stream channels, adding costs to municipalities and property owners.

The Little Black Creek Assessment and Action Plan (SWAAP) summarizes the results of a detailed assessment of LBC and presents recommendations for its protection, restoration and removal from the New York State Impaired Waterbodies List (see section 1.2.1). This project was conducted with funding from New York's Environmental Protection Fund and support from the Monroe County Department of Environmental Services and the Stormwater Coalition of Monroe County. It is intended to be a portion of a comprehensive county-wide Stormwater Master Plan that assesses all waterbodies in Monroe County in order to meet water quality goals and quantify local drainage issues.

Little Black Creek (LBC) lies southwest of the City of Rochester NY, originating in the town of Ogden, flowing east through the towns of Gates and Chili, under the Rochester International Airport to finally discharge into the Genesee River (Figure E1).

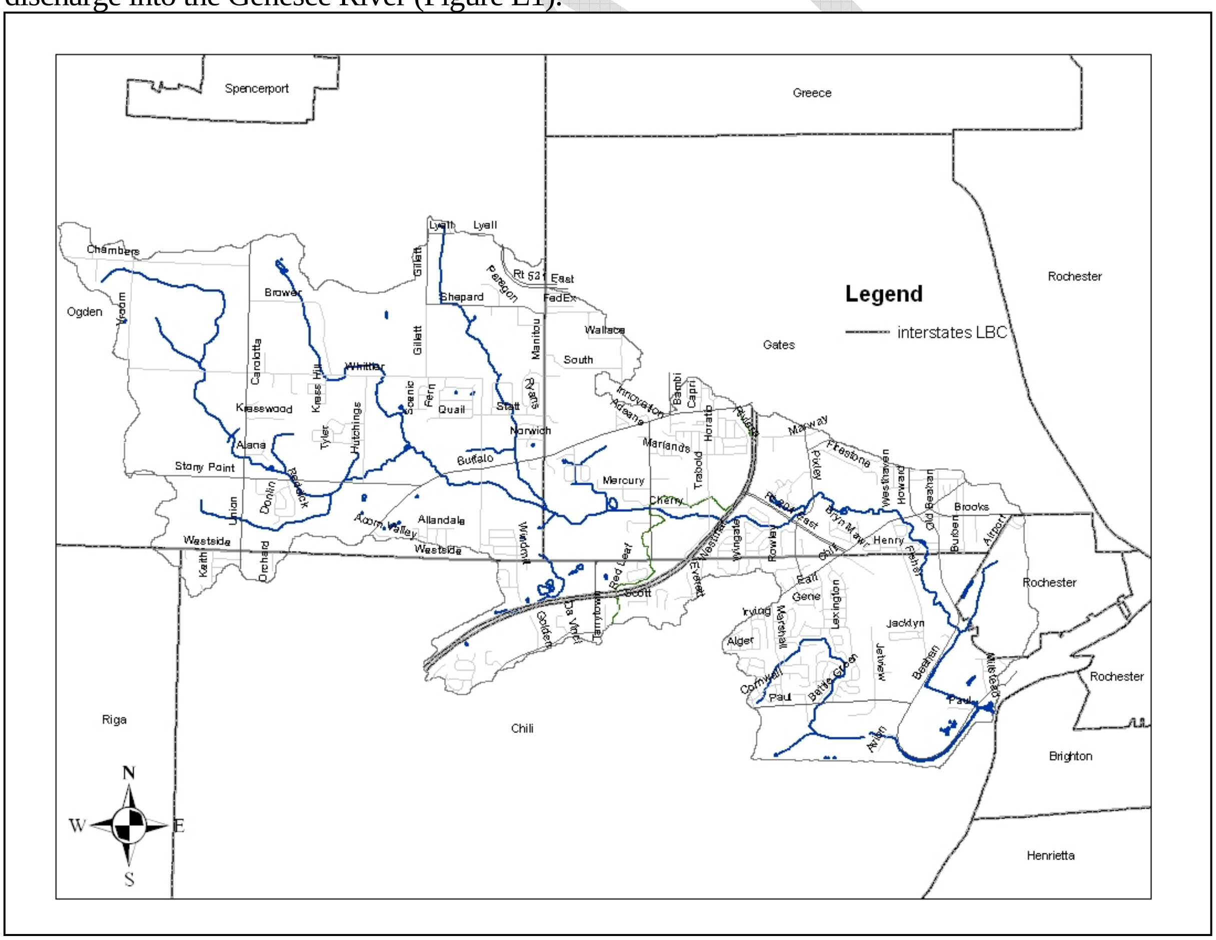

Figure E.1 Little Black Creek Watershed in Monroe County

1. Assessment

As seen from other stormwater master planning projects, achievable and sustainable results are best achieved through study and planning at the subwatershed level – an area approximately 2 to 15 square miles (1,200 -10,000 acres). The subwatershed is considered the ideal size to apply stream improvement and protection projects that are based on study and identified needs. With that in mind, the assessment process was conducted on LBC subwatershed and involved four steps: desktop assessment of watershed characteristics; water quality sampling; and stream corridor and upland field survey; and, stormwater modeling.

2. Planning

The planning process included the creation of a retrofit project inventory then, project ranking and prioritization. Implementation of retrofit projects identified for LBC were evaluated based on feasibility (i.e. land ownership & accessibility), cost effectiveness, environmental benefits and ability to provide multiple benefits. Implementation of the prioritized projects is expected to provide a combination of added water quality treatment and, in many cases, flow attenuation that will reduce erosive storm flows and capacity problems to downstream impacted reaches. An example of such a project is shown in Figure E.2 where LBC flows under NYS Route 204 divided highway just west of Pixley Road. The large utility right

Figure E.2 Potential new stormwater storage areas along NYS Route 204 in Gates of way along the highway provides an opportunity to store storm event volumes by creating a basin outside of the stream channel. The basin would hold large storm events but normal flows would typically stay in the channel.

The prioritized retrofit projects can be implemented over a number of years as funds become available. A long term monitoring plan would be done to document performance and measure effects on stream health. The metric for success will be increased aquatic life in the stream and a reduction of sediment loading delivered to the Genesee River with the ultimate goal of removal from the NYSDEC impaired waterbodies list.

Recommendations

To meet the LBC stormwater management goals and objectives a number of key actions are recommended for the watershed. These recommendations provide a framework for implementing the numerous management and restoration practices identified by the assessment process. These recommendations are presented in order of implementation priority.

Table E. 1. Potential Retrofit Projects, Costs and Benefits Gained

	Project Type	Reason for Prioritization	Cost
1	Build New Stormwater Ponds	• Treat large area • Reduces downstream erosion • Built on public property	$900K
2	Upgrades to Conventional Stormwater Ponds	• Reduces downstream erosion • Treats upstream developed area w/o quality treatment • Built on public property or on public easement	$810K
3	Green Infrastructure Retrofits	• Reduce the volume of runoff • Treats developed area w/o treatment • Utilizes available space	$167K
4	Stream Repairs	• Reduces sediment loads to stream • Improves fish and aquatic habitat	$56K
5	Stream Buffer Enhancement	• Improves fish and aquatic habit • Treats stormwater pollutants	$30K
6	Hotspots and Discharge Prevention	• Removes toxics and oxygen demanding pollutants • Source control efficiency	$1,180K
7	Residential Management Practices	• Involves the public in water protection programs • Source control efficiency	$240K

Section 1: Introduction

1.1 Setting

Little Black Creek (LBC) lies southwest of the City of Rochester NY, originating in the town of Ogden, flowing easterly through the towns of Gates and Chili then, piped under the Rochester International Airport to finally discharge into the Genesee River. The watershed covers approximately twenty-one square miles with open land, agriculture and low density residential development in the upper reaches, and medium to high-density residential development, light industrial, and commercial areas in the lower reaches. The watershed was further divided into upper and lower sections that roughly correlate to rural and urbanized areas for water quality and quantity analysis. The division also corresponds to the New York State Department of Environmental Conservation (NYSDEC) Water Use Impairment designation (where the lower segment from Coldwater Road in Gates to the mouth at the Genesee River has been categorized as impaired from unknown toxicity - see section 2.1.1 for more details). Conducting the study and assessment at this subwatershed level allows for a more thorough understanding of the entire watershed and enhances the ability to craft restoration strategies based on localized stream conditions.

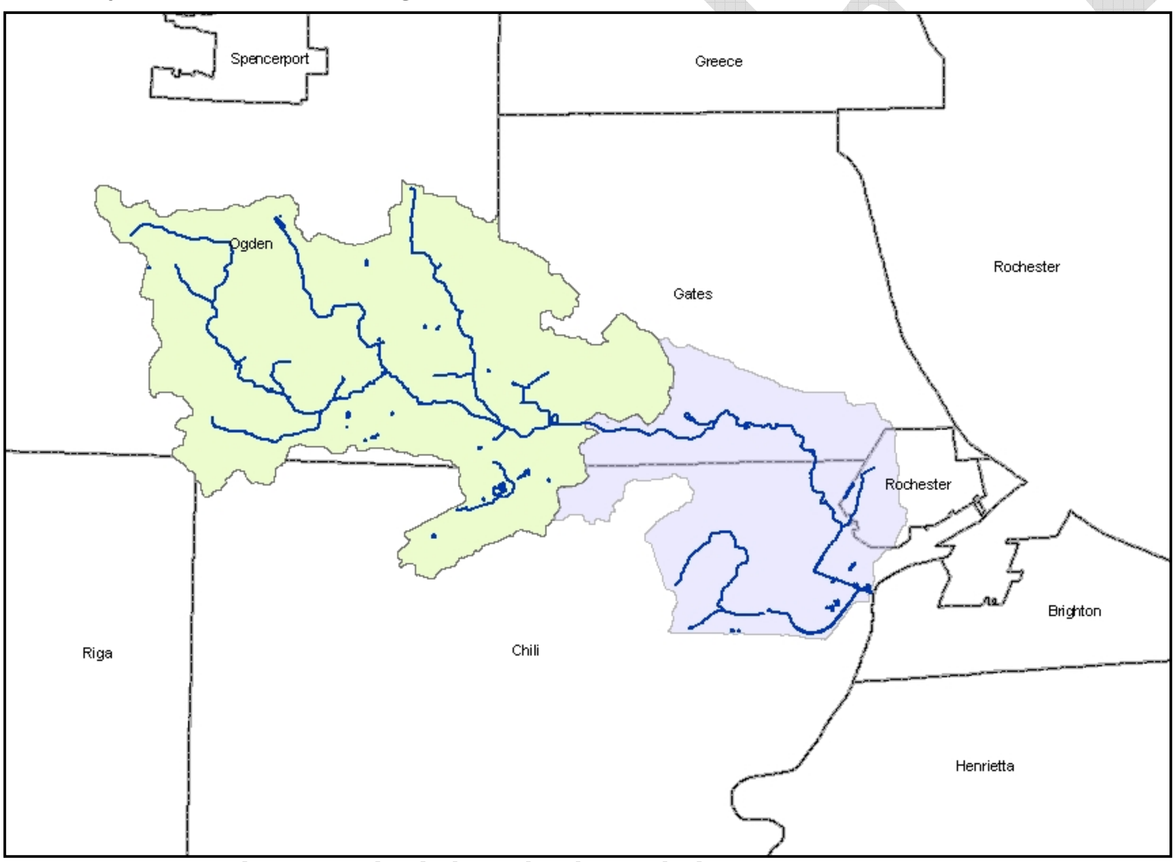

Figure 1. Upper and Lower Little Black Creek Subwatersheds

1.2 Purpose

The Little Black Creek Assessment and Action Plan (SWAAP) summarizes the results of a detailed assessment of LBC and presents recommendations for its protection, restoration and removal from the New York State Impaired Waterbodies List (see next section). This project was conducted with funding from New York's Environmental Protection Fund and support from the Monroe County Department of Environmental Services and the Stormwater

Coalition of Monroe County. It is intended to be a portion of a comprehensive county-wide Stormwater Master Plan that assesses all waterbodies in Monroe County in order to meet water quality goals and quantify local drainage issues.

1.2.1 Regulatory Background

The New York State General Permit for Stormwater Discharges from Municipal Separate Storm Sewer Systems, referred to as the "MS4 Permit", regulates 25 municipalities in Monroe County including all three in the LBC watershed. An MS4 Permit requirement for municipalities with impaired waters is to assess potential sources of stormwater pollutants, identify potential stormwater pollutant reduction measures, and evaluate their progress in addressing those pollutants to ensure no net increase of priority pollutants. LBC was selected as one of the first assessments in the County due to its water quality impairments, described in the New York State Water Quality Section 305b Report (NYS DEC, 2004) which states that lower LBC and its tributaries are impaired due to "unknown toxicity from urban stormwater runoff". The approach used in this SWAAP meets the MS4 Permit modeling requirements and demonstrates a simple approach to apply to other impaired waterbodies in Monroe County.

1.3 Goals and Objectives

An important element of stormwater planning is to establish goals and objectives that will improve the health of the waterbody through support and involvement of local stakeholders, biologists, planners and other experts. Due to limited funding, only the assessment portion of the SWAAP has been completed. Proposed steps that could be taken to insure the SWAAP reflects community goals and needs are reflected here.

A proposed step is to mail a newsletter to property owners and decision–makers in the watershed describing the SWAAP and inviting comments and participation in a second step - creating a LBC Stakeholder Task Group. The LBC Stakeholder Task Group would enlist participation from municipal boards, neighborhood and business associations, environmental groups, and residents within the watershed. Sections of this SWAAP would be distributed to participants in advance and presented for review and discussion at a number of meetings. Revisions based on group consensus would complete this document.

Proposed goals are listed here to be used as a starting point for the LBC Stakeholder Task Group to consider:

1. Mitigate stormwater impacts on water quality from new and existing development.

2. Reduce regional flooding impacts through the implementation of green infrastructure (a more effective way to improve water quality and reduce drainage problems generally through more extensive management of stormwater runoff).

3. Educate and involve the public in efforts to protect water quality.

1.4 Recommendations

Recommendations are a series of concrete actions that can help to achieve the subwatershed goals as well as to identify a timeline and party responsible for implementing these actions. Specific recommendations for LBC should be developed by the LBC Stakeholder Task Group. Potential recommendations for the Task Group to consider are listed in Section 4 along with a proposed timeline and responsible parties.

1.5 Project Scope

A brief description of the scope of SWAAP follows:

1. Desktop Assessment

The desktop assessment included a review of existing water quality monitoring data, municipal drainage studies and extensive data provided by the Monroe County GIS department. The amount of impervious cover in the watershed was measured with the use of remotely sensed data and IDRISI Andes software. The measure of watershed impervious cover is a critical metric that links watershed land-use to stream impairments and restoration potential. Maps of watershed are created from GIS data. Mapping data layers include:

- Real property tax parcels (identify Public lands),
- Most recent aerial photo,
- Topography – 1 foot intervals (where available),
- Impervious cover, land use/land cover,
- Streams with any monitoring locations noted,
- Soils,
- Subwatershed divides
- Stormwater outfalls, sewersheds and neighborhood divides (urban neighborhoods mainly),
- Floodplains and wetlands.

The results are reported in Section 2 of this document.

2. Field Study and Monitoring

The project team next conducts stream and upland surveys using appropriate worksheets for data gathering. Some strategic stormwater sampling is done to help validate the water quality modeling that is completed in item 4.

- Stream Survey – This involves a continuous walk of the stream corridor, identifying major stream impacts and potential locations for storage retrofits, stream repairs, riparian management and stormwater outfalls.
- Upland Area Survey – This involves a windshield survey to identify potential pollution sources and possible source controls, retrofits, reforestation and better management practices. Some strategic stormwater sampling may be needed to determine largest pollutant areas.

The results are reported in Sections 3.1 and 3.2 of this document.

3. Project Assessment Matrix

The third step of the process is the development of the assessment matrix that summarizes, in tabular form, current water resource conditions, desired resource conditions, stormwater retrofit opportunities with rough estimates of installation and maintenance costs. The matrix is used to generate discussion among the various stakeholders in the subwatershed, providing an opportunity for local input on the restoration objectives and concerns.

The results are reported in Section 4 of this document.

4. Model Project Effectiveness and Ranking

A stormwater modeling program was run to determine which projects will be the most cost effective in meeting specific restoration objectives. The Watershed Treatment Model (WTM) was chosen for its simplicity. The WTM is an Excel spreadsheet model typically used to:

- Estimate pollutant loading under current watershed conditions
- Determine the effects of current management practices
- Estimate load reductions associated with implementation of structural and non- structural management practices
- Evaluate the effects of future development

The WTM can examine a wide suite of treatment measures that are not typically tracked in other DEC supported models and allow the user to quantitatively examine how these practices can most effectively be combined to reduce pollutant loads.

The results are reported in Section 3.4 of this document.

1.6 Future Steps

Additional steps to complete the LBC SWAAP will need to be taken. An LBC Stakeholder Task Group will be formed to establish the goals, objectives and recommendations for the watershed. Next, a capitol improvement plan will be drawn up including detailed engineering plans, bonding to cover project costs, and project bid documents. Finally, implementation of Plan will be completed.

Long-term project tracking, operation and maintenance of the individual restoration projects must be completed along with monitoring effectiveness of program based initiatives.

Section 2: Little Black Creek Watershed Characterization

2.1 Watershed Data

Little Black Creek has a 21 square mile watershed with 38 stream miles. Basic watershed metrics can be seen in Table 1. The upper watershed is 60 percent rural with a transition in the last 20 years from 80 percent agricultural land use to its current mix of agriculture, residential, industrial and commercial use.

Table 1. Little Black Creek Subwatershed Data

Subwatershed Metric	Upper	Lower
Area (Acres)	8669	4479
Mapped Stream Miles	24	14
Miles of Piped Stream	0.2	2
Primary/secondary land use	Rural/residential	Residential/industrial
Miles of Channelized Stream	2	10
# of Stormwater Treatment Ponds	51	14
# of Stormwater Outfalls	44	90
Current Impervious Cover (%)	8	35
Estimated Future Impervious Cover (%)*	12	40
Current Health Status (see Impervious Cover Analysis discussion below)	Supports sensitive aquatic organisms	Non-supporting
Forest Cover %	39	4
Municipal Land Use Jurisdiction	Mostly within the Town of Ogden	~60/40 Gates and Chili respectively

*estimated 2021

One of the initial tasks in developing this SWAAP was to gain an understanding of the baseline, or current condition of the LBC watershed. To accomplish this, the following were done:

- Reviewed existing watershed data, studies, and reports
- Analyzed extensive watershed Geographic Information System (GIS) data
- Conducted strategic water quality sampling
- Developed a baseline Watershed Treatment Model for existing and future watershed conditions.

2.1.1 Land Use

Like most of Western New York, the LBC watershed was originally heavily forested and transitioned to agricultural in the mid to late 1800's when the stream was typically rerouted around crops and an abundance of local orchards. Using the New York State office of Real Property's Land Use Classification list, LBC watershed's current predominant land uses were found. Approximately 40 percent of the LBC watershed is residential, followed by 20 percent agricultural and 12 percent industrial (Figure 2). These values change sharply when analyzing the upper and lower watersheds separately. The upper watershed is evenly split between agricultural and low-density residential. Roughly half of the lower watershed is moderate to high-density residential with an even mix of commercial, industrial and public lands (primarily the Rochester International Airport) making up the other half.

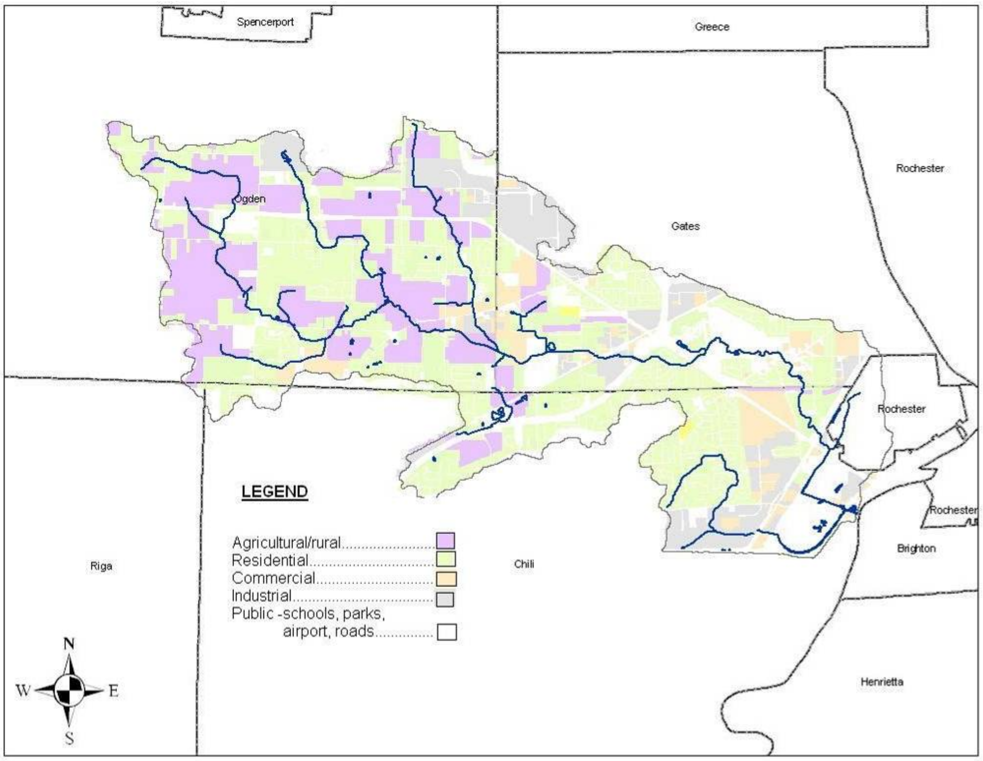

Figure 2. Little Black Creek Watershed Land Use Classification

A review of aerial photos from 1930 to current day illustrates the straightening, channelizing and stream relocation to accommodate farming and land development. The lower section remained rural until the late 1970's when a burst of growth came from the expansion of adjacent Rochester. A comparison of historic photos is shown in Figure 3. New homes were built as well as new industries and replaced agriculture as the predominant land uses over these last 40 years in Lower LBC.

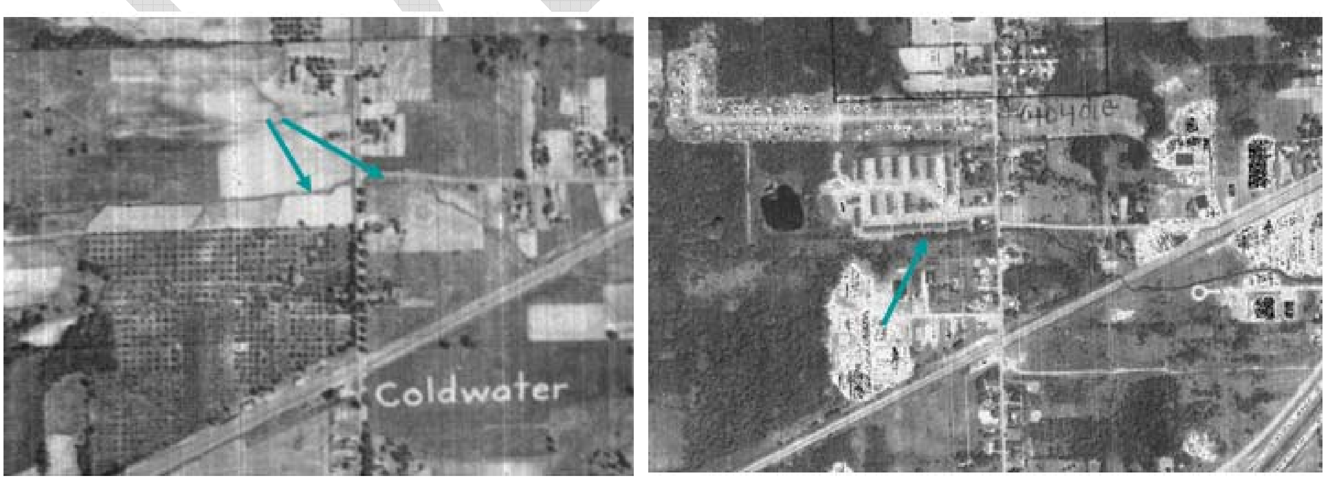

Figure 3. Comparison of land use in Little Black Creek. 1930 (left) and 1980 historic photos of Coldwater Road area (Town of Gates). Arrows point to area of straightened stream sections and, in some stretches, removed streamside vegetation.

2.1.2 Water Quality

Impervious Cover Analysis

Research has shown a direct connection between the amount of impervious cover in a watershed and the receiving stream's health. Using this research, the Center for Watershed Protection created the "Impervious Cover Model" (ICM) to predict a typical stream's health. With caveats aside such as major point sources of pollution and watershed deforestation, the decline of a stream generally becomes evident when the watershed impervious cover exceeds ten percent. The basic predictions of the ICM have been confirmed by a recent review of nearly 60 peer-reviewed stream research studies released in the last five years (Schueler, Fraley-McNeal, et al, 2008). Basically, two thirds of all the stream monitoring studies confirmed or reinforced the basic ICM relationship. As mentioned, the new studies did identify caveats on the IC/stream quality relationship spurring a reformulated ICM model to reflect this new research (Figure 4 and further described in Appendix B).

County staff estimated both existing and future impervious cover percentages for the upper and lower LBC delineated subwatersheds. These estimates were based on light detection and ranging (LIDAR) impervious cover imagery and municipal zoning maps. As shown in Table 1, future imperious cover based on a 25 percent greater build-out in 10 years in the upper watershed is projected to be in the range of 10 to 12 percent. According to the ICM, a typical stream's overall health is predicted to become impacted at this amount. Typical impairment indicators due to increased influence of stormwater runoff are increased summer stream temperature, increased bacteria levels and declining aquatic diversity. From field investigation, most indicators of stream health in LBC upper subwatershed indicate good water quality, verifying the ICM

The lower LBC subwatershed reaches fall in the non-supporting range with an average impervious cover of 35 percent. Streams in this category essentially become conduits for conveying stormwater flows, and can no longer support a diverse stream community. The stream channel becomes highly unstable, and many stream reaches experience severe widening, downcutting, and streambank erosion. Pool and riffle structure needed to sustain fish is diminished or eliminated and the substrate can no longer provide habitat for aquatic insects, or spawning areas for fish. Water quality is consistently rated as fair to poor, and water recreation is no longer possible due to the presence of high bacterial levels. The biological quality of non-supporting streams is generally considered poor, and is dominated by pollution tolerant insects and fish. The categorization is also supported by field investigation (see water quality and biology discussions below).

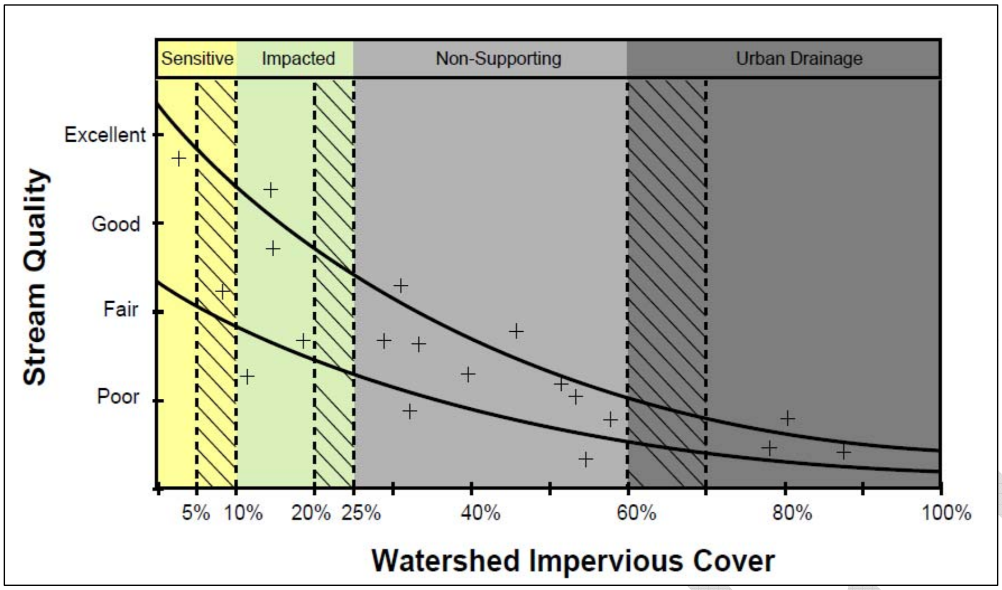

Figure 4. Reformulated Impervious Cover Model

Existing Data

In order to fulfill certain requirements of the Federal Clean Water Act, the NYSDEC has to provide regular, periodic assessments of the quality of the State's water resources and their ability to support specific uses (such as for drinking water, swimming or fishing). These assessments reflect monitoring and water quality information from NYSDEC sources, and outside the agency. The assessments are compiled and become an inventory database of all waterbodies in the State. The resulting document is the "Waterbody Inventory/Priority Waterbodies List" (WI/PWL) that lists current water quality information, characterizes known and/or suspected water quality problems and issues, and tracks progress toward their resolution. The latest inventory that includes LBC is "The 2001 Genesee River Basin WI/PWL". The document has a two-page write up (see Appendix C) on LBC lower and tributaries (a geographic area that includes the main channel and all tributaries from the mouth to Coldwater Road). The report states:

> *"Aquatic life support in the Little Black Creek has been assessed as impaired due to documented macroinvertebrate impacts. Recreational uses are also thought to be affected by stormwater discharges and urban runoff. Flooding issues in the watershed are also a concern.*
>
> *A biological (macroinvertebrate) assessment of Little Black Creek near Chili was conducted in 1999. Sampling results indicated moderately impacted water quality conditions. Although the habitat was determined to be satisfactory, mayflies were not found at the site. Impact Source Determination revealed possible toxicity affecting the fauna. (DEC/DOW, BWAR/SBU, January 2001)*
>
> *Increasing urbanization contributes stormwater runoff and various other nonpoint source pollutants. SPDES permits for the discharge of stormwater and non-contact cooling water to the creek have been issued to a few industries. Significant agricultural activity in the western half of the watershed includes dairy operations and manure spreading (Monroe County Health Department, April 2001).*
>
> *Flooding and other hydrologic issues are also of concern. The stream drains very flat terrain with several NYS Designated wetlands in an area that is undergoing increased development. Flooding has been a long-standing problem, but downed trees and a resident beaver population have exacerbated*

> *this problem. The Town of Ogden has obtained a permit to remove downed trees to open up the waterway and allow the stream to flow more freely. (Monroe County Health Department, April 2001).*
>
> *This segment includes the stream and all tribs from the mouth to Route 251 in Coldwater. The waters of the stream and tribs are primarily Class C; a small portion of the stream from above Chili Avenue to Pixley Road and trib -a are Class B. (May 2001)"*

The last sentence above refers to how New York State classifies waterbodies. The majority of LBC is classified as "C". All waters in New York State are assigned a letter classification that denotes their best uses. Letter classes such as A, B, C, and D are assigned to fresh surface waters. Best uses include: source of drinking water, swimming, boating, fishing, and shellfishing. The best usage of Class C waters is fishing where NYSDEC states: *These waters shall be suitable for fish, shellfish, and wildlife propagation and survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes.*

Information from the WI/PWL was used to compile the Clean Water Act Section 305(b) Water Quality Report (NYS DEC, 2008), which notes LBC is impaired with major aquatic life use impacts. "Known" pollutant sources are water level and flow, suspected pollutant sources are unknown toxicity from urban runoff and agriculture listed are high dissolved oxygen demand, phosphorus, pathogens and silt/sediment. The report notes industrial, municipal, on-site/septic systems, construction and urban/storm runoff as possible pollution sources.
NYSDEC defines impaired as *"…the occasional water quality, or quantity, conditions and/or habitat characteristics periodically prevent specific uses of the waterbody, or; waterbody uses are not precluded, but some aspects of the use are limited or restricted, or; waterbody uses are not precluded, but frequent/persistent water quality, or quantity, conditions and/or associated habitat degradation discourage the use of the waterbody, or; support of the waterbody use requires additional/advanced measures or treatment.*

Agriculture

Agriculture is also listed as a suspected source of nutrient pollution in the WI/PWL. The upper watershed has a significant amount of agricultural fields growing corn, wheat, soybean, oats and cabbage. The Monroe County Soil & Water Conservation District is applying Agricultural Environmental Management (AEM) approach to farms in the watershed. AEM is a voluntary, incentive-based program that helps farmers operate environmentally sound and economically viable businesses by helping to manage nutrient use, protect drinking water, conserve soil, improve neighbor and community relations, and comply with environmental regulations.

Farms in this watershed will be evaluated and ranked based on their potential contribution to water quality impacts in Little Black Creek. Farmers that participate in the AEM assessment and planning process will be offered technical assistance and cost share opportunities when available to pursue implementation of best management practices that will address the priority areas of concern identified in planning phases. An estimated 19 farms in the watershed have been evaluated using the AEM tiered approach.

Wetlands

State and federal government agencies regulate certain wetlands in order to preserve them as a natural resource. Wetlands make up a significant portion of this watershed: 14 and 6 percent of the upper and lower watersheds respectively. Wetlands serve important water quality and quantity functions in the watershed that should be factored into stormwater action plans. Because they are typically located in low, flat areas, they naturally receive stormwater runoff. However, land development has historically, filled wetlands or diverted stormwater, limiting their ability to act as natural filters and detention basins. In some situations, draining treated or pervious area runoff to natural wetlands may enhance or restore some wetlands in the LBC watershed (though developed areas should never be directly drained to natural wetlands which would degrade their habitat value).

Stream Sampling Results

As part of the SWAAP, Monroe County Department of Environmental Services conducted strategic water sampling in an effort to provide meaningful data on stream health and water quality for comparison with NYSDEC sampling and verification of modeling results. Water Quality sampling involved the collection of dry (baseflow) and wet weather grab (NEED WET WEATHER) samples for eight water quality parameters: Total Suspended Solids (TSS); Total Phosphorus (TP); Total Kjeldhal Nitrogen (TKN); Soluble Reactive Phosphorus (SRP); Ammonia; Nitrate/Nitrite (NO_x); Chloride (CHL); and Ecoli. All sample analysis was performed by the Monroe County Environmental Lab following approved procedures. Samples were collected at road crossings to allow easy access to the stream and where possible, at locations downstream from the other to allow estimates of increasing basin loads of sediment and nutrients.

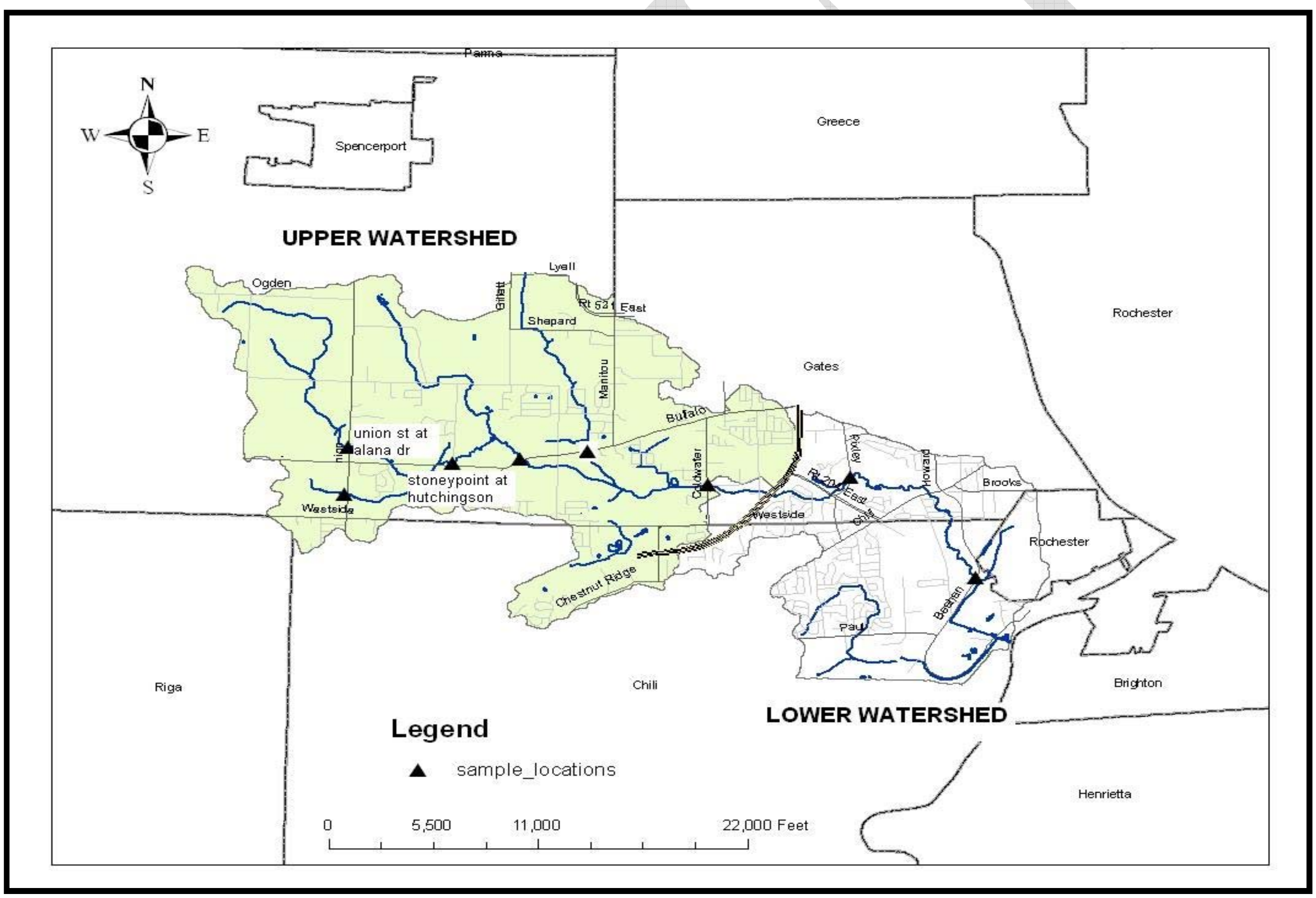

Figure 4. Little Black Creek Sampling Stations

Table 3. Baseflow Monitoring Data				All values mg/L		Ecoli mpn/100mL		
Station (upstream to down)	**Date**	**TSS**	**TP**	**SRP[1]**	**TKN**	**Ammonia**	**NO_x[2]**	**CHL**
Union St at Alana Dr	3-23-10	13	0.108	0.0230	0.736	0.0271	1.54	51.3
Hutchings at Stoney Point Rd.	3-23-10	16	0.136	0.0549	0.789	0.04522	1.09	52.1
Buffalo Rd.	3-23-10	24	0.128	0.2542	0.812	0.0155	1.11	54.5
Coldwater at Cherry Rd	3-23-10	39	0.127	0.0146	0.716	0.0107	0.894	90.3
Pixley Rd	3-23-10	17	0.0757	0.0179	0.671	0.0221	0.835	171
Beahan Rd.	3-23-10	26	0.101	0.0524	0.784	0.0512	0.716	175

NYSDEC standards:
1. Phosphate (ortho phosphate): None that will result in growth of Algae, weeds, and slime that will impair use. Guidelines: Above 0.05 mg/l "impact likely"; Above 0.1 mg/l "impact certain"
2. Nitrogen-Nitrate: Class A – 10 mg/l; Class B,C,D: none that will result in growths of Algae, weeds and slime that will impair use. Typical Natural Levels for fresh water – less then 1 mg/l
Recommended levels for trout – less then 0.06 mg/l; Sewage Treatment effluent:- 30mg/l

Baseflow data is useful to identify areas with potential base flow contamination. The addition of flow data provides the ability to predict pollutant loads and yields from stormwater runoff in urban watersheds. The results of baseflow sampling are presented in Table 3. A set of wet weather grab samples were collected after a rain event of xyz inches of rainfall shown in Table 4. ADD TABLE AFTER SAMPLE COLLECTION

Table 5 shows a comparison between Little Black Creek and national averages for event mean concentrations. One comparative study is the 1983 National Urban Runoff Program (NURP). The second is a National Summary of Pollutant Concentrations in Stormwater Runoff provided by Pitt et al, 2003.
Consider removing table

Table 5. Pollutant Concentrations from Select Studies for Residential Land Use (All values mg/L)							
Study	**TSS**	**TP**	**NH3L**	**TKN**	**SRP**	**NOX**	**Total N**
US EPA NURP, 1983	101	0.38					2.6
Pitt, 2003	48	0.3		1.4	0.17		2
Little Black 2010	Not completed	Not completed	Not completed	Not completed	Not completed	Not completed	Not completed

2.1.3 Geology and Soils

The form of a stream, its channel, banks and floodplain are the result of an evolving series of processes influenced by geology, climate, natural events and humans. The geology of northern third of the Little Black Creek watershed is the result of preglaicial, inland seas that, through sedimentation, formed the Lockport rock formation. The Lockport Group is found near the surface along the southern portion of Ogden and northern portion of Gates and visible along I-490 on the west side of Rochester and in area rock quarries. These rocks are exceedingly resistant and part of this rock unit is responsible for the resistant caprock that forms Niagara Falls. This rock layer determines the gradient of Little Black Creek for most of its length. South of the Lockport formation is the Salina formation, well known for its high salt content.

On top of these formations are glacial deposits of varying depths which make up two major soil associations. The smaller of the two soil associations is Colonie-Elnora-Minoa which is about six square miles located along the Gates and Chili town line and roughly centered on NYS Route 490 expressway. The deep, well-drained soil association is somewhat coarse to fine textured soils over deep sand formed from preglacial lake beaches, deltas and sand bars. The second major soils association is Schoharie-Odessa-Cayuga. These soils are deep, well-drained to somewhat poorly drained fine textured soils. These soils are deposits from glacial lakebeds and are generally found on flat terrain.

Soil scientists further define soils by their ability to absorb stormwater, placing each soil type into one of four categories, A through D. "A" and B soils are well drained. C and D soils are poorly drained. Percentages of each of these four soil types in LBC are: A soils 15%, B soils 12%, C soils 49%, D soils 24% (Figure 5).

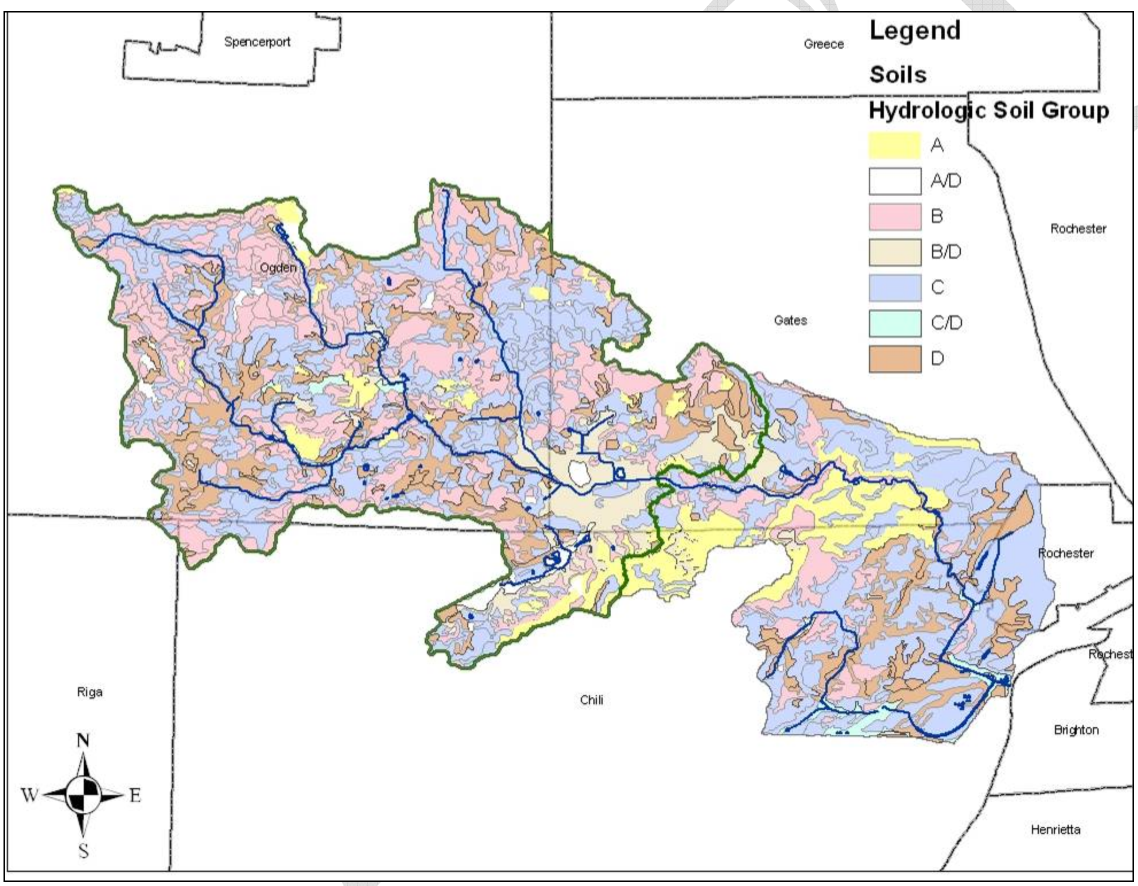

Figure 5. Little Black Creek Hydrologic Soil Types

The makeup of watershed soils is important from a restoration perspective, as it relates to the potential for infiltration of stormwater. Infiltrating stormwater reduces stormwater runoff volumes and peak flows, reducing flooding. Infiltration also recharges groundwater needed to maintain normal base flow rates in a stream needed for aquatic habitat. Once runoff is infiltrated into soils, plants and microbes can naturally filter and break down many common pollutants found in stormwater runoff, thereby improving a stream's water quality.

2.1.4 Drainage and Hydrology

Town of Ogden

The towns of Ogden and Gates have had engineers prepare drainage studies that included the Little Black Creek watershed (Larsen, 1966 and 1976 respectively). The 1966 Ogden report describes LBC watershed terrain as very flat with low stream banks that allow the stream to frequently overflow and enter adjacent floodways and floodplains. As sanitary sewers had been installed there increasing residential development, the report recommended "remedial work in the Little Black Creek watercourses over those in other watersheds in the Town". Common for the time period, solutions to capacity issues in streams relied on increasing the stream's channel size. With much of the length of the stream overgrown at that time, a common engineering recommendation was vegetation removal, regrading and widening miles of stream. This practice is discouraged today because it effectively moves the capacity problems downstream to the neighboring community as well as destroys aquatic habitat and degrades water quality. The 1966 report notes that, since bedrock defines the bottom of much of the Ogden portion of the stream bed, blasting the rock would be required to lower the channel to create more storm carrying capacity. In 1967, Ogden adopted a drainage ordinance which incorporated some of these recommendations.

A drainage area of concern noted was on Chambers St – west of Vroom Road where homes were built too low, frequently flooding. Several interviews were held with Ogden Highway Superintendent, David Widger, on drainage and flooding concerns in LBC. Ogden has an active stream cleaning and grading program to address drainage problems that result from the flat grade of the creek and low lying adjacent areas. The program minimizes residents' complaints resulting in few existing problems.

Town of Gates

Larsen Engineers completed the Town of Gates Town-Wide Drainage Study ten years after Ogden's (Larsen 1976). The drainage study notes a long history of flooded homes and streets in the LBC watershed. By this time, more environmental controls were in place nationally, in New York State, and locally. The result is seen in the recommendations proposed in this report. Page 20 notes how the cycle of urbanization is causing the loss of aquatic habitat and recommends multi-purpose corridors that would be protected by the adoption of an ordinance and supported by the creation of a drainage district. The ordinance would restrict all building and filling in the flood plain and the district would pay for the capitol improvement program that included the construction of a detention pond, bridge replacement and relief sewer (most of which were built).

Years later, the Town hired Passero Associates to perform a minor drainage study of Little Black Creek (Passero, 2000) to address drainage and assess the need for improvements. Their findings were that swales and culverts were generally undersized which has caused lowland areas to store stormwater (flood). Upstream storage areas should be made such as in the Kodak Elmgrove Industrial Complex. The study strongly recommended that drainage improvements be made in the Pixley Industrial Park and that the Hidden Valley Pond outlet be modified to better control the discharge rate (see figure 6). Further, this pond has no sediment-capturing forebay which the study recommends adding. (Note: these recommendations are also part of Section 4.).

Areas within the 100-year-floodplain in LBC are shown on Figure 7. The 100 year floodplain is the area that is expected to be flooded as a result of a storm with a one percent chance of occurring in any given year. These areas mainly border the stream however, a large floodplain along with State and Federal Wetlands fan out over the watershed's mid point. A significant flooding related issue was the revision to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps. A five-year, $1 billion project by the FEMA to draw new maps pinpointing places that have a 1 percent chance of flooding in any year. Every county in the New York region has been remapped. The revised maps show an expanded floodplain that would have required about 160 more homeowners to pay for flood insurance costing each several hundred dollars annually. However, flaws found in the revised maps removed some 30 homes.

Figure 6. Hidden Valley Pond Outlet – leaking weir lacking water quality or quantity control.

LBC drainage and flooding issues were discussed at a meeting with Town Engineers, Lee Sinsebox and Laurey Richey (Costich Engineers), and Gates Public Works Commissioner John Lathrop. Mr. Lathrop noted that the Town has installed streambank stabilization using riprap in some eroded sections and performed some debris removal as part of normal maintenance. Areas noted where drainage is a concern included: Rowley Drive residents' lawns commonly flooding; Elevated water under the bridge crossing on Coldwater Road due to the downstream railroad bridge structure blocking flow at the railroad/creek crossing near Cherry Road; and, the Elmgrove Road cross culvert that drains Kodak is undersized or too low. The pond there flows southeast to LBC and could be a potential cause of some toxics causing the Creek's use impairment. Some issues with the size of a culvert pipe there or possibly a blocked pipe.

Town of Chili

Chili had a town-wide drainage study done by Bergmann Associates in 1979. The Town reports minor maintenance drainage issues that are typically corrected with ditch cleaning. There is also some bank erosion. Debris in Little Black Creek was cleaned by Town forces between 2005 and 2007. Some areas have high water levels that can cause drainage problems but these are primarily in or very near wetland areas that are prone to seasonal standing water. In some cases, State road stormwater conveyance systems need maintenance and have caused drainage issues elsewhere.

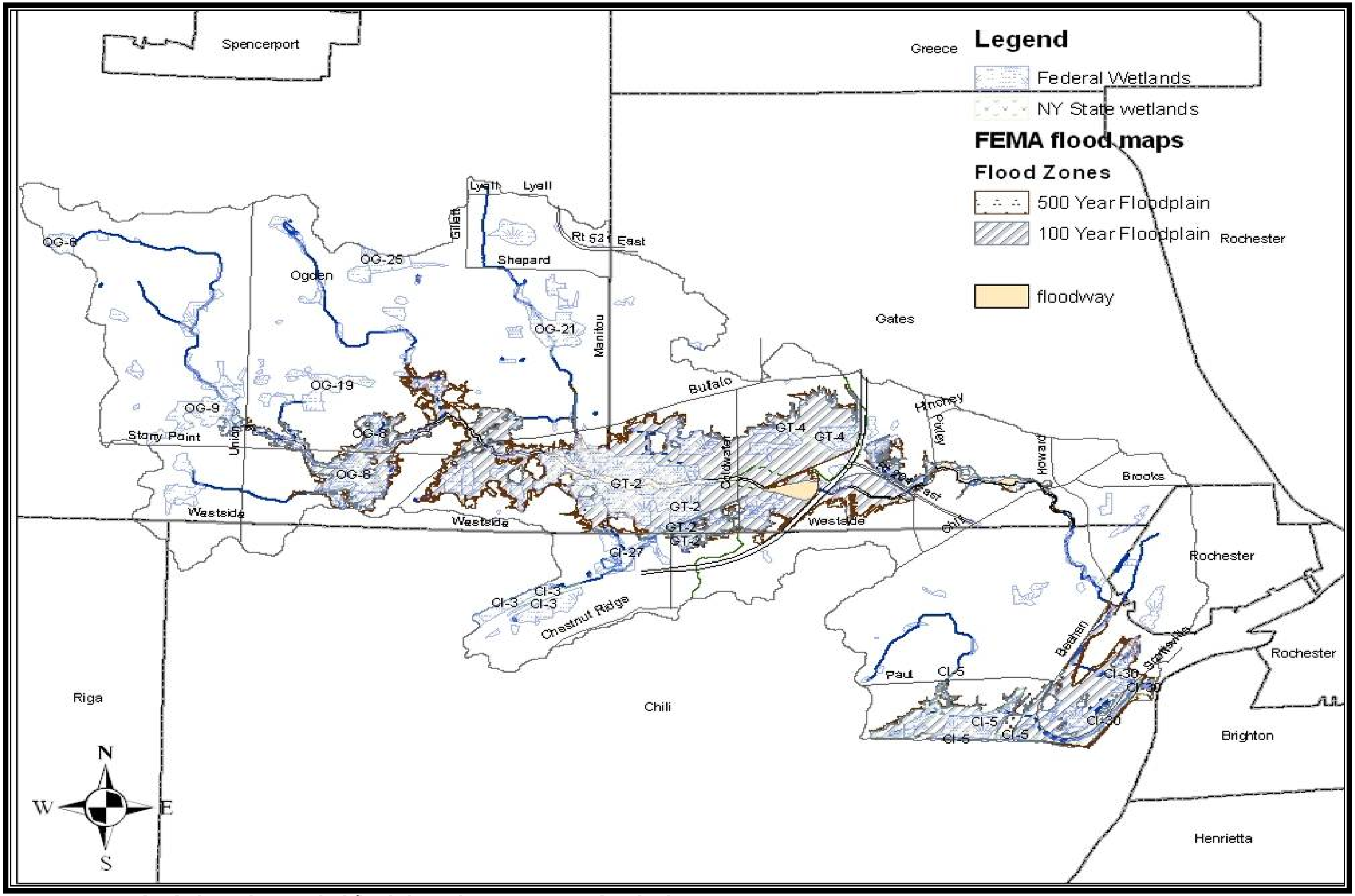

Figure 7 Little Black Creek Watershed flood plains, drainage issues and wetlands

2.1.5 Biology

County staff conducted an assessment of LBC for habitat quality and biological diversity by looking at stream substrate and benthic macroinvertebrates (aquatic insects living in the stream bed). Benthic macroinvertebrates are a common indicator of water quality in streams, rivers and lakes. The ratio and number of these macroinvertebrates change with the stream food resources and human impacts and therefore can be used as a tool for assessing the ecological status of the biotic community and water quality. Stream habitat is typically measured by examining a composite of individual habitat metrics thought to contribute to habitat quality.

The advantages of benthic macroinvertebrate sampling are numerous, but the key advantage is the invertebrates are living in the stream all the time and are subjected to all changes in water quality and habitat over the course of seasonality, storm events, and changes in the land use. This technique is widely accepted and is used by NYS DEC as an indicator of water quality across the state. Using benthic macroinvertebrate population data can give a better summary of water quality throughout the watershed and, used in conjunction with target water quality sampling, is a good rapid approach to assess the watershed.

A previously mentioned, NYSDEC conducted similar biological assessments of Little Black Creek (LBC) and concluded the lower stream segment and tributaries are impaired (NYS DEC Waterbody Inventory revised, 2007). Sources of pollutants affecting the fauna listed in this report are unknown toxicity and urban runoff.

At each sample location, macroinvertebrates were sampled with a kick net and each species was identified and counted. The stream bed habitat was also assessed at each location. Indicators of stream health are: 1) *population's pollution tolerance* which groups species present into their tolerance to polluted waters (examples of pollution intolerant species are mayflies and stoneflies), 2) *population status* which measures species diversity and population within a species, and 3) *habitat quality* which measures the amount of silt in the steam bed, bank stability and the width of the riparian zone (all thought to contribute to habitat quality). Pollutant tolerant specie examples are leeches and maggots. The quality of the habitat can be a result of many factors. Results can be found in Table 6.

Table 6. Little Black Creek 2009 Macroinvertebrate Sample Results

Site (upstream to downstream)/subwatershed	Population's Pollution Tolerance	Population Status	Habitat Quality
Union St/Upper	intolerant	intermediate	good
Alana Dr/Upper	intermediate	intermediate	good
Hutchings at Stony Point /Upper	tolerant	impacted	poor
Buffalo Rd main stem/Upper	tolerant	poor	poor
Buffalo Rd trib from Shepard Rd	tolerant	impacted	poor
Coldwater & Cherry Rd/boundary Upper to Lower	intermediate	impacted	moderate
Pixley Road/Lower	Tolerant	Impacted	Poor

Further verifying the ICM and NYSDEC study, the macroinvertebrate population as a whole in Little Black Creek is typical of a stream in an urbanizing watershed. Results indicate that the water quality of the upper watershed is generally good with some impacts found. Habitat scores indicated some variability between sample locations here. In the upper subwatershed habitat impacts were mainly silting in of the stream bed and a lack of vegetation along the stream bank from either agriculture or residential development. In the lower subwatershed channelization most affected the habitat score. The fauna and quality of habitat are degraded in all sections downstream of Buffalo Road with only pollution tolerant and intermediate tolerant species present.

Channelization has, in some cases, both widened the stream and armored the banks. A wide channel causes shallow, slow flow heating water in the summer depleting oxygen (warm water holds less dissolved oxygen for fauna to breath) and very few species survive. Stream temperature was measured at several locations in LBC (Table 7). Fish, insects, zooplankton, phytoplankton, and other aquatic species all have a preferred temperature range. If temperatures get too far above or below this preferred range, the number of individuals of the species decreases until finally there are none. Most aquatic organisms begin to feel stress at stream temperatures above 70° Fahrenheit.

Table 7. Little Black Creek Temperatures Summer 2010 (in °Fahrenheit)

	Alana Dr/Upper	Hutchings at Stony Point /Upper	Buffalo Rd main stem/Upper	Harpington Dr. (Lower)	Pixley Road/Lower	Beahan Rd.
Mean						
Max						

An example is in the Westmar Village residential neighborhood (see Figure 8). This sample location has numerous problems. The stream reach has received large amounts of sediment and there is no real stream bed. The sediment is at least a foot deep which makes this stretch of stream unsuitable habitat for benthic macroinvertbrates. In another example, the habitat was suitable for macroinvertebrates, but the population was tolerant of poor water quality, showing that the location was subjected to pollutants recently.

Figure 8. Channelization of Little Black Creek looking west from Harpington Drive bridge (Westmar Village).

2.1.6 Watershed Treatment Model Results for Pollutant Loads

The Watershed Treatment Model (WTM) was used to estimate existing and future nutrient and total suspended solid loads within the LBC watershed. The WTM, (Caraco, 2002), is a spreadsheet model used to:

- Estimate pollutant loading under current watershed conditions
- Determine the effects of current management practices
- Estimate potential load reductions associated with implementation of structural and non-structural management practices
- Evaluate the effects of future development

The model has two basic components: Pollutant Sources and Treatment Options. The Pollutant Sources component of the WTM estimates the load from primary land uses (residential, commercial, forest land) and secondary sources (i.e. active construction, managed turf, channel erosion, illicit connections) in a watershed without treatment measures in place. The Treatment Options component of the model estimates the potential reduction in this uncontrolled load if various treatment measures (both structural and nonstructural) are used. A more detailed description of the WTM is in Appendix E.

The following caveats should be considered while reviewing the use of the WTM:

- The WTM is a planning level model primarily for urban/suburban applications. There are many simplifying assumptions made by the WTM, and the model results are not calibrated. Therefore, the results of the model simulations should be compared on a relative basis rather than used as absolute values.
- The application of existing treatment practices in the LBC watershed is based on GIS data, best professional judgment, and default values associated with the WTM.

The WTM land use primary source estimates are based on area calculations from Monroe County's GIS parcel layer. Each parcel has an attribute showing the property class description as well as lot size. The WTM impervious cover estimates were determined by the Monroe County GIS Division using the 2005 Monroe County Land Cover Model and aerial imagery. The WTM estimates were adjusted where reasonable, using best professional judgment, to align more closely with the directly measured values generated from the county impervious cover layers.

Inputs for primary and secondary pollutant sources in the watershed provided the foundation of the model. Primary sources included metrics on land use, soils and depth to groundwater. Areas of residential housing (divided by density), commercial, industrial and rural watershed acreage are inputs to primary pollutant sources. The large amount of agricultural land in the upper subwatershed was lumped into the "Rural Land" category along with parks and vacant parcels. It is important to note that this type of "lumping" likely does not reflect pollutant loads from different types of agricultural land uses (say row cropland versus pastureland) as some other agriculture-based pollutant models. Also, the model currently has no default best management practices for agriculture (such as reduced tillage or proper manure management). Revising these model inputs and outputs should be a future task of SWAAP preparers.

An example of a secondary source input is the fraction of illicit connections of sanitary waste to storm sewers in the watershed. Actual numbers were available since Monroe County surveyed outfalls for illicit discharges in 2005 as required under their MS4 permits. Another WTM input estimates pollutant loads from sanitary sewers themselves. Monroe County GIS data was available for sanitary sewer systems in the watershed and once the length of sanitary sewer miles was tallied, WTM uses values for expected sanitary sewer overflows based on national studies of increased wet weather flow volumes. Loads are further refined with the WTM input question: Are there combined sewers in the watershed? This watershed has none.

The model then needs to know what existing management practices are being applied in the watershed. For structural stormwater management practices, staff reviewed aerial photos with storm sewer overlays to determine where developed areas were discharging to stormwater management practices, the type of the practice, area draining to the practice, and percent of impervious cover within the drainage area. While this was time consuming, good GIS data made it possible.

Based on primary and secondary sources of pollutants loads and existing management practices, modeling results are listed in the following two tables for: Total Nitrogen (TN); Total Phosphorus (TP); total suspended solid (TSS); fecal coliform; and, runoff volume for existing and future conditions.

Table 8. Little Black Watershed Treatment Model - Existing Load Estimates

	Existing % Impervious	**TN** (lbs/acre/yr)	**TP** (lbs/acre/yr)	**TSS** (lbs/acre/yr)	**Fecal Coliform** Billions of colonies	**Runoff Volume** (acre-ft/yr)
Upper Subwatershed	8	55,819	10,740	1,612,826	1,605,270	4,223
Lower Subwatershed	35	36,942	7,412	1,371,544	2,024,910	6,221

Table 9. Little Black Watershed Treatment Model - Future Load Estimates

	Estimated % Impervious	**Total N** (lbs/acre/yr)	**Total P** (lbs/acre/yr)	**TSS** (lbs/acre/yr)	**Fecal Coliform** Billions of colonies	**Runoff Volume** (acre-ft/yr)
Upper Subwatershed	12	57,232	10,972	1,650,652	1,527,105	4,242
Lower Subwatershed	40	37,878	7,389	1,207,233	1,722,178	5,311

Section 3. Results of Stream Corridor and Upland Assessment

3.1 Stream Corridor Assessment

County staff conducted field assessments of Little Black Creek and watershed to measure the stream's quality and impacts from its drainage area. The assessments were conducted using methods (with some modifications) developed by the Center for Watershed Protection (CWP, 2004). GPS compatible forms assist identifying and ranking the stream's physical condition and restoration potential, pollution generating hotspots, and stormwater retrofits. Field crews consisted of county staff from the Department of Environmental Services. Examples of the field forms used are provided in Appendix D.

The majority of the stream was assessed at, and adjacent to, public road crossings. Table 9 shows results from the stream corridor assessment separated by upper and lower subwatershed. The table provides the number of identified impacts in each subwatershed for the 6 categories assessed.

Table 10. Stream Corridor and Riparian Impacts by Subwatershed

	Upper Subwatershed	Lower Subwatershed
Impacted Buffer	1	6
Channel Erosion	1	10
Channel Modification	3	20
Road Stream Intersections	28	21
Trash & Debris	1	2
Outfalls	38	60

3.1.1 Impacted Buffers

Streamside buffers stabilize banks, create habitat, and remove pollutants. The vegetative species found in a stream buffer vary with a mature forest representing the optimal condition. Development in a watershed often results in encroachment, tree clearing and mowing of the buffer. These changes interrupt the continuity of the stream buffer corridor and undermine its many benefits. The stream buffer survey evaluated stream corridor lengths greater than 100 feet long that lacked at least a 25 feet wide, naturally-vegetated riparian buffer on one or both sides of stream.

Each assessed reach was given a score for reforestation potential ranging from 1-5. A score of 5 indicated that the impacted area was on public land where the riparian area does not appear to be used for any specific purpose with plenty of area available for planting. A score of 1 indicated limited restoration potential with the impacted area on private land where road, building encroachment or other features significantly limit available area for planting. 26 impacted reaches were identified. 16 of the 26 impacted reaches received scores of 3-5 indicating the greatest potential for restoration. Figure 12 shows an impacted buffer in Ogden looking north from Statt Road.

Figure 9. Impacted Buffer with Good Restoration Potential

3.1.2 Stream Bank Erosion

Stream erosion reflects the natural process of channel migration and adjustment, whereby streams continuously meander, widen and narrow in an attempt to reach a stable equilibrium. The balance between sediment load and discharge can be disrupted by development in the watershed. Severe erosion occurs when the velocity of flowing water in the stream exceeds stability thresholds for the stream materials (such as soils and rock). Research has shown a linear relationship between development in a watershed and bank instability leading to rapid and excessive bank erosion as the stream adjusts to the changing hydrologic conditions.

Extensive bank erosion and channel headcuts are expected in urban subwatersheds. Trimble (1997) estimated that more than half the sediment loads from highly urban watersheds were derived from eroded stream banks. The bedrock and low-gradient of the stream has minimized these typical effects. However, erosion problems are present and mainly consist of stream widening along impacted buffer and channelized sections (as opposed to headcutting). The erosion severity was measured on a scale from 1-5 with a score of 5 indicating eroded banks on both sides of the stream, eroding at a fast rate with erosion contributing a significant amount of sediment to the stream, and an obvious threat to property or infrastructure. Figure 13 shows an example of active stream bank erosion in Gates where the left bank rises about 30 feet and in close existing homes.

Figure 10. Active Stream Bank Erosion south of Chili Avenue and east of Mareeta Road

3.1.3 Channel Modification

As with erosion and buffers, channel modification was measured for severity and restoration potential. The highest level of severity indicates a long section (>500 ft) with very shallow channel water and no natural sediments present in the channel. Without question, the most severe case of channel modification in LBC is the segment that flows through the Greater Rochester International Airport. Long sections are piped as well as straightened (with all vegetation removed). Due to strict Federal Aviation Administration requirements at airports the airport has removed wetlands and the stream corridor vegetation to reduce the risk of wildlife collisions. Figure 14 is an example of a stream reach on LBC with a severity score of 5. Thirteen reaches were identified with channel modification with 8 of those having severity rankings of 3 or higher. All 13 are candidates for restoration.

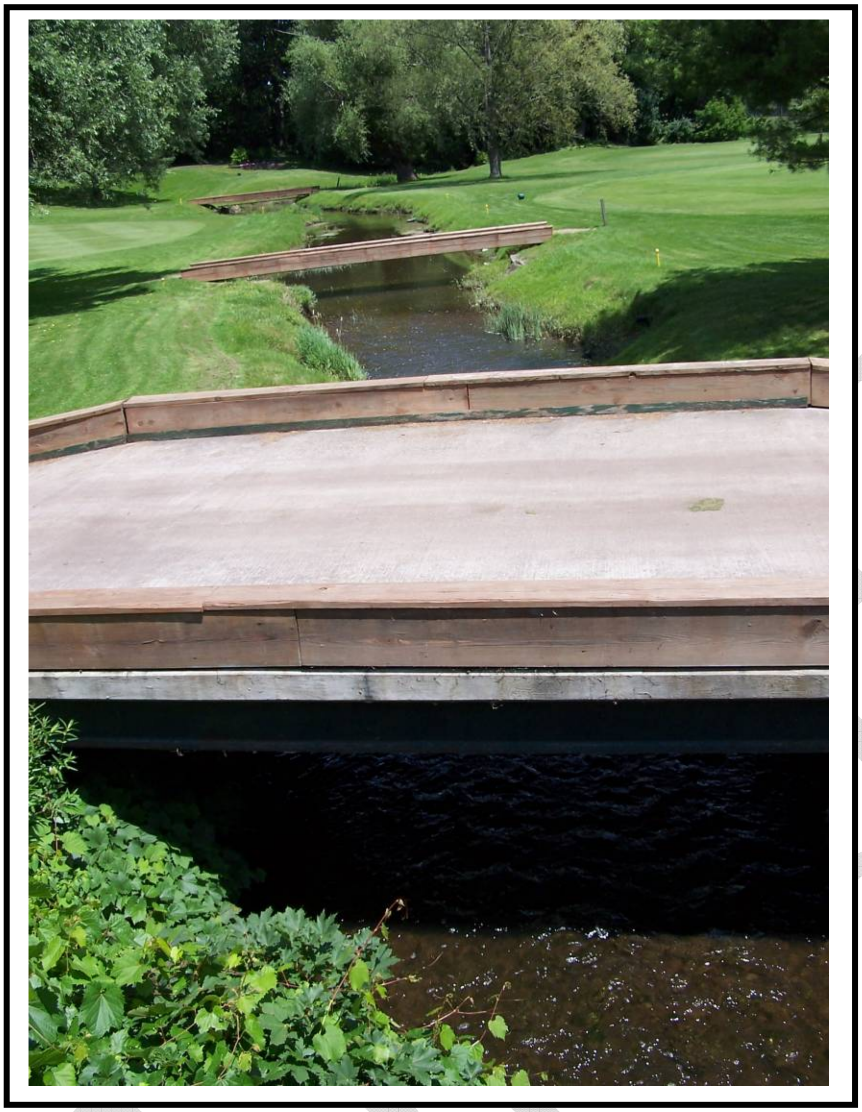

Figure 11: Channelized Stream Segment with Severity score of 5

3.1.4 Stream Crossings

Development increases the number of stream crossings which interrupt the stream corridor. These crossings can alter local steam hydrology, impact bank stability and prevent fish migration. All engineered structures that cross the stream, such as roadways, bridges, railroad crossings and other overhead utilities are assessed.

Stream crossings are important to assess as they relate to stream impacts and flooding potential. They can also be good candidates for upstream storage retrofits. Of the 71 road stream intersections in the watershed, 23 were evaluated. Of those 2 were candidates for upstream storage, 4 for stream repair and 2 for fish barrier removal.

3.1.5 Stormwater Outfalls

Stormwater outfalls along streams are widespread and consist of open channels or closed pipes that discharge stormwater runoff into streams. In developed watersheds stormwater is typically collected in a storm drain system and conveyed through an outfall. As impervious cover in a watershed increases, the density of outfalls per stream mile increases. In some cases, this causes increased flooding, peak flows and stream erosion. All pipes and channels that discharge stormwater to the stream are assessed.

In 2008 all municipal outfalls in the watershed were inspected to comply with the Municipal Separate Stormwater Sewer System Permit (NYSDEC, 2008 MS4).

3.1.6 Trash and Debris

Despite decades of anti-litter campaigns, trash still finds its way into streams and flood plains either from direct dumping or by transport through the storm drain system. The presence of trash and debris can degrade resident perceptions about stream quality, reduce community amenities, contribute pollutants and create blockages at outfalls or other locations in the stream. Areas of significant trash and debris accumulation greater than average levels observed across a survey reach are inventoried.

Three locations were identified as trash and debris hotspots. Materials found ranged from yard waste, pet waste, paper, plastic and automotive products. All locations have high potential for restoration by volunteer clean-ups, education, or removal by municipal staff. Figure 11 shows excessive debris in an industrial area of. Gates.

Figure 12. Trash and Debris – yard waste is continually dumped along 100 feet of the stream's bank in Gates.

3.2 Upland Survey

The upland land survey identifies neighborhoods and hotspots in the watershed and evaluates pollution producing behaviors. An assessment of pervious area is also conducted to identify restoration potential.

3.2.1 Hotspot Site Investigation

Stormwater hotspots are defined as commercial, municipal, industrial, institutional or transport related operations that produce higher levels of stormwater pollutants and may present a higher than normal risk for spills, leaks or illicit discharges. Using the watershed parcel records and the parcel property class description, 235 potential hotspots were identified in the LBC watershed. A majority of these are clustered in commercial and industry zoned areas along Buffalo Road, Chili Avenue and Pixley Road. Hotspots can be placed into five categories; commercial, industrial, institutional, municipal and transportation related with 72% of LBC potential hotspots falling in the industrial category.

Each type of commercial hotspot can generate its own blend of pollutants which can include nutrients, hydrocarbons, metals trash or pesticides. (CWP, 2005). Figure 12 is an example of a small industry in Gates where pollutant generated from outdoor waste disposal travel to nearby LBC.

Figure 13. Little Black Creek Watershed Hotspot

Observations were made for several categories of pollution generating activities; vehicle operations, outdoor material storage, waste management, physical condition of the building and grounds, turf landscape areas and stormwater infrastructure. Facilities were scored in each of these categories as to whether they were generating stormwater pollutants. Twenty five sites were given a status of confirmed hotspot. Three properties were identified as severe hotspots. These locations are considered to most likely pose an immediate impact to water quality.

3.2.2 Neighborhood Source Assessment

The neighborhood source assessment (NSA) evaluates how stormwater is managed, stewardship behaviors, and restoration opportunities within individual residential areas. The assessment looks specifically at lawns, rooftops, driveways, sidewalks, curbs and common areas.

Potential residential locations were identified in the office through aerial photograph interpretation. Distinct neighborhood units were delineated using land use data and digital orthophotos. Neighborhood units in the watershed included blocks with similar single-family residential housing density, physically defined communities, and apartment or town home complexes. Individual yards account for about 70% of the turf cover in urban subwatersheds, and usually the majority of total pervious cover. Yards tend to be intensively managed, and can be a potentially significant source of nutrients, pesticides, sediment, and runoff.

One location that provides an example of how the neighborhood assessment was used to determine the land use impact to LBC is the Country Shire Estates neighborhood in Ogden built in 1988. The neighborhood has well manicured lawns, indicative of large inputs of lawn care chemicals (see Figure 13).

Figure 14. A residential neighborhood identified for its highly manicured lawns

Treating the runoff from a neighborhood like Country Shire presents a challenge. In addition to retrofitting the existing pond, stormwater managers should include education and outreach programs to encourage homeowners to apply water resource stewardship practices such as disconnection of downspouts and installation of rain gardens. These restoration steps were included in the Retrofit Inventory in Section 4.

3.2.3 Pervious Area Assessment

The pervious area assessment was conducted to evaluate natural remnants and large pervious areas outside the stream corridor. During the upland survey County staff looked specifically at existing vegetative cover, potential impacts, and site constraints at each location. The potential to reforest turf areas or restore natural area remnants and open parcels via soil amendments, planting, invasive plant species removal, and trash clean-up were evaluated.

Prior to going out to the field, sites with significant turf cover and publicly-owned sites were identified in the office using aerial photos and land use mapping information.

Figure 15. Potential reforestation of large mowed areas at former Kodak Elmgrove

Section 4. Retrofit Inventory

4.1 Retrofit Project Types

Generally, watershed retrofits can be broken into two broad categories explained below:

Stormwater Retrofits

Stormwater retrofits improve water quality and reduce water quantity problems by providing stormwater treatment, storage and runoff reduction in locations where practices previously did not exist or were ineffective. They are installed to capture, infiltrate and treat stormwater runoff before it is delivered to receiving waters. Retrofits are the primary practice used to restore streams since they can remove pollutants, promote more natural hydrology, improve stormwater conveyance capacity, and minimize stream channel erosion.

Stormwater treatment, storage and runoff reduction fall into two categories: Large practices - those that treat drainage areas ranging from five to 500 acres such as ponds and wetlands and, Small practices – those that normally treat less than five acres of contributing drainage area, and frequently less than one acre such as bioretention and infiltration practices (CWP, 2007).

Candidate sites were initially identified using orthophotos, local input, and information gathered during the field assessments. Priority candidate sites in the watershed generally had one or more of the following characteristics:

- Located upstream of potential stream restoration projects
- Located at uncontrolled hotspots
- Have a large amount of impervious cover in the drainage area
- Have existing drainage infrastructure or existing stormwater practices
- On publicly-owned or operated lands
- Could serve as a demonstration project.

Retrofit objectives were set early in the planning process to target the specific pollutants impacting the watershed as well as improve existing drainage issues. Both small and large retrofit practices have great potential of increasing water quality treatment, recharge, and mitigation of known pollution problems. These practices became the focus of recommended projects for the LBC watershed.

The target volume and flow rate controls for retrofits are:

- *Recharge*(R)*:* targets rainfall events that contribute much of the annual groundwater recharge at a site but create little or no runoff from undeveloped areas with pervious surfaces. Infiltrating this volume helps restore baseflows to streams, helping to restore habitat.

- *Water Quality*(WQv): targets rainfall events that deliver the majority of the stormwater pollutants during the course of a year. The water retrofit goal is to capture and treat the 90 percent storm, as defined by the local rainfall frequency spectrum. This criterion optimizes runoff capture resulting in high load reduction for many stormwater pollutants. The rainfall depth associated with the 90 percent storm for the Rochester NY area is 0.8 inches.

- *Channel Protection* (Cpv): targets storms that generate bankfull or near bankfull flows that cause stream channel enlargement. Channel protection storage generally exceeds the water quality storage volume by 20 to 40 percent in most regions of the country.

- *Overbank Floods* (Qp10): targets large and infrequent storm events that spill over to the floodplain and cause damage to infrastructure and streamside property.

Stream Repairs

Stream repair projects stabilize eroding stream banks, remove concrete-lined or piped sections to reestablish aquatic habitat, replant the riparian corridor, and reduce pollution sources from stormwater outfalls. In areas where the stream is set away from urban property lines, natural materials and "soft" techniques are used. Soft techniques include the use of natural materials such as rocks, logs, and native vegetation to:

- Reduce pressure on eroded banks
- Prevent down-cutting of the streambed
- Restore the meander pattern found in stable streams (such as an S-curve or a sine curve)
- Reforestation of the stream buffer zone.

In areas where the stream is closer to the street and in dense urban areas, "hard" solutions such as riprap and rock walls may be used to protect and reinforce stream banks.

A more detailed description and examples of the seven types of retrofit project types considered are described with examples below:

1. Construction of New Stormwater Management Ponds

New stormwater management ponds provide flood and water quality controls with significant benefits depending on location in the watershed. Figure 15 shows the location of a future pond that has been proposed to be built adjacent to the main stem of LBC in the upper portion of the watershed. The pond would receive high flows from the creek through a constructed channel that connects the creek to the pond at the upstream end and, another channel at the downstream end that discharges “treated” water back to the creek.

2. Retrofit Conventional Flood Control Ponds

Modifying existing ponds by adding features to treat stormwater pollutants and better control small storm events has been shown to be the most cost effective stormwater retrofit. There are 66 mapped ponds that were built to provide flood control with only a fraction of those ponds providing more advanced design features. To retrofit these ponds, outlet control structures should be modified and the basin reshaped and landscaped to enhance pollutant removal, aesthetics, improve native habitat and to reduce facility maintenance requirements. An example of a proposed conversion of a conventional flood control pond is shown in Figure 16.

To promote pollutant removal, a dual functioning pond is designed to:

- Maximize the flow path through the pond,
- Slow the flow of stormwater through the pond,
- Improve how plants use stormwater to increase absorption and evapotranspiration,
- Filter and trap common runoff pollutants,

- Promote soil saturation/groundwater recharge.

Figure 16. Proposed New Stormwater Management Pond in the Town of Ogden, southwest of Buffalo and Whittier Roads

3. Green Infrastructure Retrofits

Green Infrastructure is being supported by NYSDEC and partner organizations as a more effective way to capture, treat and improve stormwater runoff. These practices capture runoff from small areas of impervious surface and infiltrate, evapotranspire, and reuse stormwater (ie. to water lawns or gardens) to maintain or restore natural site hydrology. In this way, green infrastructure practices help to reduce stress on stormwater pipes and channels and lessen the impacts of development on streams. Benefits of green infrastructure include:

- Reduce stormwater pollution levels. Once runoff is infiltrated into soils, plants and microbes can naturally filter and break down many common pollutants found in stormwater runoff..

- Moderate erosive flow energy in stream channels. The infiltration of a portion of stormwater runoff can lower stream velocity which results in less erosion to stream channels. This leads to reduced suspended solids in the stream, stable stream banks and better aquatic habitat.

- Recharge of the groundwater table needed to maintain normal dry weather base flow in a stream which is a critical element to maintain a diverse aquatic habitat.

Figure 17. Conventional Flood Control Pond on Reddick Lane in Ogden for Potential Retrofit

Figures 17 and 18 are examples of potential green infrastructure practices that could be installed in the LBC watershed. For further details and examples of these practices, see Appendix F.

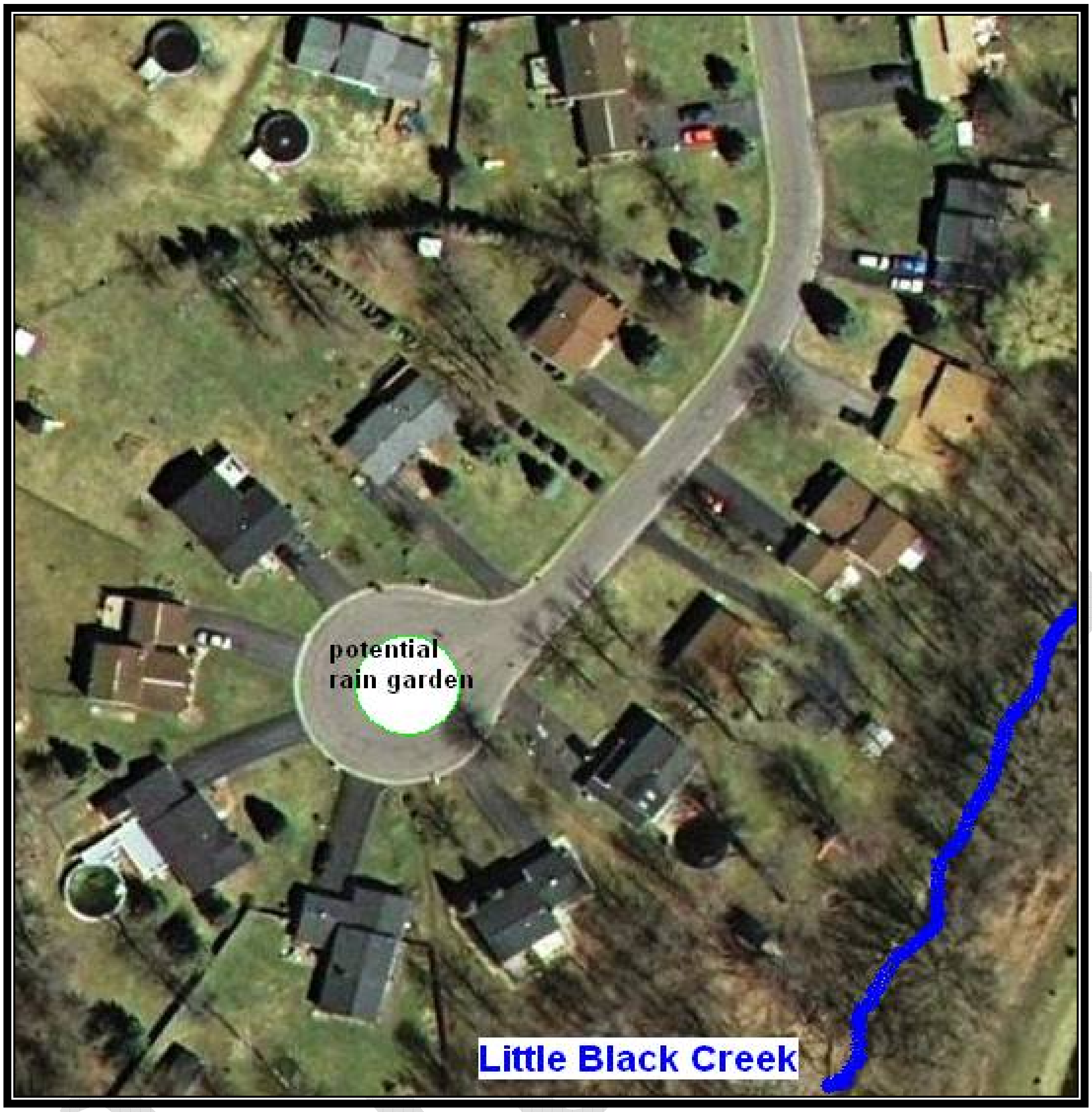

Figure 18: Proposed Cul-de-sac Rain Garden on Matthew Circle in Ogden

4. Stream Repairs

Stream repairs include physical modifications to stream channels, banks, and in-stream habitat to repair and improve degraded or unstable conditions. The project objectives are to reduce stream bank erosion, protect threatened infrastructure such as adjacent homes or roads, and recover biological diversity of a naturalized stream. Figure 7 shows a long section of Little Black Creek channelized through the Westmar Village subdivision.

5. Stream Buffer Enhancements

A stream buffer is a vegetated corridor of trees, shrubs and other native vegetation planted adjacent to the stream to protect the stream from the effects of the surrounding landscape. Replanting streamside vegetation with native shrubs, trees and plants insulate streams from a wide range of land use stressors such as stormwater runoff pollution. Figure 8 shows a high priority candidate restoration site on the south side of Statt Road in Ogden.

Figure 19: Proposed Vegetated Bioretention Swales at the intersection of Brooks Road and Chili Avenue

6. Hotspot and Discharge Prevention

Hotspot and Discharge Prevention is used to prevent the entry of sewage and other pollutants into the stream. These discharges may be caused by illicit sanitary sewage connections to the stormwater system, industrial and commercial pollutant discharges, failing sewage lines, vehicle transport or spills. Hotspot and Discharge Prevention entails the use of techniques to find, fix and prevent these illicit discharges; including conducting a survey of all known stormwater outfalls to identify suspicious discharges for further investigation.

7. Residential Management Practices

The last of the project types proposed for restoring Little Black Creek is actually a number of practices that rely on changing the day-to-day habits of watershed residents in ways that result in reductions in pollutant discharges. These practices include better management and reduced use of lawn chemicals, proper disposal of pet wastes, and understanding and applying the message "only rain down the drain" (no dumping or discharging wash waters, oils, paints and other chemicals down catch basins or stormwater conveyances).

4.2 Potential Retrofit Projects

4.2.1 Prioritization of Projects

Both field investigation and mapping tools were used to develop the inventory of retrofit projects that would meet LBC restoration objectives. Criteria was developed that used a quantitative approach where potential projects were assigned points based on the rationale described in numbered items below:

1. Feasibility Projects on public land were ranked higher because it is typically easier to implement restoration projects on public land where issues regarding property rights or privacy are avoided. Ease of access to the project area was also considered under this criterion by adding one point. Points awarded based on land ownership were as follows:

- Public lands were given three points in this category.
- Projects with stormwater easements on commercial property or covered by a homeowners association were given two points since they are considered to be less attached to mowing yards.
- Residential properties with stormwater easements were given one point.
- Projects on private property where no easement existed were not considered.

2. Multiple Benefits Many restoration projects can be designed to meet more than one subwatershed objective. The projects selected met at least two of the objectives identified for the Little Black7 Creek subwatersheds (see section 1.3 for objectives). One point was added for each expected benefit a project would deliver.

3. Environmental Benefit Environmental benefit was quantified by making an estimate of the area treated by proposed stormwater retrofits, or by estimating the length of stream restored or re-planted for stream restoration and riparian reforestation projects.

Watershed Acreage treated (for new and existing pond retrofits):

1. Large areas, greater than 40 acres were given three points.
2. Medium areas were those ranging from 10-39 acres were given two points.
3. Small areas were less than 10 acres and were given 1 point.

For Stream dechannelization and buffers:

1. Long lengths, greater than 100 feet were given three points.
2. Medium lengths were those ranging from 50-99 feet were given two points.
3. Small lengths were less than 50 feet and were given 1 point.

4. Cost Effectiveness Finding the most cost-effective solutions from a water quality perspective was a critical ranking criteria. The cost of stormwater restoration projects varies greatly, from several hundred to hundreds of thousands of dollars. Most projects were prioritized because they were simple projects that could be implemented by municipal staff, or were relatively inexpensive retrofits such as bioretention.

Figure 19 illustrates the cost effectiveness of several stormwater practices and provides the basis for this criteria ranking. Points awarded based on cost per cubic foot of stormwater treated were as follows:

1. Highly cost effective projects were those ranging from $1 to $11 and were given three points.
2. Median cost effective projects were those ranging from $12 to $25 and were given two points.
3. Low cost effective projects were those ranging from $26 and $100 and were given one point.
4. All other project types were not ranked – excluding, for example, green roofs.

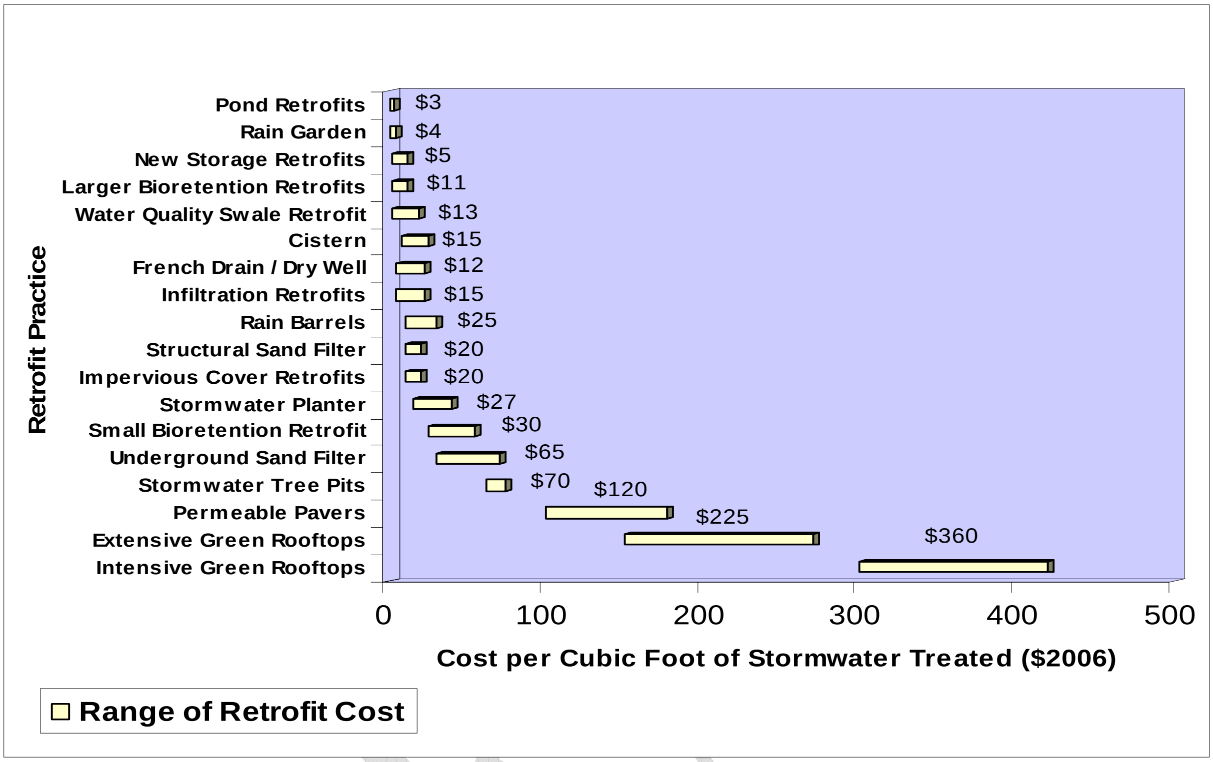

Figure 20. Range of Base Construction Costs for Various Watershed Retrofits (CWP, 2007).

4.2.2 Priority Retrofit Projects

Project List

The projects listed in Table 11 are those that were ranked the highest using the numeric criteria described in the previous section and considering a 15 year build-out timeline. A full listing of all potential restoration projects is provided in Appendix F. Additional criteria such as barriers due to State and Federal Stream and Wetland permit restrictions has been suggested and could be added along with weighting factors from the stakeholder meetings. Project types are numerically listed in the second column of Table 11, according to the seven categories described in section 4.2.1 above.

Table 11. Potential Retrofit Projects

Project Name/ Project Location	Project Type	Area Treated (acres)	Stream Length Restored (ft)	Reason for Prioritization	Planning-Level Cost Estimate
Buffalo Road at Whittier Road – Town of Ogden Flood Management Project	New Stormwater Pond	1000	NA	-Treats large area -Upstream developed area -w/o treatment -Public property	Town/land owner agreement
Median NYS Route 204 and 490 intersection	New Stormwater Pond	522	NA	-Treats large area -Upstream developed area w/o treatment -Public property	$470,000
off coldwater road adjacent and south side of railroad	New Stormwater Pond	300	NA	-Treats large area -Downstream erosion -Localized drainage issues -Public property	$350,000
south side of NYS Route 204 and east of Pixley Road	New Stormwater Pond	75	NA	-Treats large area -Downstream erosion -Localized drainage issues -Available space	$80,000
10 Reddick Ln off Stoney Pt. Rd. Ogden	Upgrade of Conventional Flood Control Pond	35	NA	-Treats large area -Downstream erosion -Localized drainage issues -Available space	$60,000
NYS Rt 531 median west of Manitou Ogden	Upgrade of Conventional Flood Control Pond	10	NA	-Downstream erosion -Upstream developed area -w/o treatment	$30,000
3285 Buffalo Rd Church of the Epiphany Gates	Upgrade of Conventional Flood Control Pond	11	NA	-Downstream erosion -Upstream developed area w/o treatment -Localized drainage issues	$30,000
Kodak Elmgrove interior roads Creative at Innovation	Upgrade of Conventional Flood Control Pond	20	NA	-Public property -Upstream developed area -w/o treatment -Localized drainage issues	$60,000
85 Forest Meadow Trail N Forest Estates Ogden	Upgrade of Conventional Flood Control Pond	28	NA	-Public property -Downstream erosion	$30,000
100 Paragon Dr Westover Business Pk. Gates	Upgrade of Conventional Flood Control Pond	52	NA	-Treats large area -Downstream erosion -Upstream developed area -w/o treatment	$30,000
NYS Rt 531 median west of Manitou S. Side Ogden	Upgrade of Conventional Flood Control Pond	12	NA	-Public property -Downstream erosion	$30,000
Kodak Elmgrove Pond near Buffalo Gates	Upgrade of Conventional Flood Control Pond	50	NA	-Downstream erosion -Public property -Treats large area	$30,000

Table 11. Potential Retrofit Projects (continued)

Project Name/ Project Location	Project Type (s)[1]/ Description	Area Treated (acres)	Stream Length Restored (ft)	Reason for Prioritization	Planning-Level Cost Estimate
490 Westbound exit cloverleaf @ Buffalo Rd E bound exit Gates	Upgrade of Conventional Flood Control Pond	10	NA	-Downstream erosion -Upstream developed area w/o treatment -Public property	$60,000
3 Woodbriar Ln. Chili	Upgrade of Conventional Flood Control Pond	40	NA	-Treats large area -Downstream erosion -Upstream developed area -w/o treatment	$60,000
199 Hidden Valley Rd (HOA) Gates	Upgrade of Conventional Flood Control Pond	120	NA	-Public property -Treats large area -Downstream erosion -Upstream developed area w/o treatment	$60,000
1489 Howard Rd Westgate Plaza Gates	Upgrade of Conventional Flood Control Pond	34	NA	-Downstream erosion -Upstream developed area w/o treatment	$30,000
1532 Brooks Ave Comida (Jet Black) Gates	Upgrade of Conventional Flood Control Pond	10	NA	-Downstream erosion -Localized drainage issues -Public property	$30,000
249 Fisher Road Wegmans Comida Gates	Upgrade of Conventional Flood Control Pond	23	NA	-Public property -Treats large area -Downstream erosion -Upstream developed area w/o treatment	$60,000
249 Fisher Road Wegmans Comida Gates	Upgrade of Conventional Flood Control Pond	11	NA	-Public property -Downstream erosion	$30,000
249 Fisher Road Wegmans Comida Gates	Upgrade of Conventional Flood Control Pond	65	NA	-Public property -Treats large area -Downstream erosion	$30,000
512 Paul Rd Wellington HOA Chili	Upgrade of Conventional Flood Control Pond	40	NA	-Treats large area -Downstream erosion -Upstream developed area w/o treatment	$30,000
74 White Oak Bend and 813 Marshall Rd.Wellington Subd Chili	Upgrade of Conventional Flood Control Pond	20	NA	-Downstream erosion -Upstream developed area w/o treatment	$60,000
82 Battle Green Dr. Lexington Subd Chili	Upgrade of Conventional Flood Control Pond	20	NA	-Downstream erosion -Upstream developed area w/o treatment	$60,000
Florence Brasser Gates Chili School 1000 Chili Center Rd.	Green Infrastructure Retrofit	3	NA	-Upstream developed area w/o treatment -Public Land -Education opportunity	$30,000

Table 11. Potential Retrofit Projects (continued)

Project Name/ Project Location	Project Type (s)[1]/ Description	Area Treated (acres)	Stream Length Restored (ft)	Reason for Prioritization	Planning-Level Cost Estimate
Walt Disney Elem.Gates Chili School 175 Coldwater Road	Green Infrastructure Retrofit	3	NA	-Upstream developed area w/o treatment -Public Land -Education opportunity	$20,000
Monroe County Fleet Ctr. 134 Paul Road	Green Infrastructure Retrofit	10	NA	-Adjacent to stream -Available space -Public Land -Hot spot reduces runoff volume	$15,000
Generations Child Care Gates Chili School 2400 Chili Ave.	Green Infrastructure Retrofit	3	NA	-Adjacent to stream -Available space -Public Land -Education opportunity	$15,000
Gates Highway Garage 475 Trabold Road	Green Infrastructure Retrofit	6	NA	-Adjacent to stream -Available space -Public Land -Hot spot reduces runoff volume	$15,000
284 Paul Road Town of Chili lot (corner of Jet View Dr.)	Green Infrastructure Retrofit	.5	NA	-Downstream erosion -Upstream developed area -w/o treatment -Public property	$15,000
Roch-Gen Rgnl Transport Auth. Truck Terminal 588 Trabold Road	Green Infrastructure Retrofit	2	NA	-Downstream erosion -Upstream developed area w/o treatment -Public property	$15,000
Monroe County Truck terminal 799 Beahan Road	Green Infrastructure Retrofit	2	NA	-Adjacent to stream -Available space -Public Land -Hot spot reduces runoff volume	$15,000
2653 Chili Ave, Town of Chili open space	Green Infrastructure Retrofit	.25	NA	-Upstream developed area w/o treatment -Public property	$5,000
Multiple institutional and commercial properties at the Greater Roc Int Airport	Green Infrastructure Retrofit	20	NA	-Reduces runoff volume & pollutants	$22,000
Blue Ridge Trail Town of Chili Open Space -Trib of LBC	Stream Repairs, Stream Buffer Enhancement	NA	1500	-Public property - w/ available space -Education opportunity -Impacted Stream Buffer	$15,000
44 Loyalist Ave Town of Chili Open Space -Trib of LBC	Stream Repairs, Stream Buffer Enhancement	NA	600	-Public property - w/ available space -Education opportunity -Impacted Stream Buffer	$8,000
Harpington Drive, Westmar Village.	Stream Repairs, Stream Buffer Enhancement	NA	500	-property w/ available space -Education opportunity -Some erosion	$8,000

Table 11. Potential Retrofit Projects (continued)					
Project Name/ Project Location	**Project Type (s)[1]/ Description**	**Area Treated (acres)**	**Stream Length Restored (ft)**	**Reason for Prioritization**	**Planning-Level Cost Estimate**
Gates Highway Dept.	Stream Repairs,Stream Buffer Enhancement	NA	900	-Education opportunity -Erosion -Public property	$16000
North Side of Sunderland Trail	Stream Repairs,Stream Buffer Enhancement	NA	900	-Homeowners Association -property w/ available space -Education opportunity	$16000
Brooklea Country Club	Stream Repairs,Stream Buffer Enhancement	NA	1500	-Commercial property -Downstream erosion	$23,000
Multiple Businesses near Manitou Rd Ogden Gates Town line	Hotspot and Discharge Prevention	300	NA	-Hotspot discharge removal	$160,000
Multiple Businesses near Cherry and Trabold Rds	Hotspot and Discharge Prevention	90	NA	-Good cost-benefit ratio	$280,000
Multiple Businesses around Pixley Industrial	Hotspot and Discharge Prevention	NA	NA	-Source Control	$220,000
Multiple Businesses near airport	Hotspot and Discharge Prevention	NA	NA	-Source Control	$520,000
Multiple Residential Areas Chili	Residential Management Practices	2000	NA	-Addresses pollutants -delivered from largest land -use in watershed	$40,000
Multiple Residential and Commercial Areas Gates	Residential Management Practices	NA	NA	-Source control	$200,000
TOTAL ALL PROJECTS					$3,465,000

Ultimately, implementation of these projects will only be possible through support from local stakeholders and strong leadership from municipal, state, and federal partners.

4.4 Watershed Treatment Model Results

As described in section 2.1.5, the Watershed Treatment Model (WTM) was used to estimate existing and future loads of stormwater pollutants delivered to Little Black Creek. To create these estimates, the model requires inputs for the level of watershed development (acres of residential, commercial, rural, roads etc), existing stormwater management practices, and planned buildouts. Retrofit practices proposed in Table 11 were then added to the model and the predicted pollutant loads and corresponding reductions are shown in Table 12. WTM was run separately for the upper and lower watersheds, primarily to better represent the very different density of development in the two areas.

Table 12. Pollutant Loads from Various Sources w/Retrofit Practices Upper Watershed					
	Total Nitrogen	Total Phosphorus	Total Suspended Solids	Fecal Coliform	Runoff Volume
Pollutant Source	**lb/year**	**lb/year**	**lb/year**	**billion/year**	**(acre0feet/year)**
Urban Land	16,093	2,458.76	141,994	329,901	3,571
Active Construction	122	24	82,648	0	121
Sanitary Sewer Overflows	268	45	1,786	202,657	0
Channel Erosion	1,643	1,560	410,655	0	0
Road Sanding	0	0	574	0	0
Rural Land	24,007	3,653	521,900	203,541	374
Livestock	916	107	0	4,973	0
Illicit Connections	119	26	830	80,965	0
Septic Systems	4,919	820	32,790	43,903	0
Total Load w/Practices	48,087	8694	1,193,177	865,940	4,066
Existing Load (from Table 8)	55,819	10,740	1,612,826	1,605,270	4,223
Percent Reduction with Restoration	14	19	26	46	4

Table 13. Pollutant Loads from Various Sources w/Retrofit Practices Lower Watershed					
Pollutant Source	**Total Nitrogen**	**Total Phosphorus**	**Total Suspended Solids**	**Fecal Coliform**	**Runoff Volume**
	lb/year	**lb/year**	**lb/year**	**billion/year**	**(acre0feet/year)**
Urban Land	29,498	5,002	794,773	1,334,710	5,960
Active Construction	43	9	29,579	0	43
Sanitary Sewer Overflows	303	50	2,018	229,091	0
Channel Erosion	1,376	1,308	344,099	0	0
Road Sanding	0	0	828	0	0
Rural Land	1,927	293	41,900	16,341	51
Livestock	0	0	0	0	0
Illicit Connections	101	23	715	67,882	0
Septic Systems	206	34	1,374	9,646	0
Total Load w/Practices	33,454	6,719	1,215,286	1,657,670	6,054
Existing Load (from Table 9)	36,942	7,412	1,371,544	2,024,910	6,221
Percent Reduction with Restoration	9%	9%	11%	18%	3%

At the time this writing, NYS had not yet prepared a Total Maximum Daily Load Analysis for LBC so it is not known whether the reductions shown here would be adequate for a future TMDL. As previously noted, Little Black Creek "Known" pollutant sources are water level and flow, suspected pollutant sources are unknown toxicity from urban runoff and agriculture listed are high dissolved oxygen demand, phosphorus, pathogens and silt/sediment. . Measures to address each of these are discussed separately below:

To lower dissolved oxygen demand through restoration efforts, general actions would include reducing the amount of organic material such as leaf litter and sanitary waste from entering the stream. Planting trees along the stream would serve to increase shade over the stream and reduce summer water temperature. While these actions are proposed here, few simple models can predict their results accurately (dissolved oxygen values are not represented in the WTM loads).

Phosphorus is a nutrient that is most typically a concern in freshwater ponds and lakes as the primary cause of weeds and algae growth. A guidance level concentration given by NYSDEC is 20 micrograms per liter of water for "still" bodies of water (ponds and lakes). There is no NYS guidance to date on the limit a flowing stream can assimilate without causing impairment. All wet weather flows sampled in Little Black Creek exceeded the 20 micrograms limit by large amounts (see Figure 7). A restoration proposal is to increase awareness of the impacts of excess lawn fertilizers through enhanced education efforts that will ultimately lead to behavior changes. The model assumes that 90 percent of watershed residents will hear the lawn care message. Of that 90%, the model estimates that between 10 and 50 percent of residents will change their actual fertilizer use. The education program objectives are to have residents reduce fertilizer usage, switch to zero phosphorus fertilizer or use no fertilizer at all. The resultant estimate of benefit is a reduction of 491 pounds of phosphorus and a 25,000 pound reduction in nitrogen.

Pathogens in urban streams are generally considered to be a group of fecal coliform bacteria delivered to streams from a variety of sources. Sampling for the presence of these bacteria was done during the assessment of Little Black Creek (see Ecoli sampling results shown in Figure 11). Determining the source of bacteria (humans, pets, birds, or wildlife) can be done by DNA analysis which was beyond the scope of this study. An example of DNA testing for Ecoli bacteria can be seen in the Lower Boise watershed study (Doran, 2002). Of the total identifiable bacteria throughout the watershed, 17 percent came from human sources, 22 percent from pets, 35 percent from avian populations, 15 percent from wildlife, and 11 percent from livestock. The LBC watershed has essentially no livestock, though, concerns for the proper disposal of pet waste is part of the Stormwater Coalition of Monroe County's current water quality educational program. No additional actions for pet waste are proposed beyond the current program. Septic systems are often a source of bacteria in watersheds and the WTM estimates the benefit of an enhanced septic system education and upgrade program. Such a program would involve expanded outreach in the form of educational brochures and workshops as well as increasing inspections, system upgrades and retirement of septic systems. The WTM estimates a 39 percent reduction in fecal coliform would be realized from these actions.

Silt/sediment (referred to as total suspended solids or TSS) is the last impairment listed for Little Black Creek. Several restoration proposals will provide sediment reductions including: upgrades to conventional flood control ponds (100,000 pounds of sediment removed annually); small improvements in the current construction inspection program (40,000 pound reduction); and repairs to eroding stream channels (6,000 pound reduction).

Section 5. Recommendations

While goals and recommendations for restoring LBC need to be adopted by the stakeholders that live and work there, environmental regulations may direct certain actions be undertaken by local government to meet water quality standards. The first step listed below is to enlist participation of these stakeholders. The draft goal and recommendations, if implemented, should meet water quality standards expected to be imposed and provide noticeable improvements to the Creek in function and water quality.

5.1 Little Black Creek Draft Watershed Goal

The watershed assessment and planning effort began with the goal to: *improve water quality in LBC and its tributaries by reducing the volume and concentration of polluted stormwater runoff that enters the stream. The goal can best be met by improving and installing infrastructure capable of infiltrating and treating polluted stormwater, restoring natural aquatic habitat and, getting residents and business owners actively involved in pollution prevention practices.* This goal is consistent with the Stormwater Action Planning objective of identifying major stormwater quantity and quality issues throughout the County that provides a framework for a capitol improvement program to address these issues.

5.2 Draft Recommendations

When project goals and the assessment findings are considered, it becomes possible for project staff to establish a series of recommendations for future actions. Specific recommendations will be developed for the LBC subwatersheds with input from local stakeholders, observations made during the stream and subwatershed assessments and best professional judgment from the project staff. These recommendations can then be divided into short, mid and long-term recommendations. Short-term recommendations should occur with the next year and include those deemed most important or imminent to protecting the health of the subwatershed. Mid-term recommendations should occur within one to three years and long-term recommendations may take longer than three years to implement.

(a)
(b) Examples of Short-Term Recommendations

1S. Establish a watershed stakeholders group. A stakeholders group consisting of local residents and municipal officials should be established to consider the Assessment and Action Plan and to guide future activities to ensure they reflect local interests.

1) **2S. Develop a public education campaign that improves watershed awareness and targets municipal officials, developers, business owners and residents.**

3S. Implement small-scale priority restoration projects in LBC. Of the small-scale priority restoration projects identified in LBC, the short-term goal should be to implement two projects. Small-scale projects can be performed with a low-tech engineering approach and utilize volunteer labor for installation of portions of the projects such as plantings.

(c)
(d) Examples of Mid-Term Recommendations

1M. Directly contact landowners of potential restoration sites to discuss possible project implementation. Coalition should work with other local partners to contact landowners of priority restoration projects identified in LBC to solicit their interest in implementation. This will likely involve several phone calls or meetings and may necessitate obtaining additional information about the site (e.g., site plans, utility locations), working with local consulting firms to estimate costs, presenting ideas to local homeowners associations (HOAs), and educating the landowners about watershed issues and the benefits of restoration.

2M. Establish a program to conduct regular sampling for macroinvertebrates. Utilize the already established monitoring stations to continue to monitor the long-term health of the bug community on an annual or bi-annual basis. Selecting a few key water quality parameters based on the previous results will provide a multi-faceted approach that will help to identify the sources of any observed patterns of decline. This program will be particularly important to monitor the effects of new development on stream health in LBC.

3M. Conduct an annual State of the State of Little Black Creek Watershed meeting for local partners. Invitees would include local governments, developers, businesses and watershed residents. The purpose of the meeting is to interact and talk about the latest work being done in the LBC watershed and to generate interest in implementing priority projects.

4M. Modify relevant local codes and ordinances to allow and encourage use of Better Site Design techniques. Working with the Stormwater Coalition of Monroe County, the towns of Ogden, Chili and Gates should begin to make changes to their codes and ordinances to reflect the concepts of better site design and green infrastructure practices. A good starting point may be to present the recommendations to local planning commissions or similar entity to get their buy-in and facilitate the process.

5M. Implement large-scale priority restoration projects in LBC. Of the proposed large-scale priority restoration projects identified in LBC, a mid-term goal should be to implement two projects. Large-scale projects require a greater degree of design and engineering, are typically more expensive and may include multiple components such as stormwater retrofits, stream restoration and riparian plantings.

6M. Establish a program to monitor watershed restoration and protection efforts. It is important to measure and track both the short and long-term health of LBC to determine the effectiveness of restoration efforts. As restoration projects are implemented in the LBC watershed, a monitoring plan should be developed for each project. Specifically, opportunities to measure the effectiveness of innovative restoration projects, such as bioretention or downspout disconnection, should be explored.

7M. Establish a restoration committee to seek funding for implementation of stormwater restorations and stream restoration projects. This committee should have a goal of obtaining funding for two large-scale and two small-scale restoration projects in LBC each year. Specific tasks include identifying potential funding mechanisms, submitting proposals for funding and/or soliciting potential funders.

Examples of Long-Term Recommendations

1L. Adopt a stormwater ordinance that requires new development to incorporate better site design principles including infiltration and recharge of stormwater runoff. Revisions have been adoption to the NYS Stormwater Management Design Manual that emphasize innovative stormwater treatment practices termed “Green Infrastructure”. There is a five-step process for stormwater site planning and practice selection in the SWPPP; site planning to preserve natural features and reduce impervious cover, calculation of the sites water quality volume, incorporation of runoff reduction techniques by applying green infrastructure, the use of standard treatment practices where applicable, and finally design of volume and peak discharge control practices. The goal is to encourage source control stormwater management and increase groundwater infiltration as a means to minimize stormwater discharge and limit the amount of surface pollutants entering New York streams. It is recommended that Ogden, Chili and Gates adopt the NY State regulations in a stormwater ordinance to encourage the use of practices that provide infiltration and recharge of stormwater.

5.3 Long Term Monitoring

Monitoring is an essential component of watershed planning for documenting project success, tracking stream health over time, and testing the effectiveness of innovative restoration practices. The Center for Watershed Protection proposes a strategy for long term monitoring that will be proposed for Little Black Creek Watershed. Three ways to monitor project success include:

1. Track the number and location of restoration projects and subwatershed recommendations that have been implemented.
2. Conduct post-construction monitoring of structural restoration practices to ensure that they are functioning properly.
3. Measure the effect of restoration efforts on stream health.

The Center recommends establishing a long-term monitoring program that utilizes the above three methods to track project success. The first component, tracking the number and location of restoration projects and recommendations that have been implemented, can be done using a simple spreadsheet, or may be integrated with a Geographic Information System (GIS) to add a spatial element. Basic information about each project should be included in the spreadsheet, and the information should be updated on an annual basis.

The second component, conducting post-construction monitoring of restoration practices to ensure they are functioning properly, should be required with implementation of structural restoration practices such as stormwater treatment practices or stream restoration projects. A maintenance and inspection plan should be developed during the early stages of the project to prevent practice failure and allow a periodic check to ensure the practice is functioning properly. Practices that do not require regular maintenance should, at a minimum, be inspected on an annual basis.

The third component of a long-term monitoring plan is to measure the effect of restoration practices on stream health. This can be done at both the site and the subwatershed scale; however, detecting change is more easily accomplished at an individual site. For example, it may be difficult at the subwatershed level to distinguish between actual change due to restoration efforts versus changes due to climatic variation and weather patterns. Given these considerations, it is recommended that water quality and biological monitoring in LBC be approached in the following three ways:

1. Track long-term water quality and stream health using macroinvertebrates. Macroinvertebrates are indicators of stream health whose life cycle places them in a stream for a period often of six to twelve months and therefore reflect the conditions in the stream over a longer period of time compared to a water quality sample. Macroinvertebrate sampling should be conducted on an annual or bi-annual basis in the Little Black Creek Watershed at the already established sampling stations to continue to track long-term health in the watershed. At a minimum, several key water quality parameters should also be selected based on previous macroinvertebrates results and monitored with the macroinvertebrates to provide clues to the sources of any observed decline in bug communities.

2. Track improvements in water quality from implementation of restoration projects at either the site level or reach level. This monitoring could be useful for testing the pollutant removal effectiveness of innovative practices such as bioretention or sand filters. For example, volunteers could conduct storm event monitoring of inflow water quality versus outflow water quality for a newly installed bioretention facility. Another example is to monitor the effect of downspout disconnection in a single headwater neighborhood (implemented through a targeted door-to-door outreach effort) by monitoring the streamflow at the neighborhood outlet both before and after downspout disconnection occurs.

3. Track the effects of an individual development project at the reach level to determine the impact of either an innovative or traditional development. Ideally, this would include water quality and biological monitoring, although intensive water quality monitoring including storm events may be cost prohibitive. This effort would be best achieved by applying a paired watershed study approach, which would require monitoring a control reach within LBC as well. It is important that the control reach does not have any development within its drainage area.

A paired watershed study is one of the best ways to document change in nonpoint source (NPS) pollution. (CWP, 2004) The following caveats apply to a paired watershed study:

- Anticipated (or modeled) change should be greater than 20% for the parameter of interest or detecting change over background noise will be very difficult.
- A control watershed (reach) must be used in order to select out background noise due to variations in weather, climate etc.
- Monitoring must occur both pre- and post-restoration efforts

5.4 Recommendations for Future Watershed Assessments

Lessons learned from the LBC assessment will be applied to this future assessment in an effort to streamline the rapid assessment process for future use. Recommendations and lessons learned are summarized in Table 14.

Table 13. Recommendations for Future Assessments

Activity	Recommendation
Stakeholder Involvement	Work with watershed stakeholders earlier in the process to help identify potential problems in the watershed. This will help in both the stream corridor and upland surveys and provide a better foundation for future retrofits
Hydrologic Modeling	The hydrologic component will be an important part of future assessments. Site selection for flow monitoring is important. Installation of stations for flow measurements are recommended as well as occasional manual discharge measurements. The development of a local hydrologic modeling tool will also be useful.
Sampling	Rely less on composite samples and more on grab samples in an effort to locate specific pollution hotspots
placeholder	
placeholder	

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APPENDICES

Appendix A: Little Black Creek Sampling Data

Sampdate	Ordno	Sampnam	Analyte	Numres	Units
3/23/10	378057	7	CHL	54.487	mg/L
3/23/10	378053	5	CHL	170.95	mg/L
3/23/10	378052	4	CHL	175.39	mg/L
3/23/10	378051	3	CHL	51.314	mg/L
3/23/10	378050	2	CHL	52.13	mg/L
3/23/10	378049	1	CHL	90.258	mg/L
3/23/10	378051	3	NH3L	0.0271	mg/L
3/23/10	378053	5	NH3L	0.0221	mg/L
3/23/10	378057	7	NH3L	0.0155	mg/L
3/23/10	378052	4	NH3L	0.0512	mg/L
3/23/10	378049	1	NH3L	0.0107	mg/L
3/23/10	378050	2	NH3L	0.0452	mg/L
3/23/10	378049	1	NOX L	0.8943	mg/L
3/23/10	378052	4	NOX L	0.7164	mg/L
3/23/10	378051	3	NOX L	1.5427	mg/L
3/23/10	378050	2	NOX L	1.0873	mg/L
3/23/10	378057	7	NOX L	1.1071	mg/L
3/23/10	378053	5	NOX L	0.8346	mg/L
3/23/10	378051	3	OP L	0.023	mg/L
3/23/10	378050	2	OP L	0.0549	mg/L
3/23/10	378057	7	OP L	0.0254	mg/L
3/23/10	378053	5	OP L	0.0179	mg/L
3/23/10	378052	4	OP L	0.0524	mg/L
3/23/10	378049	1	OP L	0.0146	mg/L
3/23/10	378053	5	SO4-IC	32.96	mg/L
3/23/10	378049	1	SO4-IC	30.814	mg/L
3/23/10	378052	4	SO4-IC	33.818	mg/L
3/23/10	378051	3	SO4-IC	19.189	mg/L
3/23/10	378050	2	SO4-IC	21.675	mg/L
3/23/10	378057	7	TKN	0.8121	mg/L
3/23/10	378052	4	TKN	0.784	mg/L
3/23/10	378053	5	TKN	0.6714	mg/L
3/23/10	378051	3	TKN	0.7356	mg/L
3/23/10	378049	1	TKN	0.7155	mg/L
3/23/10	378050	2	TKN	0.7894	mg/L
3/23/10	378053	5	TP	0.0757	mg/L

3/23/10	378052	4	TP	0.1012	mg/L
3/23/10	378051	3	TP	0.1084	mg/L
3/23/10	378050	2	TP	0.1356	mg/L
3/23/10	378049	1	TP	0.1272	mg/L
3/23/10	378057	7	TP	0.1281	mg/L
3/23/10	378052	4	TSS-AER 9CM	26	mg/L
3/23/10	378051	3	TSS-AER 9CM	13.3	mg/L
3/23/10	378050	2	TSS-AER 9CM	16	mg/L
3/23/10	378049	1	TSS-AER 9CM	39	mg/L
3/23/10	378057	7	TSS-AER 9CM	24	mg/L
3/23/10	378053	5	TSS-AER 9CM	17	mg/L

Appendix B: Impervious Cover Model Description

The Impervious Cover Model

** For updated information on how impervious cover impacts aquatic systems, you might want to check out Impacts of Impervious Cover on Aquatic Systems, available from the Center for Watershed Protection at http://www.cwp.org.*

Stream research generally indicates that certain zones of stream quality exist, most notably at about 10% impervious cover, where sensitive stream elements are lost from the system. A second threshold appears to exist at around 25 to 30% impervious cover, where most indicators of stream quality consistently shift to a poor condition (e.g., diminished aquatic diversity, water quality, and habitat scores). Table 1 reviews the key findings of recent research regarding the impacts of urbanization on aquatic systems.

Table 1. Review of Key Findings of Recent Research Examining the Relationship of Urbanization on Aquatic Systems

Watershed Indicator	***Key Finding***	***Reference***	***Year***	***Location***
Aquatic insects	Negative relationship between number of insect species and urbanization in 21 streams.	Benke, *et al*.	1981	Atlanta
Aquatic habitat	There is a decrease in the quantity of large woody debris (LWD) found in urban streams at around 10% impervious cover.	Booth, *et al*.	1996	Washington
Fish, habitat & channel stability	Channel stability and fish habitat quality declined rapidly after 10% impervious area.	Booth	1991	Seattle
Fish, habitat	As watershed population density increased, there was a negative impact on urban fish and habitat	Couch, *et al*.	1997	Atlanta
Aquatic insects and fish	A comparison of three stream types found urban streams had lowest diversity and richness	Crawford & Lenat	1989	North Carolina
Stream temperature	Stream temperature increased directly with subwatershed impervious cover.	Galli	1991	Maryland
Aquatic insects	A significant decline in various indicators of wetland aquatic macroinvertebrate community health was observed as impervious cover increased to levels of 8-9%.	Hicks & Larson	1997	Connecticut
Insects, fish,	Steepest decline of biological functioning	Horner, *et al*.	1996	Puget Sound

habitat water quality, riparian zone	after 6% imperviousness. There was a steady decline, with approx 50% of initial biotic integrity at 45% impervious area.			Washington
Aquatic insects and fish	Unable to show improvements at 8 sites downstream of BMPs as compared to reference conditions.	Jones, *et al*.	1996	Northern Virginia
Aquatic insects	Urban streams had sharply lower insect diversity with human population above 4/acre. (About 10%)	Jones & Clark	1987	Northern Virginia
Aquatic insects & fish	Macroinvertebrate and fish diversity decline significantly beyond 10-12% impervious area.	Klein	1979	Maryland
Aquatic insects	Drop in insect taxa from 13 to 4 noted in urban streams.	Garie and McIntosh	1986	New Jersey
Fish spawning	Resident and anadromous fish eggs & larvae declined in 16 streams with > 10% impervious area.	Limburg & Schmidt	1990	New York
Fish	Shift from less tolerant coho salmon to more tolerant cutthroat trout pop.-between 10-15% impervious area at 9 sites.	Luchetti & Fuersteburg	1993	Seattle
Stream channel stability	Urban stream channels often enlarge their cross-sectional area by a factor of 2 to 5. Enlargement begins at relatively low levels of impervious cover.	MacRae	1996	British Columbia
Aquatic insects & stream habitat	No significant difference in biological and physical metrics for 8 BMP sites versus 31 sites without BMPs (with varying impervious area).	Maxted and Shaver	1996	Delaware
Insects, fish, habitat, water quality, riparian zone	Physical and biological stream indicators declined most rapidly during the initial phase of the urbanization process as the percentage of total impervious area exceeded the 5-10% range.	May, *et al*.	1997	Washington
Aquatic insects and fish	There was significant decline in the diversity of aquatic insects and fish at 10% impervious cover.	MWCOG	1992	Washington, DC
Aquatic insects	As watershed development levels increased, the macroinvertebrate community diversity decreased.	Richards, *et al.*	1993	Minnesota
Aquatic insects	Biotic integrity decreases with increasing urbanization in study involving 209 sites, with a sharp decline at 10% I. Riparian	Steedmen	1988	Ontario

	condition helps mitigate effects.			
Wetland plants, amphibians	Mean annual water fluctuation inversely correlated to plant & amphibian density in urban wetlands. Declines noted beyond 10% impervious area.	Taylor	1993	Seattle
Wetland water quality	There is a significant increase in water level fluctuation, conductivity, fecal coliform bacteria, and total phosphorus in urban wetlands as impervious cover exceeds 3.5%.	Taylor, *et al.*	1995	Washington
Sediment loads	About 2/3 of sediment delivered into urban streams comes from channel erosion.	Trimble	1997	California
Water quality-pollutant conc.	Annual P, N, COD, & metal loads increased in direct proportion with increasing impervious area.	US EPA	1983	National
Fish	As watershed development increased to about 10%, fish communities simplified to more habitat and trophic generalists.	Weaver	1991	Virginia
Aquatic insects & fish	All 40 urban sites sampled had fair to very poor index of biotic integrity (IBI) scores, compared to undeveloped reference sites.	Yoder	1991	Ohio

Taking all the research together, it is possible to construct a simple urban stream classification scheme based on impervious cover and stream quality. This simple classification system contains three stream categories, based on the percentage of impervious cover. Figure 1 illustrates this simple, yet powerful model that predicts the existing and future quality of streams based on the measurable change in impervious cover.

The model classifies streams into one of three categories: sensitive, impacted, and non-supporting. Each stream category can be expected to have unique characteristics as follows:

Sensitive Streams. These streams typically have a watershed impervious cover of zero to 10 percent. Consequently, sensitive streams are of high quality, and are typified by stable channels, excellent habitat structure, good to excellent water quality, and diverse communities of both fish and aquatic insects. Since impervious cover is so low, they do not experience frequent flooding and other hydrological changes that accompany urbanization. It should be noted that some sensitive streams located in rural areas may have been impacted by prior poor grazing and cropping practices that may have severely altered the riparian zone, and consequently, may not have all the properties of a sensitive stream. Once riparian management improves, however these streams are often expected to recover.

Impacted Streams. Streams in this category possess a watershed impervious cover ranging from 11 to 25 percent, and show clear signs of degradation due to watershed urbanization. The elevated storm flows begin to alter stream geometry. Both erosion and channel widening are clearly evident. Streams banks become unstable, and physical habitat in the stream declines noticeably. Stream water quality shifts into the fair/good category during both storms and dry weather periods. Stream biodiversity declines to fair levels, with most sensitive fish and aquatic insects disappearing from the stream.

Non-Supporting Streams. Once watershed impervious cover exceeds 25%, stream quality crosses a second threshold. Streams in this category essentially become conduits for conveying stormwater flows, and can no longer support a diverse stream community. The stream channel becomes highly unstable, and many stream reaches experience severe widening, downcutting, and streambank erosion. Pool and riffle structure needed to sustain fish is diminished or eliminated and the substrate can no longer provide habitat for aquatic insects, or spawning areas for fish. Water quality is consistently rated as fair to poor, and water recreation is no longer possible due to the presence of high bacterial levels. Subwatersheds in the non-supporting category will generally display increases in nutrient loads to downstream receiving waters, even if effective urban BMPs are installed and maintained. The biological quality of non-supporting streams is generally considered poor, and is dominated by pollution tolerant insects and fish.

Although the impervious cover model is supported by research, its assumptions and limitations need to be clearly understood. There are some technical issues involved in its development which are discussed below:

<u>Limitations of the Impervious Cover Model</u>

1. Scale effect. The impervious cover model should generally only be applied to smaller urban streams from first to third order. This limitation reflects the fact that most of the research has been conducted at the catchment or subwatershed level (0.2 to 10 square mile area), and that the influence of impervious cover is strongest at these spatial scales. In larger watersheds and basins, other land uses, pollution sources and disturbances often dominate the quality and dynamics of streams and rivers.

2. Reference condition. The simple model predicts **potential** rather than **actual** stream quality. Thus, the reference condition for a sensitive stream is a high quality, non-impacted stream within a given ecoregion or sub-ecoregion. It can and should be expected that some individual stream reaches or segments will depart from the predictions of the impervious cover model. For example, physical and biological monitoring may find poor quality in a stream classified as sensitive, or good diversity in a non-supporting one. Rather than being a shortcoming, these "outliers" may help watershed managers better understand local watershed and stream dynamics. For example, an "outlier" stream may be a result of past human disturbance, such as grazing, channelization, acid mine drainage, agricultural drainage, poor forestry practices, or irrigation return flows.

3. Statistical variability*.* Individual impervious cover/stream quality indicator relationships tend to exhibit a considerable amount of scatter, although they do show a general trend downward as impervious cover increases. Thus, the impervious cover model is not intended to predict the precise score of an individual stream quality indicator for a given level of impervious cover. Instead, the model attempts to predict the average behavior of a group of stream indicators over a range of impervious cover. In addition, the impervious cover thresholds defined by the model are not sharp breakpoints, but instead reflect the expected transition of a composite of individual stream indicators.

4. Measuring and projecting impervious cover. Given the central importance of impervious cover to the model, it is very important that it be accurately measured and projected. Yet comparatively relatively little attention has been paid to standardizing techniques for measuring existing impervious cover, or forecasting future impervious cover. Some investigators define impervious cover as "effective impervious area" (i.e., impervious area not directly connected to a stream or drainage system) which may be lower than total impervious cover under certain suburban or exurban development patterns (Sutherland, 1995).

5. Regional adaptability. To date, much research used to develop the model has been performed in the mid-Atlantic and Puget Sound eco-regions. In particular, very little research has been conducted in western, midwestern, or mountainous streams. Further research is needed to determine if the impervious cover model applies in these ecoregions and terrains.

6. Defining thresholds for non-supporting streams. Most research has focused on the transition from sensitive streams to impacted ones. Much less is known about the the nature of the transition from impacted streams to non-supporting ones. The impervious cover model projects the transition occurs around 25% impervious cover for small urban streams, but more sampling is needed to firmly establish this threshold.

7. Influence of BMPs in extending thresholds. Urban BMPs may be able to shift the impervious cover thresholds higher. The ability of the current generation of urban BMPs to shift these thresholds however, appears to be very modest according to several lines of evidence. First, a handful of the impervious cover/stream indicator research studies were conducted in localities that had some kind of requirements for urban best management practices; yet no significant improvement in stream quality was detected. Second, Maxted and Shaver (1996) and Jones, *et al.* (1996) could not detect an improvement in bioassessment scores in streams served by stormwater ponds.

8. Influence of riparian cover in extending thresholds. Conserving or restoring an intact and forested riparian zone along urban streams appears to extend the impervious cover threshold to a modest degree. For example, Steedman (1988) found that forested riparian stream zones in Ontario had higher habitat and diversity scores for the same degree of urbanization than streams that lacked an intact riparian zone. Horner, *et al.* (1996) also found evidence of a similar relationship. This is not surprising, given the integral role the riparian zone plays in the ecology and morphology of headwater streams. Indeed, the value of conserving and restoring riparian forests to protect stream ecosystems is increasingly being recognized as a critical management tool in rural and agricultural landscapes as well (CBP, 1995).

9. Potential for stream restoration. Streams classified by their potential for restoration (also known as restorable streams) offer opportunities for real improvement in water quality, stability, or biodiversity and hydrologic regimes through the use of stream restoration, urban retrofit and other restoration techniques.

10. Pervious areas. An implicit assumption of the impervious cover model is that pervious areas in the urban landscape do not matter much, and have little direct influence on stream quality. Yet urban pervious areas are highly disturbed, and possess few of the qualities associated with similar pervious cover types situated in non-urban areas. For example, it has recently been estimated that high input turf can comprise up to half the total pervious area in suburban areas

(Schueler, 1995a). These lawns receive high inputs of fertilizers, pesticides and irrigation, and their surface soils are highly compacted.

Although strong links between high input turf and stream quality have yet to be convincingly demonstrated, watershed planners should not neglect the management of pervious areas. Pervious areas also provide opportunities to capture and store runoff generated from impervious areas. Examples include directing rooftop runoff over yards, the use of swales and filter strips, and grading impervious areas to pockets of pervious area. When pervious and impervious areas are integrated closely together, it is possible to sharply reduce the "effective" impervious area in the landscape (Southerland, 1995).

While there are some limitations to the application of the urban stream impervious cover model, impervious cover still provides us with one of the best tools for evaluating the health of a subwatershed. Impervious cover serves not only as an indicator of urban stream quality but also as a valuable management tool in reducing the cumulative impacts of development within subwatersheds.

Appendix C: NYSDEC Priority Waterbodies Little Black Creek Information Sheet

Little Black Creek, Lower, and tribs (0402-0047) — Impaired Seg

Waterbody Location Information

Revised: 10/23/02

Water Index No:	Ont 117- 18			**Drain Basin:**	Genesee River
Hydro Unit Code:	04130003/100	**Str Class:**	C*		Lower Genesee River
Waterbody Type:	River			**Reg/County:**	8/Monroe Co. (28)
Waterbody Size:	33.8 Miles			**Quad Map:**	ROCHESTER WEST (I-10-1) ...
Seg Description:	stream and tribs from mouth to Coldwater				

Water Quality Problem/Issue Information

(CAPS indicate MAJOR Use Impacts/Pollutants/Sources)

Use(s) Impacted	Severity	Problem Documentation
AQUATIC LIFE	Impaired	Known
Recreation	Stressed	Suspected
Habitat/Hydrolgy	Stressed	Known

Type of Pollutant(s)

Known: Water Level/Flow
Suspected: UNKNOWN TOXICITY
Possible: Nutrients

Source(s) of Pollutant(s)

Known: - - -
Suspected: URBAN RUNOFF, Agriculture
Possible: Storm Sewers

Resolution/Management Information

Issue Resolvability: 1 (Needs Verification/Study (see STATUS))
Verification Status: 2 (Problem Verified, Cause Unknown)
Lead Agency/Office: DOW/BWAR — **Resolution Potential:** Medium
TMDL/303d Status: (TMDL Not Required (No Impairment))

Further Details

Aquatic life support in the Little Black Creek has been assessed as impaired due to documented macroinvertebrate impacts. Recreational uses are also thought to be affected by stormwater discharges and urban runoff. Flooding issues in the watershed are also a concern.

A biological (macroinvertebrate) assessment of Little Black Creek near Chili was conducted in 1999. Sampling results indicated moderately impacted water quality conditions. Although the habitat was determined to be satisfactory, mayflies were not found at the site. Impact Source Determination revealed possible toxicity affecting the fauna. (DEC/DOW, BWAR/SBU, January 2001)

Increasing urbanization contributes stormwater runoff and various other nonpoint source pollutants. SPDES permits for the discharge of stormwater and non-contact cooling water to the creek have been issued to a few industries. Significant agricultural activity in the western half of the watershed includes dairy operations and manure spreading. (Monroe County Health Department, April 2001)

Flooding and other hydrologic issues are also of concern. The stream drains very flat terrain with several NYS Designated wetlands in an area that is undergoing increased development. Flooding has been a long-standing problem, but downed trees and a resident beaver population have exacerbated this problem. The Town of Ogden has obtained a permit to remove downed trees to open up the waterway and allow the stream to flow more freely. (Monroe County Health Department, April 2001)

This segment includes the stream and all tribs from the mouth to Route 251 in Coldwater. The waters of the stream and tribs are primarily Class C; a small portion of the stream from above Chili Avenue to Pixley Road and trib -a are Class B. (May 2001)

Appendix D: Blank USA/USSR/Retrofit Field Forms

Storm Water Outfalls **OT**

WATERSHED/SUBSHED:		**DATE:** ___/___/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**___:___AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#	
SITE ID (*Condition-#*): **OT-**_____	**LAT** ___°_____'_____" **LONG** ___°_____'_____"	**LMK**_____	**GPS:** (*Unit ID*)

BANK: ☐ LT ☐ RT ☐ Head

FLOW: ☐ None ☐ Trickle ☐ Moderate ☐ Substantial ☐ Other:

TYPE: ☐ Closed pipe
- **MATERIAL:** ☐ Concrete ☐ Metal ☐ PVC/Plastic ☐ Brick ☐ Other:
- **SHAPE:** ☐ Single ☐ Circular ☐ Double ☐ Elliptical ☐ Triple ☐ Other:
- **DIMENSIONS:** Diameter:_____(in)
- **SUBMERGED:** ☐ No ☐ Partially ☐ Fully

TYPE: ☐ Open channel
- **MATERIAL:** ☐ Concrete ☐ Earthen ☐ Other:
- **SHAPE:** ☐ Trapezoid ☐ Parabolic ☐ Other:
- **DIMENSIONS:** Depth: _____(in) Width (Top):_____(in) " (Bottom):_____(in)
- *NOT APPLICABLE*

CONDITION: ☐ None ☐ Chip/Cracked ☐ Peeling Paint ☐ Corrosion ☐ Other:

ODOR: ☐ No ☐ Gas ☐ Sewage ☐ Rancid/Sour ☐ Sulfide ☐ Other:

DEPOSITS/STAINS: ☐ None ☐ Oily ☐ Flow Line ☐ Paint ☐ Other:

VEGGIE DENSITY: ☐ None ☐ Normal ☐ Inhibited ☐ Excessive ☐ Other:

PIPE BENTHIC GROWTH: ☐ None ☐ Brown ☐ Orange ☐ Green ☐ Other:

POOL QUALITY: ☐ No pool ☐ Good ☐ Odors ☐ Colors ☐ Oils ☐ Suds ☐ Algae ☐ Floatables ☐ Other:

FOR FLOWING ONLY		
	COLOR:	☐ Clear ☐ Brown ☐ Grey ☐ Yellow ☐ Green ☐ Orange ☐ Red ☐ Other:
	TURBIDITY:	☐ None ☐ Slight Cloudiness ☐ Cloudy ☐ Opaque
	FLOATABLES:	☐ None ☐ Sewage (toilet paper, etc.) ☐ Petroleum (oil sheen) ☐ Other:

OTHER CONCERNS: ☐ Excess Trash (paper/plastic bags) ☐ Dumping (bulk) ☐ Excessive Sedimentation ☐ Needs Regular Maintenance ☐ Bank Erosion ☐ Other:

POTENTIAL RESTORATION CANDIDATE ☐ Discharge investigation ☐ Stream daylighting ☐ Local stream repair/outfall stabilization ☐ no ☐ Storm water retrofit ☐ Other:

If yes for daylighting:
Length of vegetative cover from outfall: __________ft Type of existing vegetation:____________________ Slope: __________°

If yes for stormwater:
Is stormwater currently controlled? ☐ Yes ☐ No ☐ Not investigated
Land Use description:______________________________
Area available:

OUTFALL SEVERITY: (*circle #*)	Heavy discharge with a distinct color and/or a strong smell. The amount of discharge is significant compared to the amount of normal flow in receiving stream; discharge appears to be having a significant impact downstream.	Small discharge; flow mostly clear and odorless. If the discharge has a color and/or odor, the amount of discharge is very small compared to the stream's base flow and any impact appears to be minor / localized.	Outfall does not have dry weather discharge; staining; or appearance of causing any erosion problems.
	5 4	3 2	1

SKETCH/NOTES:

REPORTED TO AUTHORITIES: ☐ YES ☐ NO

Severe Bank Erosion **ER**

WATERSHED/SUBSHED:		**DATE:** ___/___/___	**ASSESSED BY:**
SURVEY REACH:	**TIME:** ___:___AM/PM	**PHOTO ID** (CAMERA-PIC #): /#	
SITE ID: *(Condition-#)* ER-_____	*START* LAT ___° ___' ___" LONG ___° ___' ___" LMK _____ *END* LAT ___° ___' ___" LONG ___° ___' ___" LMK _____		**GPS:** *(Unit ID)*

PROCESS: ☐ Currently unknown

☐ Downcutting ☐ Bed scour
☐ Widening ☐ Bank failure
☐ Headcutting ☐ Bank scour
☐ Aggrading ☐ Slope failure
☐ Sed. deposition ☐ Channelized

BANK OF CONCERN: ☐ LT ☐ RT ☐ Both *(looking downstream)*
LOCATION: ☐ Meander bend ☐ Straight section ☐ Steep slope/valley wall ☐ Other:
DIMENSIONS:
Length *(if no GPS)* LT______ft and/or RT________ft | Bottom width ______ft
Bank Ht LT______ft and/or RT________ft | Top width ________ft
Bank Angle LT______° and/or RT______° | Wetted Width ______ft

LAND OWNERSHIP: ☐ Private ☐ Public ☐ Unknown **LAND COVER:** ☐ Forest ☐ Field/Ag ☐ Developed:

POTENTIAL RESTORATION CANDIDATE: ☐ Grade control ☐ Bank stabilization
☐ No ☐ Other:

THREAT TO PROPERTY/INFRASTRUCTURE: ☐ No ☐ Yes (Describe):

EXISTING RIPARIAN WIDTH: ☐ ≤25 ft ☐ 25 - 50 ft ☐ 50-75ft ☐ 75-100ft ☐ >100ft

EROSION SEVERITY *(circle#)* Channelized= ☐ 1	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.	Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure	Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.
	5 4	3 2	1
ACCESS:	Good access: Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.	Fair access: Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.	Difficult access. Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required.
	5 4	3 2	1

NOTES/CROSS SECTION SKETCH:

REPORTED TO AUTHORITIES ☐ YES ☐ NO

Impacted Buffer **IB**

WATERSHED/SUBSHED:		DATE: ___/___/___	ASSESSED BY:
SURVEY REACH:	TIME:___:___AM/PM	PHOTO ID: (*Camera-Pic #*) /#	
SITE ID: (*Condition-#*) IB-_____	*START* LAT ___° ___' ___" LONG ___° ___' ___" LMK _____ *END* LAT ___° ___' ___" LONG ___° ___' ___" LMK _____		GPS: (*Unit ID*)

IMPACTED BANK: ☐ LT ☐ RT ☐ Both

REASON INADEQUATE: ☐ Lack of vegetation ☐ Too narrow ☐ Widespread invasive plants ☐ Recently planted ☐ Other:

LAND USE:	Private	Institutional	Golf Course	Park	Other Public
(Facing downstream) LT Bank	☐	☐	☐	☐	☐:
RT Bank	☐	☐	☐	☐	☐:

DOMINANT LAND COVER:	Paved	Bare ground	Turf/lawn	Tall grass	Shrub/scrub	Trees	Other
LT Bank	☐	☐	☐	☐	☐	☐	☐:
RT Bank	☐	☐	☐	☐	☐	☐	☐:

INVASIVE PLANTS: ☐ None ☐ Rare ☐ Partial coverage ☐ Extensive coverage ☐ unknown

STREAM SHADE PROVIDED? ☐ None ☐ Partial ☐ Full

WETLANDS PRESENT? ☐ No ☐ Yes ☐ Unknown

POTENTIAL RESTORATION CANDIDATE ☐Active reforestation ☐Greenway design ☐ Natural regeneration ☐ Invasives removal ☐ no ☐ Other:

RESTORABLE AREA

	LT	BANK	RT
Length (ft):	_______		_______
Width (ft):	_______		_______

REFORESTATION POTENTIAL: (*Circle #*)

Impacted area on public land where the riparian area does not appear to be used for any specific purpose; plenty of area available for planting	Impacted area on either public or private land that is presently used for a specific purpose; available area for planting adequate	Impacted area on private land where road; building encroachment or other feature significantly limits available area for planting
5 4	3 2	1

POTENTIAL CONFLICTS WITH REFORESTATION ☐ Widespread invasive plants ☐ Potential contamination ☐ Lack of sun ☐ Poor/unsafe access to site ☐ Existing impervious cover ☐ Severe animal impacts (deer, beaver) ☐ Other:

NOTES:

Stream Crossing **SC**

WATERSHED/SUBSHED:		**DATE:** ___/___/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:** ___:___AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#	
SITE ID: (*Condition-#*) SC-____	**LAT** ___°____'____" **LONG** ___°____'____" **LMK**____		**GPS** (*Unit ID*)

TYPE: ☐ Road Crossing ☐ Railroad Crossing ☐ Manmade Dam ☐ Beaver Dam ☐ Geological Formation ☐ Other:

FOR ROAD/ RAILROAD CROSSINGS ONLY

SHAPE:	**# BARRELS:**	**MATERIAL:**	**ALIGNMENT:**	**DIMENSIONS:** (*if variable, sketch*)
☐ Arch ☐ Bottomless ☐ Box ☐ Elliptical ☐ Circular ☐ Other:	☐ Single ☐ Double ☐ Triple ☐ Other:	☐ Concrete ☐ Metal ☐ Other:	☐ Flow-aligned ☐ Not flow-aligned ☐ Do not know	Barrel diameter: ________(ft) Height: ________(ft)
CONDITION: (*Evidence of...*) ☐ Cracking/chipping/corrosion ☐ Downstream scour hole ☐ Sediment deposition ☐ Failing embankment ☐ Other (*describe*):			**CULVERT SLOPE:** ☐ Flat ☐ Slight (2° – 5°) ☐ Obvious (>5°)	Culvert length: ________(ft) Width: ________(ft) Roadway elevation:________(ft)

POTENTIAL RESTORATION CANDIDATE ☐ no — ☐ Fish barrier removal ☐ Culvert repair/replacement ☐ Upstream storage retrofit ☐ Local stream repair ☐ Other:

IS SC ACTING AS GRADE CONTROL ☐ No ☐ Yes ☐ Unknown

If yes for fish barrier

EXTENT OF PHYSICAL BLOCKAGE:
☐ Total ☐ Partial
☐ Temporary ☐ Unknown

CAUSE:
☐ Drop too high Water Drop: _____ (in)
☐ Flow too shallow Water Depth:_____ (in)
☐ Other:

BLOCKAGE SEVERITY: (*circle #*)

A structure such as a dam or road culvert on a 3rd order or greater stream blocking the upstream movement of anadromous fish; no fish passage device present.	A total fish blockage on a tributary that would isolate a significant reach of stream, or partial blockage that may interfere with the migration of anadromous fish.	A temporary barrier such as a beaver dam or a blockage at the very head of a stream with very little viable fish habitat above it; natural barriers such as waterfalls.

5 4 3 2 1

NOTES/SKETCH:

REPORTED TO AUTHORITIES ☐ YES ☐ NO

Channel Modification **CM**

WATERSHED/SUBSHED:		**DATE:** ___/___/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:** ___:___AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#	
SITE ID: (*Condition-#*) CM-_____	*START* **LAT** ___° ___' ___" **LONG** ___° ___' ___" **LMK** _____ *END* **LAT** ___° ___' ___" **LONG** ___° ___' ___" **LMK** _____		**GPS:** (*Unit ID*)

TYPE: ☐ Channelization ☐ Bank armoring ☐ concrete channel ☐ Floodplain encroachment ☐ Other:

MATERIAL:			**DIMENSIONS:**
☐ Concrete ☐ Gabion	Does channel have perennial flow?	☐ Yes ☐ No	Height ____________(ft)
☐ Rip Rap ☐ Earthen	Is there evidence of sediment deposition?	☐ Yes ☐ No	Bottom Width ____________(ft)
☐ Metal	Is vegetation growing in channel?	☐ Yes ☐ No	Top Width: ____________(ft)
☐ Other:	Is channel connected to floodplain?	☐ Yes ☐ No	Length: ____________(ft)

BASE FLOW CHANNEL	**ADJACENT STREAM CORRIDOR**
Depth of flow ___________(in)	Available width LT________(ft) RT_______(ft)
Defined low flow channel? ☐ Yes ☐ No	Utilities Present? ☐ Yes ☐ No Fill in floodplain? ☐Yes ☐ No
% of channel bottom _________%	

POTENTIAL RESTORATION CANDIDATE ☐ Structural repair ☐ Base flow channel creation ☐ Natural channel design ☐ Can't tell
☐ no ☐ De-channelization ☐ Fish barrier removal ☐ Bioengineering

CHANNEL-IZATION SEVERITY: (*Circle #*)	A long section of concrete stream (>500') channel where water is very shallow (<1" deep) with no natural sediments present in the channel.	A moderate length (> 200') ,but channel stabilized and beginning to function as a natural stream channel. Vegetated bars may have formed in channel.	An earthen channel less than 100 ft with good water depth, a natural sediment bottom, and size and shape similar to the unchannelized stream reaches above and below impacted area.
	5 4	3	2 1

NOTES:

Trash and Debris **TR**

WATERSHED/SUBSHED:		**DATE:** ___/____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**___:___AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#	
SITE ID: (*Condition-#*) **TR-**_____	**LAT** ___°_____'_____" **LONG** ___°_____'_____" **LMK**_____		**GPS:** (*Unit ID*)

TYPE: ☐ Industrial ☐ Commercial ☐ Residential	**MATERIAL:** ☐ Plastic ☐ Paper ☐ Metal ☐ Tires ☐ Construction ☐ Medical ☐ Appliances ☐ Yard Waste ☐ Automotive ☐ Other:	**SOURCE:** ☐ Unknown ☐ Flooding ☐ Illegal dump ☐ Local outfall	**LOCATION:** ☐ Stream ☐ Riparian Area ☐ Lt bank ☐ Rt bank	**LAND OWNERSHIP:** ☐ Public ☐ Unknown ☐ Private **AMOUNT** (*# Pickup truck loads*):

POTENTIAL RESTORATION CANDIDATE ☐ Stream cleanup ☐ Stream adoption segment ☐ Removal/prevention of dumping
☐ no ☐ Other:

If yes for trash or debris removal	**EQUIPMENT NEEDED:** ☐ Heavy equipment ☐ Trash bags ☐ Unknown	**DUMPSTER WITHIN 100 FT:** ☐ Yes ☐ No ☐ Unknown
	WHO CAN DO IT: ☐ Volunteers ☐ Local Gov ☐ Hazmat Team ☐ Other	

CLEAN-UP POTENTIAL: (*Circle #*)	A small amount of trash (i.e., less than two pickup truck loads) located inside a park with easy access	A large amount of trash, or bulk items, in a small area with easy access. Trash may have been dumped over a long period of time but it could be cleaned up in a few days, possibly with a small backhoe.		A large amount of trash or debris scattered over a large area, where access is very difficult. Or presence of drums or indications of hazardous materials	
	5	4	3	2	1

NOTES:

REPORTED TO AUTHORITIES ☐ YES ☐ NO

Utility Impacts **UT**

WATERSHED/SUBSHED:	**DATE:** ___/____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#
SITE ID: (*Condition-#*) UT-_____	**LAT**___° _____' _____" **LONG** ___° _____' _____" **LMK:** _____	**GPS:** (*Unit ID*)

TYPE: ☐ Leaking sewer ☐ Exposed pipe ☐ Exposed manhole ☐ Other:	**MATERIAL:** ☐ Concrete ☐ Corrugated metal ☐ Smooth metal ☐ PVC ☐ Other:	**LOCATION:** ☐ Floodplain ☐ Stream bank ☐ Above stream ☐ Stream bottom ☐ Other:	**POTENTIAL FISH BARRIER:** ☐ Yes ☐ No **CONDITION:** ☐ Joint failure ☐ Protective covering broken ☐ Other:	**PIPE DIMENSIONS:** Diameter: _____in Length exposed: _____ft ☐ Pipe corrosion/cracking ☐ Manhole cover absent

EVIDENCE OF DISCHARGE:	**COLOR**	☐ None ☐ Clear ☐ Dark Brown ☐ Lt Brown ☐ Yellowish ☐ Greenish ☐ Other:
	ODOR	☐ None ☐ Sewage ☐ Oily ☐ Sulfide ☐ Chlorine ☐ Other:
	DEPOSITS	☐ None ☐ Tampons/Toilet Paper ☐ Lime ☐ Surface oils ☐ Stains ☐ Other:

POTENTIAL RESTORATION CANDIDATE ☐ Structural repairs ☐ Pipe testing ☐ Citizen hotlines ☐ Dry weather sampling
☐ no ☐ Fish barrier removal ☐ Other:

If yes to fish barrier, Water Drop: ________ (in)

UTILITY IMPACT SEVERITY: (*Circle #*)			
Leaking= ☐ 5	Section of pipe undermined by erosion and could collapse in the near future; a pipe running across the bed or suspended above the stream; a long section along the edge of the stream where nearly the entire side of the pipe is exposed; or a manhole stack that is located in the center of the stream channel and there is evidence of stack failure.	A moderately long section of pipe is partially exposed but there is no immediate threat that the pipe will be undermined and break in the immediate future. The primary concern is that the pipe may be punctured by large debris during a large storm event.	Small section of exposed pipe, stream bank near the pipe is stable; the pipe is across the bottom of the stream but only a small portion of the top of the pipe exposed; the pipe is exposed but is reinforced with concrete and it is not causing a blockage to upstream fish movement; a manhole stack that is at the edge of the stream and does not extend very far out into the active stream channel.
	5	4 3	2 1

NOTES:

REPORTED TO LOCAL AUTHORITIES ☐ Yes ☐ No

Miscellaneous **MI**

WATERSHED/SUBSHED:	**DATE:** ___/____/___	**ASSESSED BY:**	
SURVEY REACH ID:	**TIME:**___:___AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#	
SITE ID: (*Condition-#*) **MI-**_____	**LAT**___°_____'_____" **LONG** ___°_____'_____" **LMK:** _____		**GPS:** (*Unit ID*)

POTENTIAL RESTORATION CANDIDATE ☐ Storm water retrofit ☐ Stream restoration ☐ Riparian Management
☐ no ☐ Discharge Prevention ☐ Other:

DESCRIBE:

REPORTED TO LOCAL AUTHORITIES ☐ Yes ☐ No

WATERSHED/SUBSHED:	**DATE:** ___/____/___	**ASSESSED BY:**	
SURVEY REACH ID:	**TIME:**___:___AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#	
SITE ID: (*Condition-#*) **MI-**_____	**LAT**___°_____'_____" **LONG** ___°_____'_____" **LMK:** _____		**GPS:** (*Unit ID*)

POTENTIAL RESTORATION CANDIDATE ☐ Storm water retrofit ☐ Stream restoration ☐ Riparian Management
☐ no ☐ Discharge Prevention ☐ Other:

DESCRIBE:

REPORTED TO LOCAL AUTHORITIES ☐ Yes ☐ No

WATERSHED/SUBSHED:	**DATE:** ___/____/___	**ASSESSED BY:**	
SURVEY REACH ID:	**TIME:**___:___AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#	
SITE ID: (*Condition-#*) **MI-**_____	**LAT**___°_____'_____" **LONG** ___°_____'_____" **LMK:** _____		**GPS:** (*Unit ID*)

POTENTIAL RESTORATION CANDIDATE ☐ Storm water retrofit ☐ Stream restoration ☐ Riparian Management
☐ no ☐ Discharge Prevention ☐ Other:

DESCRIBE:

REPORTED TO LOCAL AUTHORITIES ☐ Yes ☐ No

Photo Inventory

(By Camera)

Project: ____________

Group: ______________

Camera: ___________

This field sheet is to be completed AS photos are taken in the field. The intent is to force us to organize pictures taken on a camera basis. Fill out one sheet per camera (add sheets as needed). Only fill in Date/Reach/Location ID when you start in a new spatial or temporal location.

Date	Stream/ Reach	Location ID	Photo #	Description

Appendix E: Watershed Treatment Model

Monroe County, New York, Field Tests the Watershed Treatment Model 2010 Beta Edition

Paula Smith,[a] Andy Sansone,[b*] and Deb Caraco[c]

The Center for Watershed Protection is continually seeking to test new tools or new applications of tools and incorporate them into our watershed analysis and planning process. We also encourage partner organizations and communities to test the tools that we develop. In this issue of the Bulletin, our first brave volunteers, Andy Sansone and Paula Smith of the Monroe County Environmental Services, tested the Watershed Treatment Model (WTM) in Shipbuilders Creek (SC), a small watershed draining directly to Lake Ontario. Originally released in 2003, we recently updated the WTM, and Andy and Paula have tested the revised version, referred to as the WTM 2010 beta edition. This article describes the WTM 2010 beta edition, details Paula and Andy's bold adventure, and recounts some important lessons learned.

What Is the WTM and How Can I Use It in My (Total Maximum Daily) Life?

The WTM (Caraco, 2002) is a spreadsheet-based, decision-making and pollutant-accounting tool that calculates annual runoff volumes and pollutant loads (including total suspended solids, total nitrogen, bacteria, and total phosphorus) in small watersheds. Since the WTM is a simple modeling tool (i.e., it is not physically based and it calculates on an annual basis), watershed practitioners need to consider when to apply it in a total maximum daily load (TMDL) watershed, and when other, more complex, models may be appropriate.

When the practices needed to meet the requirements of a TMDL will be costly or widespread, an intense modeling and monitoring effort may save money in the long term. Since the WTM is not a physically based model, it does not have the ability to produce hydrographs that reflect watershed processes and does not reflect seasonal variability. As a result, the WTM may not be the best tool for *developing* TMDLs in these cases. On the other hand, TMDLs increasingly must be developed and implemented rapidly, particularly in small urban or urbanizing watersheds where changing land use requires immediate action. In some cases, even simple surrogates, such as impervious cover (see Arnold et al., this issue), have been used to develop TMDLs. The WTM offers another alternative in these watersheds, allowing the watershed manager to focus in some detail on particular pollutants and to compare a range of treatment options quickly.

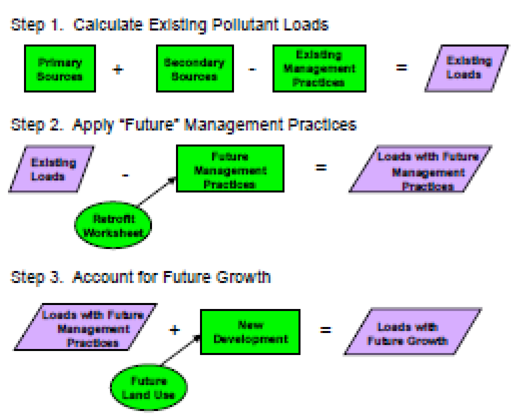

Figure 1. Model structure of the WTM. Note that the purple boxes refer to loads, including both pollutant loads and runoff volumes. The oval shapes are "support" worksheets of the WTM that provide input to another calculation sheet.

Another role for the WTM is as a *tracking tool*. Even for TMDLs that warrant more complex modeling, implementation ultimately happens at the local level. For example, the requirements of a TMDL may be integrated into a municipal separate storm sewer system (MS4) permit. With rare exceptions, local governments are facing tight budgets and need tools that they can implement with existing staff resources. Since the WTM is a spreadsheet, local government staff can maintain it and can update it over time without hiring an outside consultant. One potential application is to populate the WTM with data from an initial monitoring effort, such as pollutant loads and practice efficiencies, then use the WTM to track practice implementation over time.

Some Details about the WTM

The WTM is structured to answer three questions (Figure 1):

- What is the current pollutant load and runoff volume in the watershed?

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*Corresponding author

- What is the load or volume with future (i.e., proposed) management practices?
- What is the load or volume after growth occurs in the watershed?

Each component of the figure represents one Excel worksheet that calculates the total load or load reduction.

The major inputs to the WTM (shown in green in Figure 1) include primary pollutant sources, secondary pollutant sources, and management practices (current and future). Primary sources include any pollutant source that can be determined by land use alone, while secondary sources require additional data (Table 1). Many of the secondary sources are individual point sources (such as National Pollutant Discharge Elimination System [NPDES] dischargers), but others are more diffuse, and include sources such as illicit discharges or septic systems.

Table 1. WTM pollutant sources.

Primary Sources	
Residential Land (various densities) Commercial Land Industrial Land Roadway	Open Water Active Construction Rural Land (includes cropland and pasture) Other Land Uses (User-Defined)
Secondary Sources	
Septic Systems SSOs CSOs Illicit Connections Channel Erosion	Livestock Marinas Road Sanding NPDES Dischargers

Notes: CSO, combined sewer overflow; SSO, sanitary sewer overflow.

The WTM accounts for the benefits of management practices in both the "current" and "future" conditions. The WTM is unique in both the range of practices it characterizes and the techniques it uses to estimate their effectiveness. The wide range of practices encompasses nonstructural as well as structural practices, including programmatic measures such as lawn care education (Table 2).

Since ideal (i.e., literature value) load reductions can rarely be achieved with any management practice, the WTM accounts for these deficiencies using a series of *discount factors* to reflect practice implementation. For structural practices, these factors reflect a lack of space or poor maintenance and can hamper practice effectiveness over time. For programmatic practices, they reflect incomplete adoption of the practice by watershed residents. In both of these cases, specific design features (in the case of the structural practices), or outreach techniques (in the case of an education program) can make the practice more or less effective.

Table 2. Management practices in the WTM.

Structural Practices	
Stormwater Treatment Practices (e.g., Ponds and Infiltration)	Stormwater Retrofits Channel Protection
Nonstructural and Programmatic Practices	
Lawn Care Practices Street Sweeping Riparian Buffers Catch Basin Cleanouts	Marina Pumpouts Illicit Connection Removal CSO Repair Septic System Inspection/Repair
Erosion and Sediment Control Lawn Care Education Pet Waste Education	Septic System Education Land Conversion Redevelopment with Improvements

Notes: CSO, combined sewer overflow.

The WTM accounts for the effects of future growth on pollutant loads, using future land use data (derived from a zoning map or other build-out projection) and applying programs that will be in place to control runoff from new development. The resulting load from new development is then added to the "load with future management practices" to calculate the load including growth.

New Updates for the WTM 2010 Beta Edition

Updates to the WTM 2010 beta edition, which we tested for this article, include (1) the incorporation of runoff reduction, (2) a description of the influence of turf and septic systems in more detail, and (3) the addition of a "retrofit worksheet" that allows model users to describe individual stormwater retrofit practices. Accounting for runoff reduction is a critical modification to the WTM because it brings to light the advantages of many low-impact development practices, which would otherwise receive very little credit. Assumptions for calculating runoff reduction were taken from Hirschman et al. (2008).

Example Application: Shipbuilders Creek in Monroe County, New York

Background

Shipbuilders Creek (SC) lies east of the City of Rochester, New York, originating in the town of Penfield and ultimately discharging to the Rochester Embayment of Lake Ontario (Figure 2). SC was elevated to the New York State 303(d) list of impaired waters in 2008, with impairments including high dissolved oxygen demand, phosphorus, pathogens, and silt/sediment. The list notes industrial, municipal, on-site/septic systems, construction, and urban/storm runoff as possible pollution sources.

Figure 2. Shipbuilders Creek watershed, which drains directly to Lake Ontario.

While no TMDL has been developed for SC, New York State's 2010 MS4 permit states that "...if a small MS4 discharges a stormwater pollutant of concern (POC) to impaired waters...the permittee must ensure no net increase in its discharge of the listed POC to that water. By January 8, 2013, permittees must assess their progress and evaluate their stormwater management program with respect to the MS4's effectiveness in ensuring no net increase..." (New York State DEC, 10). In anticipation of this requirement and as a part of a larger master planning effort to improve water quality within the county, a project team that included staff from the Monroe County Department of Environmental Services and the Monroe County Soil and Water Conservation District Monroe County selected the WTM as a modeling tool. The modeling effort described in this article focused on quantifying the benefits of specific management practices in this urban watershed and thus uses steps one and two illustrated in Figure 1.

Developing Model Inputs

A geographic information system (GIS) is an invaluable tool in developing the input data for the WTM, and we were fortunate to have high-quality data layers as well as a GIS unit and well-trained staff. Below, we describe the methods used to develop the model inputs using GIS data layers.

Land Use

The WTM characterizes land use into categories, such as "single-family residential" (at various densities), "commercial," or "forest," and assigns default values of impervious cover and turf cover (as a percentage) for each land use category. While this portion of the model appears simple, the project team found that developing the layers accurately required a multistep process to develop inputs that accurately reflected the watershed.

In the first step, clips were created from GIS layers—such as parcels, soils, roads, sewers, and waterways—to the watershed boundary. The parcel layer included data regarding the property class and parcel size. The property class gave a very accurate description of how the land was being used, allowing us to distinguish the areas of single-family residential from multifamily residential parcels as well as various types of commercial property (Figure 3). Residential parcels were further subdivided into various densities (e.g., high-density versus low-density) based on the parcel size.

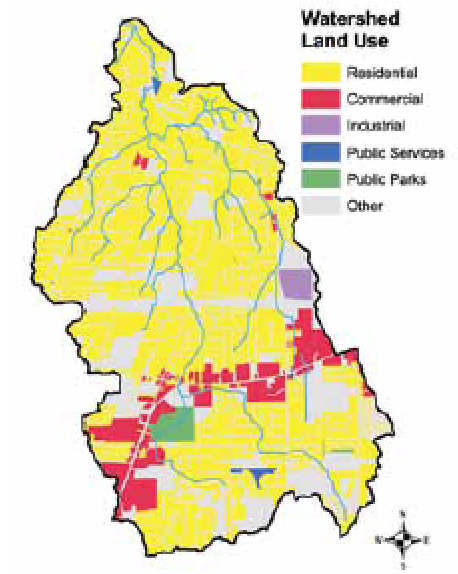

Figure 3. Land use data derived from Monroe County's parcel layer.

The Monroe County Department of Environmental Services also maintains a very high–quality land use/land cover data layer developed from a model using remotely sensed data created from four band ortho imagery and using IDRIS Andes software. The data were extremely helpful, but at first seemed at odds with the land use information derived from the parcel layers. While the imagery data indicated that approximately 30% of the SC watershed was forested, the data developed using WTM standard assumptions and the parcel layer indicated a far lower forest cover. This discrepancy resulted because a number of parcels in the low-density residential category (< 1 dwelling/acre) in the watershed are heavily forested. To resolve this discrepancy, we modified the WTM default of 70% turf cover to 44% turf to provide a more realistic characterization of this land use category.

Soils

The WTM requires soils data, including hydrologic soil group (groups A, B, C, and D), and depth to groundwater. We obtained soil types from existing GIS layers. To determine both the depth to groundwater and the hydrologic soil group, project staff used the US Department of Agriculture Natural Resources Conservation Service's Web Soil Survey, an interactive soil mapping site.

Secondary Sources

Secondary sources in SC included storm sewer overflows (SSOs), septic systems, illicit connections, and channel erosion. The team used known information gathered from field analyses to improve the estimates derived from WTM model defaults. For example, project team members had completed a detailed analysis of illicit connections in the watershed and had conducted stream assessments using the unified stream assessment (USA) technique (Kitchell and Schueler 2005). This integration of known watershed data and model defaults allowed project staff to more accurately characterize these diffuse sources (Table 3).

Table 3. Characterizing secondary sources in Shipbuilders Creek

Source	Model Defaults	Supplemental Data or Confirmation
Septic Systems	Failure rates and effectiveness determined based on soil type, density, system type, and maintenance.	No modifications to defaults. Input data based on known number of customers and detailed knowledge of maintenance policies.
SSOs	Default based on number of SSOs per mile of sewer.	Used defaults and confirmed results based on wet weather flow at WWTPs.
Illicit Connections	Default number per household.	Adjusted to reflect known number of connections based on IDDE field surveys.
Channel Erosion	Monroe County selected a generalized option that characterizes erosion as high, medium, or low.	Characterized as "low" based on stream surveys using the USA

Notes: IDDE, illicit discharge detection and elimination; WWTP, wastewater treatment plant; USA, unified stream assessment.

Structural Stormwater Practices

The WTM requires an assessment of existing practices, including the area draining to each practice type as well as discount factors to reflect practice design, maintenance, and design volumes. Monroe County did not have a single database of stormwater practices and drainage areas, so project staff reviewed aerial photos with storm sewer overlays to determine if developed areas were discharging to stormwater management practices, the type of the practice, the area draining to the practice, and the percentage of impervious cover within the drainage area. While this was time-consuming, good GIS data made it possible. The discount factors reflected staff knowledge of design and maintenance of practices within the watershed.

Residential Turf Management

The WTM estimates loads and runoff volumes from turf based on the area of turf and current turf management practices in the watershed. Some input data include the number of new homes, which typically use more fertilizer than older homes, the number of "highly managed" lawns, and the area of compacted lawns. In addition to accurately calculating the area of turf in the landscape using LIDAR data, we conducted an upland watershed assessment, using techniques similar to the *urban site and subwatershed reconnaissance* described by Wright et al. (2004). Data gathered from these assessments allowed staff to accurately characterize both the area and the condition of turf throughout in the watershed.

Pet Waste Education

The WTM quantifies the effectiveness of pet waste education programs using generalized model defaults that characterize the behavior of pet owners. In the SC watershed, an active educational program is in place, and three professional phone surveys have been conducted in the region that includes SC to measure and track awareness and behavior related to water pollution. Using these survey data, team members modified the WTM's default estimates of pet owner behavior to reflect actual conditions in the SC watershed.

Results

The WTM 2010 beta edition reports loads to groundwater and loads to surface waters separately. The surface loads are then further subdivided into storm and nonstorm loads. In the SC watershed, managers focused on the load to surface waters, assuming that the loads to groundwater do not ultimately reach the receiving water. Table 4 indicates results for phosphorus and bacteria for illustrative purposes. The loads from urban land (i.e., stormwater runoff) dominated the loads for all pollutants. This result is consistent with watershed characteristics since about 75% of the land use in the watershed is residential. The relatively small pollutant loads from active construction reflect the current slow pace of construction.

The project team also evaluated future management practices, including a comprehensive stormwater retrofit program, coupled with some modest, watershed-wide improvements such as increased public educational programs for pet waste and lawn care, repairs and removal of some existing septic systems, and elimination of some illicit discharges. Collectively, these practices would reduce loads of phosphorus and bacteria by 13% and 17%, respectively.

In addition, staff investigated the effectiveness of each practice (Figure 4). While the retrofit program represents 60% of the total load reduction achieved for phosphorus, practices such as illicit connection removal are much more important for bacteria. These results indicate that a combined approach will be needed to address all POCs in the SC watershed.

Table 4. Surface Surface Water Loads (Phosphorus and Fecal Coliform) Before and After Proposed Management Practices

	Total Phosphorus (kg/year)			Fecal Coliform (billion/year)		
	Load Before	Load After	Reduction (%)	Load Before	Load After	Reduction (%)
Urban Land	2,433	2,054	16%	919,641	742,213	19%
Active Construction	14	8	42%	-	-	
SSOs	29	27	8%	291,960	270,063	8%
Channel Erosion	472	463	2%	-	-	-
Rural Land	187	187	0%	22,924	22,924	0%
Livestock	22	22	0%	1,600	1,600	0%
Open Water	3	3	0%	-	-	-
Illicit Connections	44	0	100%	256,238	-	100%
Septic Systems	62	48	22%	32,906	25,886	21%
Total Storm Load	3,090	2,695	13%	1,090,145	901,769	17%
Total Non-Storm Load	176	118	33%	435,124	160,917	63%
Total Load to Surface Waters	3,266	2,812	14%	1,525,269	1,062,686	30%

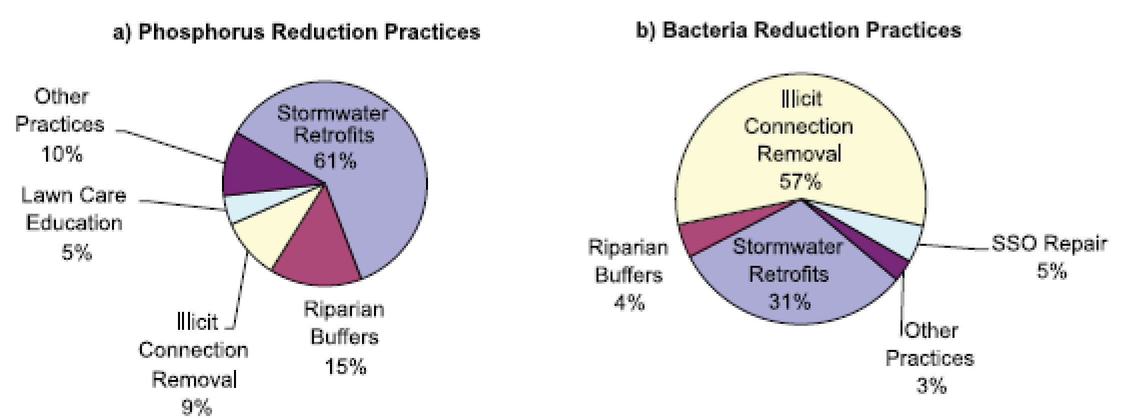

Figure 4. Estimated pollutant removal attributable to various management practices for phosphorus (a) and for bacteria (b).

Next Steps

This initial modeling exercise represents a first step in ongoing watershed planning activities in SC. It also provides an effective demonstration toward future efforts to meet New York State's requirements to model and demonstrate that future growth will not result in an increase in any POC. Along with ensuring no net increase, an additional goal is to improve water quality wherever possible in the most cost-effective manner. Future efforts to support these goals will include the following:

- A detailed build out analysis to examine future growth
- A full retrofit analysis to prioritize and evaluate individual retrofit options
- Cost estimations to compare the cost-effectiveness of various options
- Ongoing surveys and tracking of implementation and land use to continually update the "existing loads" portion of the model

Summary and Lessons Learned

To date, the WTM has proven to be an appropriate and relatively flexible tool for evaluating stormwater treatment options in SC. Key lessons learned include the following:

- Model default data are based on research but should always be adjusted with local data where available.
- While the mapping data required appear relatively simple, the best results are derived from multiple sources (e.g., aerial photography and land cover and land use).
- Good GIS data are needed to successfully use the WTM.
- The WTM is designed to be used hand in hand with field assessment methods, such as stream and upland surveys, and results improve as these data are incorporated.
- One strength of the WTM is that, while data input can be time-consuming, the model can be operated by nonmodelers and retained as a program tool.

Where To Get a Copy

The WTM is posted on the Center for Watershed Protection's website (www.cwp.org) for free download. The WTM 2010 beta edition reflects the authors' knowledge of the best science and incorporates comments from users. The Center is currently incorporating agricultural management practices into the model. In the longer term, the Center intends to create (1) a graphical user interface to ease data input; (2) an interface to import GIS data for land use inputs; and (3) a web-based version of the model to allow for tracking and compilation of progress at a national, regional, or state level.

If you would like to use the WTM, or if you have used it and have questions or comments, please email Deb Caraco at dsc@cwp.org.

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Appendix F: Recommended Restoration Projects

Table Appendix F.1 - Stormwater Ponds in the upper watershed (Note: red text denotes prioritized projects)

pond #	Project	Project Type	DA/IC treated	Feasibility[1]	Cost Effectiveness[2]	Environmental Benefit[3]	Ownership	Multiple Benefits[4]	% Capture[5]	Total Score
3	44 reddick Ln in Stoney Pt Sec3 in Ogden	dry pond conv.	20/ 5	1	3	2	public	I, WQ, CP	0	9
4	10 Reddick Ln in Stoney Pt Ogden	dry pond conv.	35/ 7	4	3	2	public	WQ, CP	0	11
10	9 Denishire Dr in Fairview Heights Ogden	dry pond conv.	16/ 5	1	3	2	private	WQ, CP	0	8
18	NYS Rt 531 median west of Manitou Ogden	dry pond conv.	10 /1	4	3	2	public	I, WQ, CP	0	12
20	2580 Manitou Rd Fedex Ogden	dry pond conv.	6 /4	2	3	1	private	I, WQ, CP	0	9
23	2600 Manitou Rd Eastman Kodak Gates	dry pond conv.	46/ 10	2	3	2	private	WQ, CP	0	9
24	7 RyansRun Valley Brook Ogden	dry pond conv.	37/ 13	1	3	2	private	WQ, CP	0	8
27	10 Quail Ln W Whittier Estates sec 7 Ogden	dry pond conv.	19 /6	1	3	2	private	I, WQ, CP	0	9
28	55 Regency Oaks Blvd Regency Oaks Ind Pk Ogden	dry pond conv.	7 /4	2	3	1	private	WQ, CP	0	8

[1] For all footnotes – go to end of this Appendix

pond #	Project	Project Type	DA/IC treated	Feasibility[1]	Cost Effectiveness[2]	Environmental Benefit[3]	Ownership	Multiple Benefits[4]	% Capture[5]	Total Score
30	Westview commons Apt Gates	dry pond conv.	20 /4	2	3	2	private	WQ, CP	0	9
31	3285 Buffalo Rd Church of the Epiphany Gates	dry pond conv.	11 /6	2	3	2	private	I, WQ, CP	0	10
33	5 Glen Livet Dr Golden Estates Chili	dry pond conv.	8/ 2	1	3	1	private	WQ, CP	0	5
38	35 Da Vinci Dr Renaissance Chili	dry pond conv.	14/ 4	1	3	2	private	I, WQ, CP	0	9
39	1 Sunview Dr Marlands Pk Chii	dry pond conv.	21 /6	2	3	2	private	WQ, CP	0	9
42	88 Whittier Rd Whittier Rd Party Hs Ogden	dry pond conv.	2 /1	2	3	1	private	WQ, CP	0	8
55	7 Carlotta Dr. Carlotta Subd sec2 Ogden	dry pond conv.	20/ 2	1	3	2	private	WQ, CP	0	8
66	Creative at Inoation	dry pond conv.	20/15	4	3	2	public	I, WQ, CP	0	12
58	27 Alana Dr. O'Brien Subd. Ogden	dry pond conv.	15 /2	1	3	2	private	I, WQ, CP	0	9
TOTAL dry			**327 97**							
1	34 Alderbrook Tr Arbor Ck Estates Ogden	clean/modify outlet	15 /2	1	3	2	private	CP	0.9	7
2	3 Nelson Morton Blvd Roberts	clean/modify outlet	23 /6	2	3	2	private	CP	0.5	8

pond #	Project	Project Type	DA/IC treated	Feasibility[1]	Cost Effectiveness[2]	Environmental Benefit[3]	Ownership	Multiple Benefits[4]	% Capture[5]	Total Score
	Wesleyan Ogden									
5	3 Union Pt Dr Union Pt Estates Ogden	clean/modify outlet	61 /7	1	3	3	private	CP	0.5	8
6	2 Union Pt Dr Union Pt estates Ogden	clean/modify outlet	48 /5	1	3	3	private	CP	0.5	8
7	17 Mondavi Circle Brittany Manor Oden	clean/modify outlet	23 /4	1	3	2	private	CP	0	7
8	35 King Fisher Dr. Brookhaven Estates Ogden	clean/modify outlet	175 /20	1	3	3	private	CP	0	8
9	28 King Fisher Dr Brookhaven Estates Ogden	clean/modify outlet	160 /16	1	3	3	private	I, CP	0	9
11	70 Quali Ln W Whittier Ogden	clean/modify outlet	45 /14	1	3	3	private	I,CP	0	9
12	85 Forest Meadow tr N Forest Estates Ogden	clean/modify outlet	28 /8	4	3	2	public	CP	0	10
13	45 Vantage Point Center Ogden	clean/modify outlet	29 /17	2	3	2	private	CP	0	8
14	100 Paragon Dr Westover Business Pk	clean/modify outlet	52 /16	2	3	3	private	I, CP	0	10

pond #	Project	Project Type	DA/IC treated	Feasibility[1]	Cost Effectiveness[2]	Environmental Benefit[3]	Ownership	Multiple Benefits[4]	% Capture[5]	Total Score
15	2600 Manitou Rd Eastman Kodak Ogden	clean/modify outlet	63 /32	2	3	3	private	CP	0	9
16	NYS Rt 531 median west of Manitou S. Side Ogden	clean/modify outlet	12 /2	4	3	2	public	CP	0	10
17	business ctr dr ogden	clean/modify outlet	6 /1	2	3	1	private	CP	0	7
19	2580 Manitou Rd Fedex Gates	clean/modify outlet	11 /8	2	3	1	private	CP	0	7
21	135Fedex Way Gates	clean/modify outlet	5 /3	2	3	1	private	I,CP	0	8
22	2696 Manitou Rd Eastman Kodak Gates	clean/modify outlet	18/ 11	2	3	2	private	I, CP	0	9
25	3861 Buffalo Rd Ogden	clean/modify outlet	4 /3	1	3	1	private	CP	0	6
26	2830 Manitou Rd Willa Columbo Subd Gates	clean/modify outlet	20 /8	1	3	2	private	CP	0.5	7
29	3555 Buffalo Rd Westview Commons Gates	clean/modify outlet	13/ 8	2	3	2	private	CP	0	8
32	92 Windmill Tr Country Shire Estates sec 6 Ogden	clean/modify outlet	40 /10	1	3	3	private	CP	0.5	8
34	28 Acorn Valley Tr Oak Ridge Estates Ogden	clean/modify outlet	15/ 3	1	3	2	private	I, CP	0.5	8

pond #	Project	Project Type	DA/IC treated	Feasibility[1]	Cost Effectiveness[2]	Environmental Benefit[3]	Ownership	Multiple Benefits[4]	% Capture[5]	Total Score
35	100 Foxe Commons Chili Hunt hollow HOA	clean/modify outlet	25 /6	2	3	2	private	I, CP	0.5	9
36	14 Hunting Spring Chestnut HOA Chili	clean/modify outlet	32 /8	2	3	2	private	CP	0	8
37	30 Sunset Hill Chili Private	clean/modify outlet	25/ 6	1	3	2	private	CP	0	7
41	2735 Buffalo Rd Crystal commons Gates	clean/modify outlet	36 /13	2	3	2	private	I, CP	0	9
56	11 Kresswood Dr Kresswood Meadows Ogden	clean/modify outlet	10 /1	1	3	2	private	I,CP	0.5	8
59	39 Brocckton Pl Arbor Ck Estates Odgen	clean/modify outlet	18/ 4	1	3	2	private	I,CP	0.5	8
60	2605 Manitou Rd Caldwell Manufact Ogden	clean/modify outlet	25 /13	2	3	2	private	CP	0	8
61	3841 Buffalo Rd Ogden	clean/modify outlet	7 /4	1	3	1	private	CP	0	6
62	60 Regency Oaks Blvd Ogden	clean/modify outlet	8 /2	2	3	1	private	CP	0	7
64	7 Andilyn Ct Ogden	clean/modify outlet	30 /3	1	3	2	private	CP	0	7
65	2735 Buffalo Rd Crystal commons Gates	clean/modify outlet	6 /4	2	3	1	private	I, CP	0	8

pond #	Project	Project Type	DA/IC treated	Feasibility[1]	Cost Effectiveness[2]	Environmental Benefit[3]	Ownership	Multiple Benefits[4]	% Capture[5]	Total Score
67	Elmgrove at Buffalo	clean/modify outlet	50/25	4	3	3	public	I, CP	0	12
Total Wet			**1364/ 293**							

Table Appendix F.2 - Stormwater Ponds in the lower watershed (Note: red text denotes prioritized projects)

SubWS /pond #	Project	Project Type	DA/IC treated	Feasibility[1]	Cost Effectiveness[2]	Environmental Benefit[3]	Ownership	Multiple Benefits[4]	% Capture[5]	Total Score
D52	490 Cloverleaf @ Buffalo Rd E bound exit Gates	Dry Basin conversion	10/ 1	4	3	2	public	WQ, CP		11
F40	200 Aviation Dr. Paul Rd Ind Subd Chili	clean/modify outlet	23/ 10	3	3	2	private	CP		9
F43	3 Woodbriar Ln Town of Chili	Dry Basin conversion	40/ 8	4	3	3	public	I, WQ, CP		13
G45	199 Hidden Valley Rd (HOA) Gates	clean/modify outlet	120/ 72	3	3	3	private	S,WQ, CP		12
G50	1489 Howard Rd Westgate Paza Gates	clean/modify outlet	34 /24	4	3	2	public	CP		10
G51	1532 Brooks Ave Comida (Jet Blak) Gates	clean/modify outlet	10/10	4	3	2	public	CP		10
G53	249 Fisher Road Wegmand Comida Gates	Dry Basin conversion	23/ 5	4	3	2	public	I, WQ, CP		12

SubWS /pond #	Project	Project Type	DA/IC treated	Feasibility[1]	Cost Effectiveness[2]	Environmental Benefit[3]	Ownership	Multiple Benefits[4]	% Capture[5]	Total Score
G54	1500 Brooks Av Wegman Offices Gates	clean/modify outlet	33/30	3	3	2	public	CP		9
H44	249 Fisher Road Wegmand Comida Gates	clean/modify outlet	11/2	4	3	2	public	CP		10
H46	249 Fisher Road Wegmand Comida Gates	clean/modify outlet	65/26	4	3	3	public	CP		11
H47	6 Kings Way Maple Hollow Subd Chili	clean/modify outlet	15/3	1	3	2	private	CP		7
H48	512 Paul Rd Wellington HOA Chili	clean/modify outlet	30/10	3	3	2	HOA	CP		9
H49	512 Paul Rd Wellington HOA Chili	clean/modify outlet	40/13	3	3	3	HOA	CP		10
H66	74 White Oak Bend and 813 Marshall Road Wellington Subd Chili	Dry Basin conversion	20/7	3	3	2	HOA	I, WQ CP		12
67	Kodak Elmrove Buffalo Road near Elmgrove, Gates	clean/modify outlet	50/35	4	3	2	public	I, WQ CP		12
H68	82 Battle Green Dr, Lexington Sud Chili	Dry Basin conversion	20/4	4	3	2	public	WQ, CP		11
		TOTAL DRY	**73/ 14**							
		TOTAL WET LOWER WS	**401/207**							

Table Appendix F.3 Potential New Stormwater Ponds

Project Name/ Project Location	**Project Type**	**DA**	**Area Treated (acres)**	**Area and depth of practice**	**Stream Length Restored (ft)**	**Rv**	**WQv (ac-ft)**	**Comments**
Buffalo Road at Whittier Road – Town of Ogden Flood Management Project	New Stormwater Pond	4198	1000	2 acres 4 ft	NA	0.122	8	treat approximately 1/4 of DA, ~ based on NYSDOT excavation and disposal of fill @$25/CM ~ $33/CY
Median NYS Route 204 and 490 intersection	New Stormwater Pond	large	522	2 acres 4 ft		0.23	8	assume 20 IC area is about 2 acres and could be larger if median was used - say ave 4 feet deep then 8 ac-feet
off coldwater road adjacent and south side of railroad	New Stormwater Pond	large	300	1.5 acres 4 ft		0.14	2.8	assume 10% IC picks up drainage from south and east side of coldwater on south side of rr - site can have excess WQv if acres and 4 ft deep
south side of NYS Route 204 and est of Pixley Road	New Stormwater Pond	large	75	15K SF, 4 ft		0.275		assume a 25% IC available space ~ 300x50 4 feet ave depth >

TABLE NOTES

[1] Land Ownership and accessibility - Public property = 3 HOA, Industrial or Commercial w/Easement = 2 Residential w/Easement = 1 point. Accessible – add 1 point

[2] Low medium and high costs = 3 , 2 or 1 respectively based on table of cost per cubic foot of storage ($1-11 low;$12-25 med.;$26 + high)

[3] drainage area to pond: 1- 9 acres = 1 point; 10-39 acres = 2 points; >40 acres = 3 points

[4] Each objective is 1 point: S = flood storage; WQ = Water Quality; CP = reduced streambank erosion; I = infiltration; E= education; A=augment (if CP is added and a downstream erosion site is w/in 2500 feet add 1 point)

(5) No Points for this category - Capture is used in the WTM and is the % of rainfall a practice captures. Use 0 for dry ponds and those built before 1995, use .5 for ponds built between 1995 and 2005, use .9 for newer ponds