Buckland Creek Stormwater Assessment and Action Plan

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Written Under the Direction of

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Buckland 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 Town of Brighton, 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
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 Buckland Creek Assessment and Action Plan (SWAAP) summarizes the results of a detailed assessment of Buckland Creek 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.

The headwaters of Buckland Creek are in the southeast part of the City of Rochester NY, flowing east through the Town of Brighton to finally discharge into Allen Creek (Figure E1).

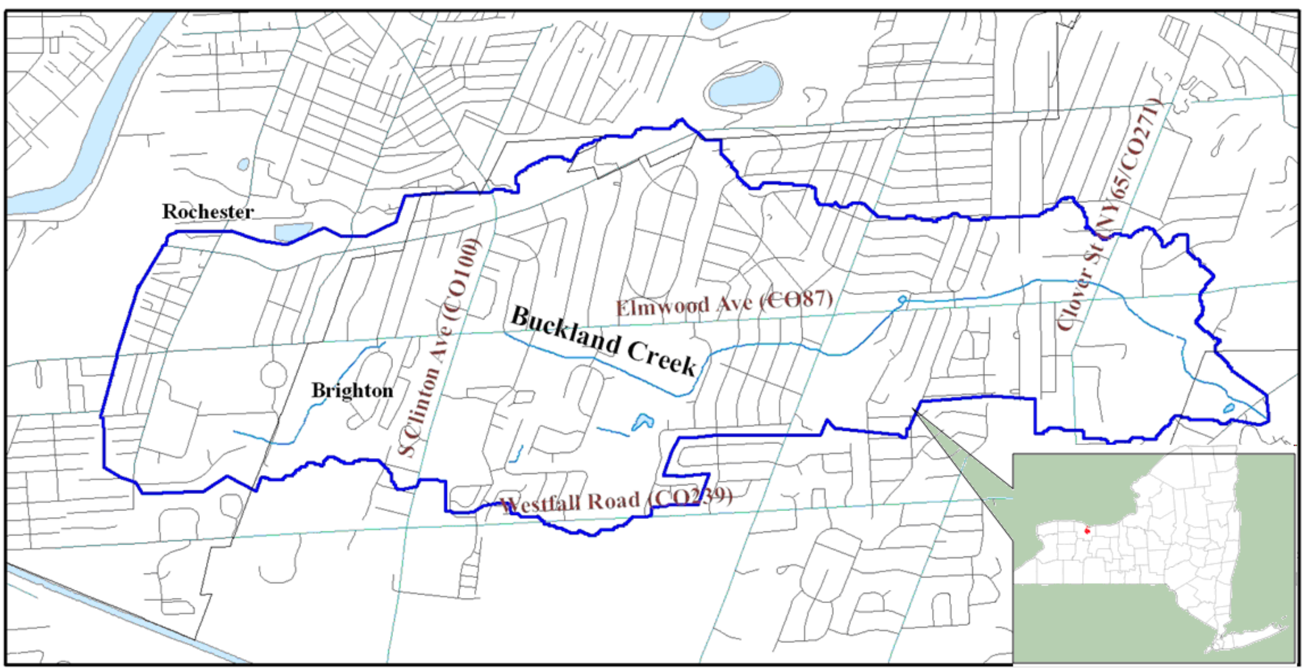

Figure E.1 Buckland Creek Watershed in Monroe County

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 (Center for Watershed Protection, 2004a). With that in mind, the assessment process was conducted on Buckland Creek 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 Buckland Creek 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 Buckland Creek flows between the Brightonian (a nursing home) and the Brighton DPW facility. The open area adjacent to the stream 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 stream channel should also be planted to restore the riparian area.

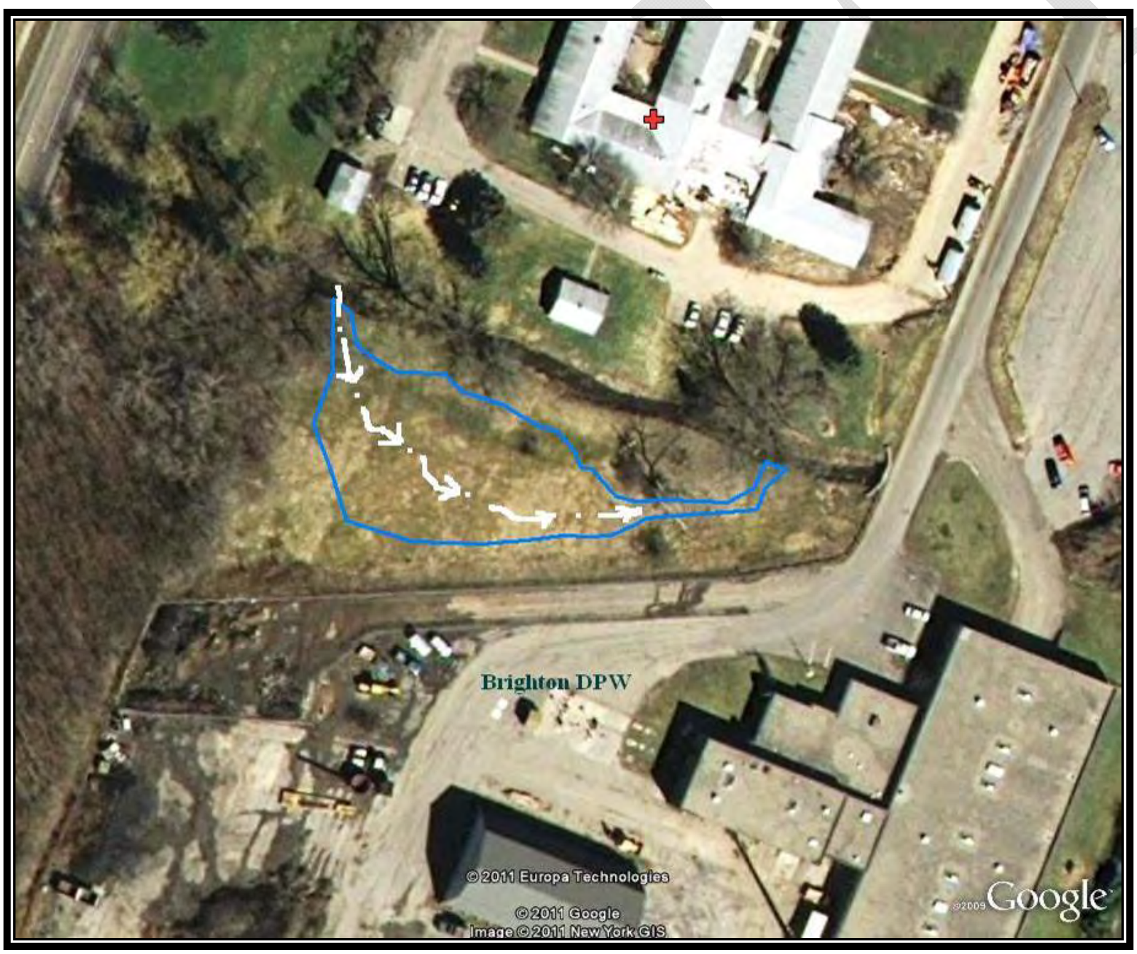

Figure E.2 Potential new stormwater storage areas at Brighton DPW

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 Allen Creek with the ultimate goal of removal of Allen Creek from the NYSDEC impaired waterbodies list.

Recommendations

To restore Buckland Creek, 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

The headwaters of Buckland Creek are in the southeast part of the City of Rochester NY. The drainage flows east through the Town of Brighton to finally discharge into Allen Creek. The watershed covers approximately 2450 acres of mostly high density residential development with some commercial and public land use throughout (see Figure 1). Due to the fairly consistent land use, water quality and quantity analysis for the watershed was evaluated as a whole (as opposed to watersheds with significant land use variations between rural and urbanized areas that require further divisions into subwatersheds).

Figure 1. Highly developed nature of the Buckland Creek Watershed

1.2 Purpose

The Buckland Creek Stormwater Assessment and Action Plan (SWAAP) summarizes the results of a detailed assessment of Buckland Creek 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 the Stormwater Coalition of Monroe County with support from the Monroe County Department of Environmental Services. 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 those in the Buckland Creek watershed: the City of Rochester and the Town of Brighton. 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 pollutants of concern (POCs). Impaired waters are listed in the New York State Water Quality Section 305b Report (NYS DEC, 2004). Buckland Creek is a major tributary of Allen Creek which the 305b Report identifies as impaired due to urban stormwater runoff. This SWAAP meets the MS4 Permit modeling requirements and demonstrates a simple approach to ensure, what the Permit terms, "no net increase of priority pollutants". See Section 2.1.2 Water Quality, Existing Data and Appendix C for more information.

POCs in Buckland Creek are nutrients from urban stormwater runoff. Examples of stormwater pollutants and the effects of watershed development on stream health include:

- **Sediments, Phosphorus, and Stream bank Erosion** -The increased volume, velocity and flow rate of stormwater from impervious surfaces increase pollutant loads and thereby, erosion of stream beds and banks.

- **Pathogens** - Wet weather concentrations of microbial pathogens such as *Cryptosporidium*, *Escherichia coli* (*E.coli*), *Giardia lamblia* are organisms that can cause illness when consumed and are significant water quality concerns in urban streams.

- **Stream Baseflow** - Widespread urbanization also modifies the normal or baseflow in streams by decreasing infiltration into the ground and thereby reducing the ability for groundwater to recharge the stream.

- **Habitat Degradation** - Much of Buckland Creek has been relocated around development to increase the build out of parcels. In addition, several sections of the stream have been lined with rock or piped. These practices increase water temperature and limit aquatic habitat.

- **Low Dissolved Oxygen and Pollutants that deplete Dissolved Oxygen -** The stream system gains oxygen from the atmosphere and from plants as a result of photosynthesis. Running water, because of its churning, dissolves more oxygen than still water. Respiration by aquatic animals, decomposition, and various chemical reactions consume oxygen. Pollutants often contain organic materials that decompose using oxygen in the process. Sources of oxygen-consuming waste include wastewater, stormwater runoff from farmland and feedlots or urban runoff, and failing septic systems.

- **Other Pollutants** – There are many other pollutants that can be carried to streams in stormwater runoff including: Aesthetics (floatables, odors), Priority Organics (PCBs, mirex, dioxin); Thermal increases; frequent bankfull flows, Nutrients, Oil and Grease, Metals, and Salts.

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. These are best developed with 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. However, 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 Buckland Creek Stakeholder Task Group. The Buckland Creek 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 Buckland Creek 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 watershed goals as well as identify a timeline and party responsible for implementing each action. Specific recommendations for Buckland Creek should be developed by the Buckland Creek Stakeholder Task Group. Potential recommendations for the Task Group to consider are listed in Section 4 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 described 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 watershed, 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 2.1.6 of this document.

1.6 Future Steps

Additional steps to complete the Buckland Creek SWAAP will need to be taken. A Buckland Creek 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: Buckland Creek Watershed Characterization

2.1 Watershed Data

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

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

Buckland Creek has a 3.8 square mile watershed with other basic watershed metrics shown in Table 1.

Table 1. Buckland Creek Subwatershed Data

Metric	Value
Area (Acres)	2450
Mapped Stream Miles	4.7
Miles of Piped Stream	0.5 (included in above)
Primary/secondary land use	Residential/commercial
Miles of Channelized Stream	4.1
# of Stormwater Treatment Ponds	14
# of Stormwater Outfalls	90
Current Impervious Cover (%)	41
Estimated Future Impervious Cover (%)*	45
Current Health Status (see Impervious Cover Analysis discussion below)	Does not support most aquatic organisms
Wetland acres	125
Municipal Land Use Jurisdiction	Mostly within the Town of Brighton

*estimated 2021

2.1.1 Land Use

Like most of Western New York, the Buckland Creek watershed was originally heavily forested and transitioned to agricultural in the mid to late 1800's when streams were typically rerouted around crop fields and orchards. In the 1930's through the next 60 years, agricultural land was largely replaced with residential and commercial land uses. Using the New York State office of Real Property's Land Use Classification list, Buckland Creek watershed's current predominant land uses were found and are shown in Figure 2. Approximately 43 percent of the Buckland Creek watershed is residential, followed by 27 percent commercial (including public buildings such as the Brighton Twelve Corners School Campus).

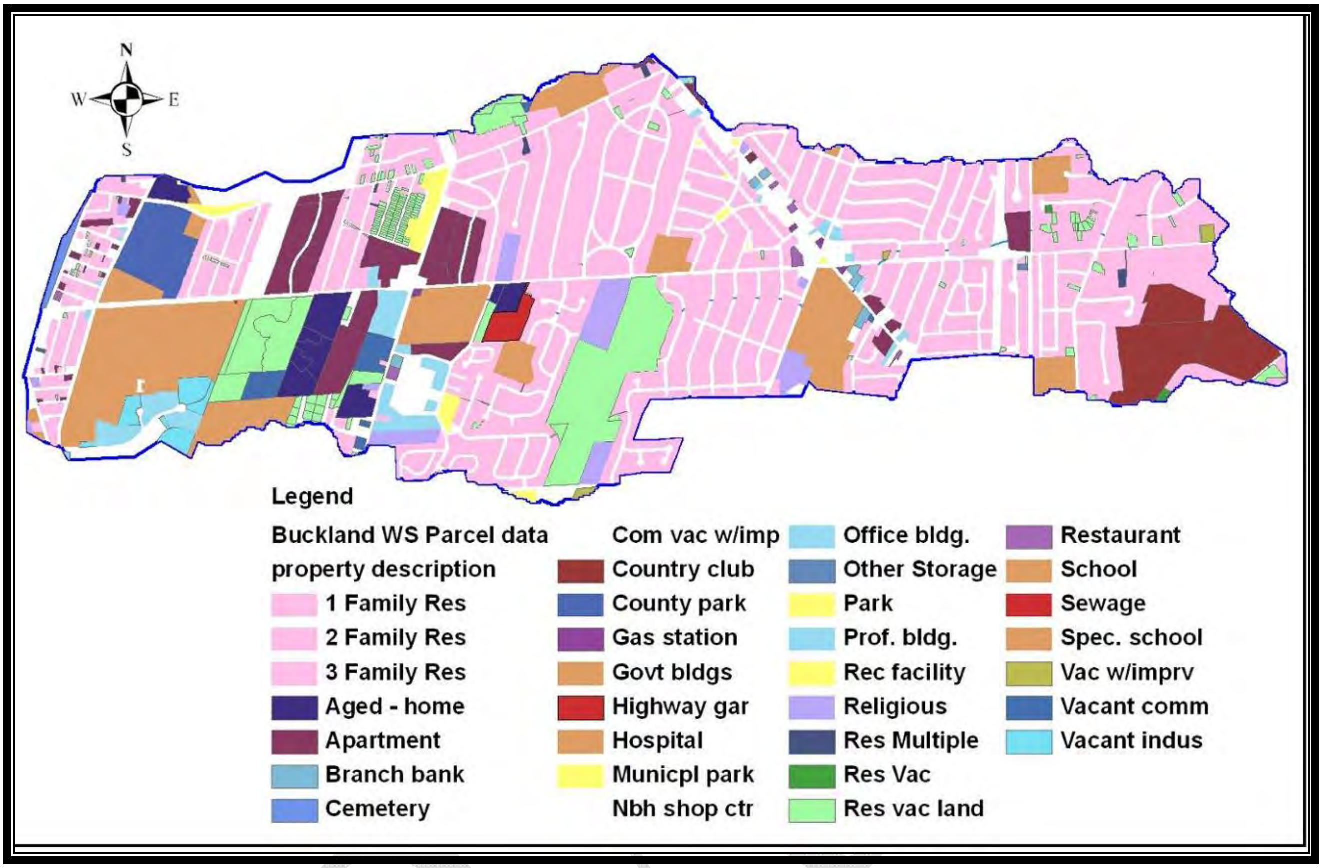

Figure 2. Buckland Creek Watershed Land Use Classification

A comparison of land use through aerial photos from 1930 and 2009 illustrates the increase in land development (see Figure 3). New homes were built as well as schools and commercial areas, replacing agriculture along the southeastern edge of the City of Rochester.

Figure 3. Comparison of land use in Buckland Creek Watershed - 1930 (left) and 2009 (right). Photos are of the Elmwood and South Clinton Avenue area (Town of Brighton).

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, 2010). 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 Buckland Creek watershed. These estimates were based on light detection and ranging (LIDAR) impervious cover imagery, mapping data analysis and municipal zoning maps (to estimate build out). As shown in Table 1, future impervious cover based on a partial build-out in 10 years is 45 percent. According to the ICM, a typical stream's overall health is predicted to be non-supporting (of aquatic life) at this amount. 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. Streams in this category essentially become conduits for conveying stormwater flows. Typical impairment indicators are increased summer stream temperature, highly unstable stream channels (evidenced by severe widening, downcutting, and streambank erosion), increased bacteria levels, and low or no aquatic diversity. From field investigation, the health of Buckland Creek verifies the ICM since the creek does not support much aquatic life (see Biology, section 2.1.5).

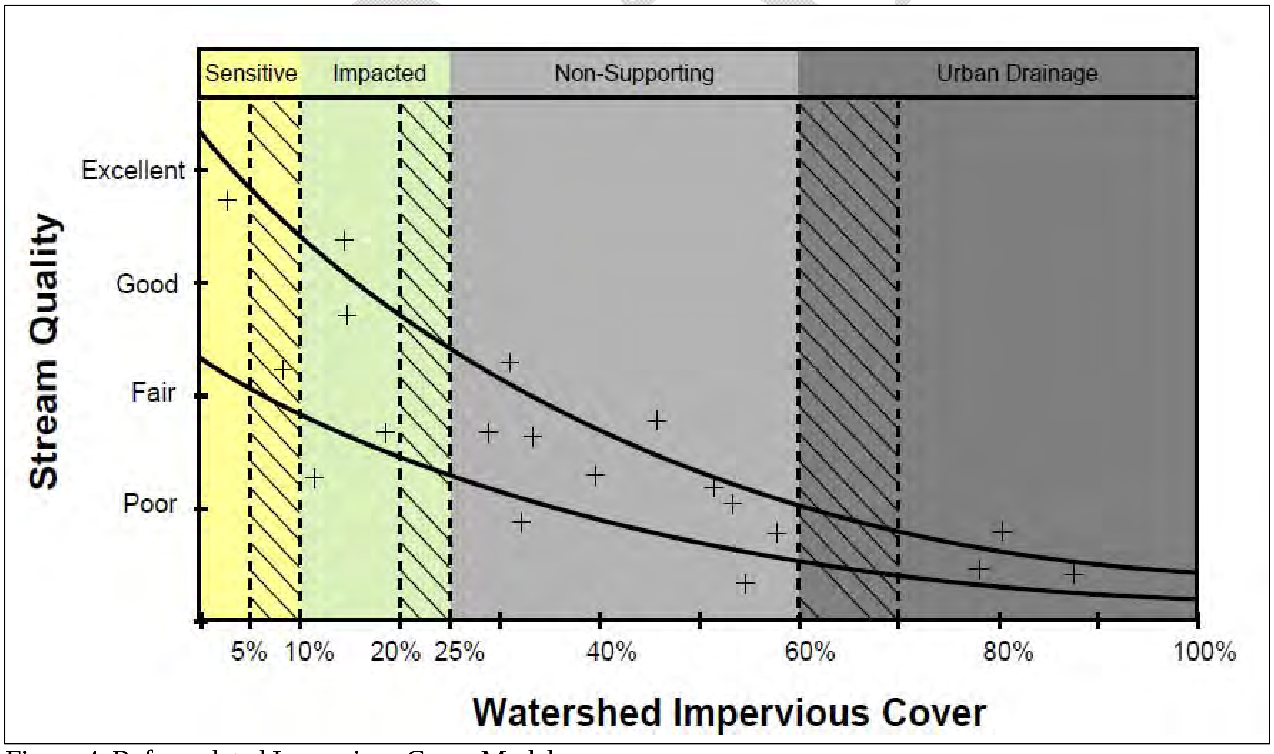

Figure 4. Reformulated Impervious Cover Model

Existing Data

In order to fulfill certain requirements of the Federal Clean Water Act, NYSDEC has to provide regular, periodic assessments of our water resources' quality and ability to support specific uses (such as for drinking water, swimming or fishing). These assessments reflect monitoring and water quality information from NYSDEC and others. 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 tracks progress toward improvements. The latest data from this source that includes Buckland Creek is titled "The 2004 Waterbody Inventory For Central Lake Ontario Watershed" (2004 NYSDEC WI/PWL). The document has a two-page write up for Allen Creek and its tributaries (Buckland Creek is a tributary of Allen Creek, see Appendix C). Known Pollutants listed are nutrients from urban stormwater runoff. Suspected pollutants are silt and sediment from construction sites and streambank erosion. Salt is also listed as a suspected pollutant from road deicing. Possible pollutants listed are pathogens from agriculture (outside of the Buckland Creek Watershed).

All waters in New York State are assigned a letter classification that denotes their best uses. Letter classes A, B, C, and D are assigned to fresh surface waters. Best uses include: source of drinking water, swimming, boating, fishing, and shellfishing. Buckland Creek is classified as "B". NYSDEC states the best usage of Class B waters are "… *primary and secondary contact recreation and fishing. These waters shall be suitable for fish, shellfish, and wildlife propagation and survival".*

In addition to NYSDEC data, over nine years of stream sampling by Brighton High School's Environmental Club was obtained from science teacher and club leader George Smith. Some of this data is presented in later parts of this section and in Appendix B.

Wetlands

State and federal government agencies regulate certain wetlands in order to preserve them as a natural resource. Regulated NYS wetlands make up 2% of the land area in the watershed and federally regulated wetlands make up 3 percent (see map, Figure 10). 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 Buckland Creek watershed (though polluted runoff from developed areas should be treated first since it would degrade 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 (stream baseflow) and wet weather grab 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 downstream from the other to allow estimates of increasing basin loads of sediment and nutrients (see Figure 5).

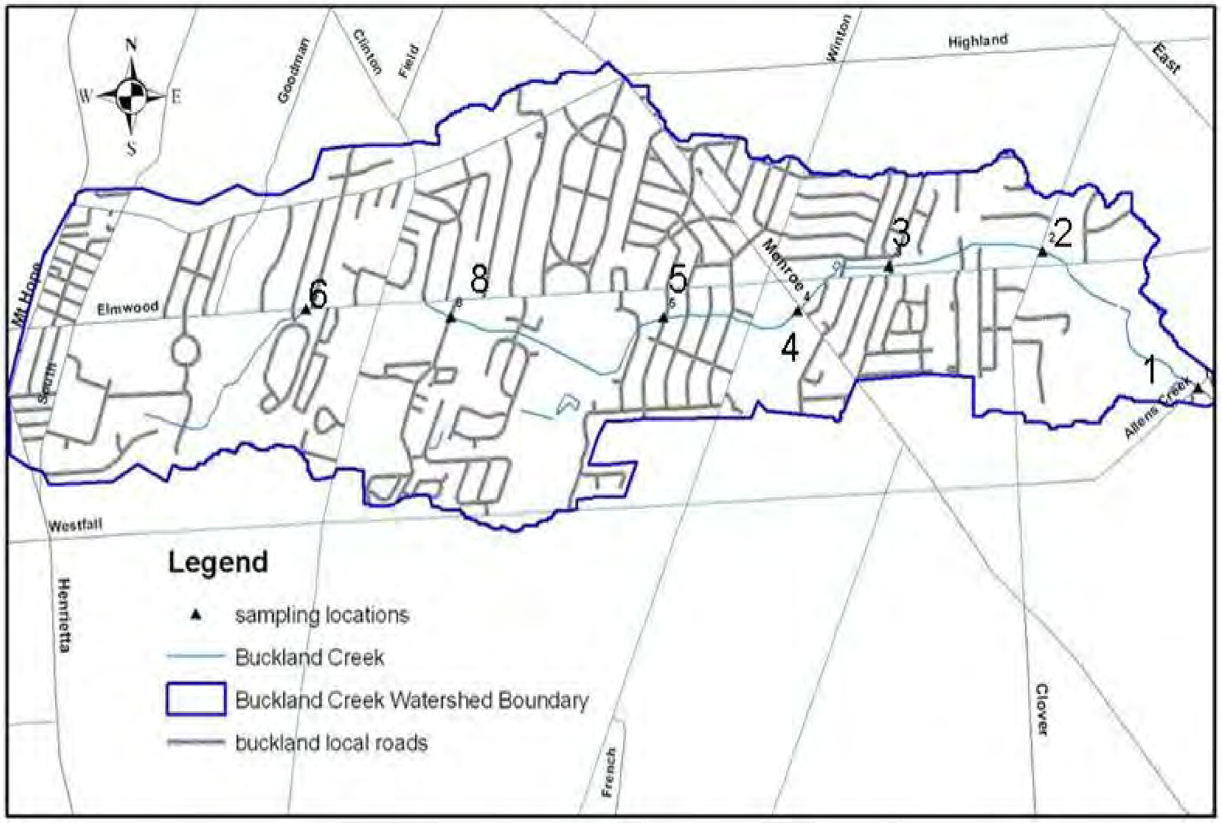

Figure 5. Buckland Creek Sampling Locations

Base and wet weather flow samples were collected by the manual grab sample method to determine the concentration of pollutants at the time the sample is taken. More detailed flow-weighted sampling to predict pollutant loads and yields over time were not completed due to budget constraints. Concentrations of pollutants in the baseflow of the stream are useful to identify areas with potential base flow contamination and, as a comparison to wet weather flow that characterizes stormwater runoff chemistry from the watershed. Sample results are shown in Table 2 and Figures 6-8.

Table 2 shows that two sample sites Clover Street and Commonwealth Road (site numbers 2 and 3 respectively) were dry during baseflow sampling. While it is common for urban streams to run dry during summer months, these dry locations are likely due to the fractured rock layer that causes the creek flow to actually "fall" below ground and reemerge downstream of Clover Street within the Golf Course (see further discussion in Geology and Soils, section 2.1.3). Also note that sample site 7 was removed from the data set after finding the stream in this uppermost part of the watershed has been diverted to another branch of Allen Creek. This allowed the Lac De Ville Boulevard Site to be added as sample site number 8.

Table 2. Stream Sampling Results All values mg/L accept Ecoli MPN/100mL

Station (upstream to down)	Baseflow (July 12 & 30th , 2010):Wet weather flow (July 23 and August 30, 2010)							
	E Coli	**TSS**	**TP**	**SRP[1]**	**TKN**	**Ammonia**	**NO_x[2]**	**CHL**
1 -Allen Creek Road	105:21,420	1.2:38.4	0.03:0.06	0.03:0.07	0.04:0.26	0.04:0.01	0.4:0.26	140:51
2 -Clover Street	Dry:13,170	Dry:144	Dry:0.06	Dry:0.04	Dry:0.25	Dry:0.11	Dry:0.32	Dry:87
3 - Commonwealth Rd.	Dry:10,190	Dry:90.7	Dry:0.08	Dry:0.05	Dry:0.34	Dry:0.05	Dry:0.35	Dry:101
4- Brighton School Campus near Monroe	345:13,760	4.5:83.0	0.05:0.08	0.03:0.04	0.30:0.37	0.05:0.02	0.29:0.36	257:116
5- Bonnie Brae	579:8,130	20.4:87.0	0.19:0.09	0.06:0.04	0.91:0.47	0.05:0.02	0.59:0.30	367:109
8- Lac De Ville Blvd.	1,553:13,540	3.0:251	0.09:0.05	0.03:0.04	0.25:0.22	0.05:0.02	1.16:0.48	340:156
6 - St John's Meadows at Elmwood Avenue	291:11,870	10.0:61.0	0.04:0.06	0.02:0.03	0.48:0.27	0.02:0.02	0.15:0.25	437:140

NYSDEC standards:

1. Soluable Reactive 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

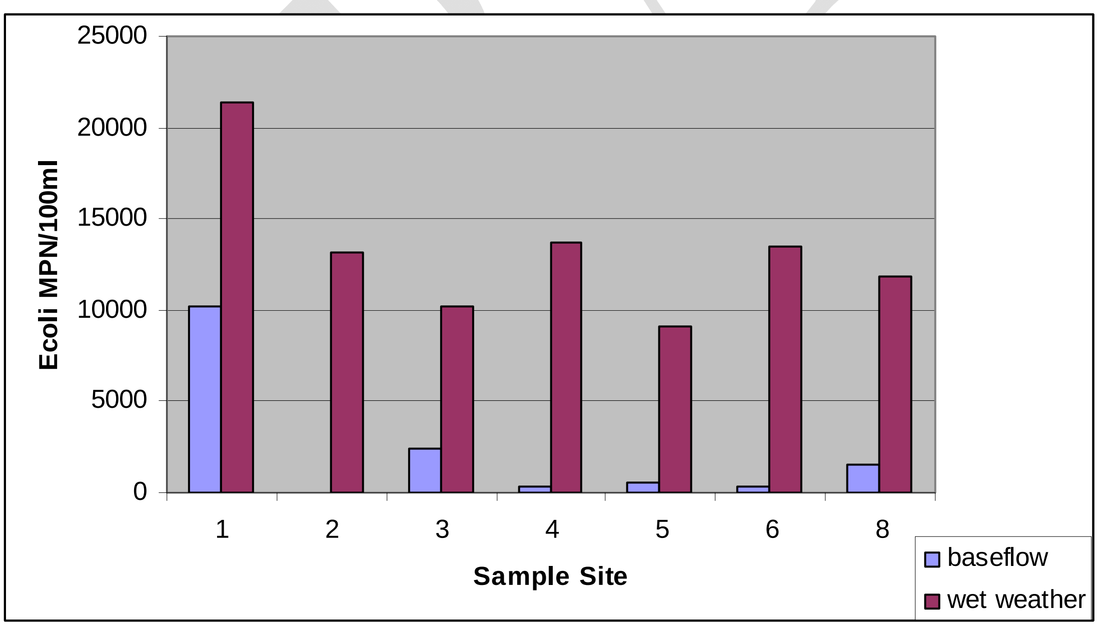

Figure 6. Comparison of Baseflow and Wet Weather Flow for Ecoli Sampling Results

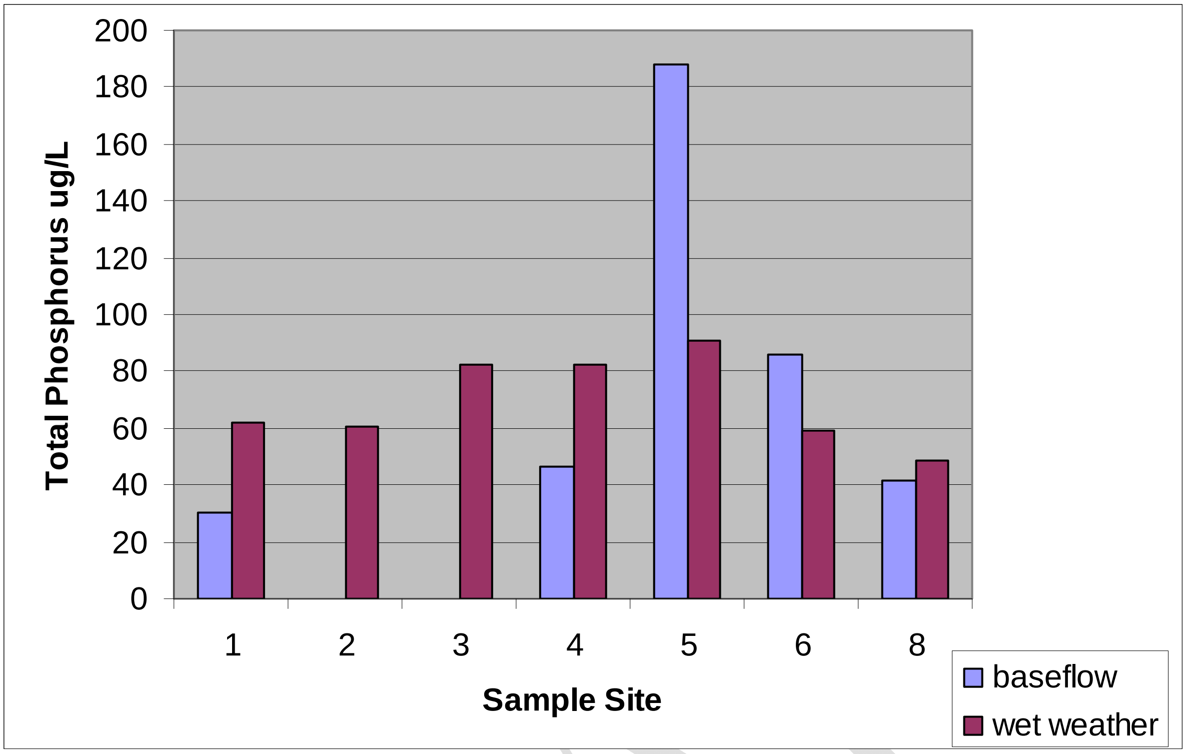

Figure 7. Comparison of Baseflow and Wet Weather Flow for Total Phosphorus

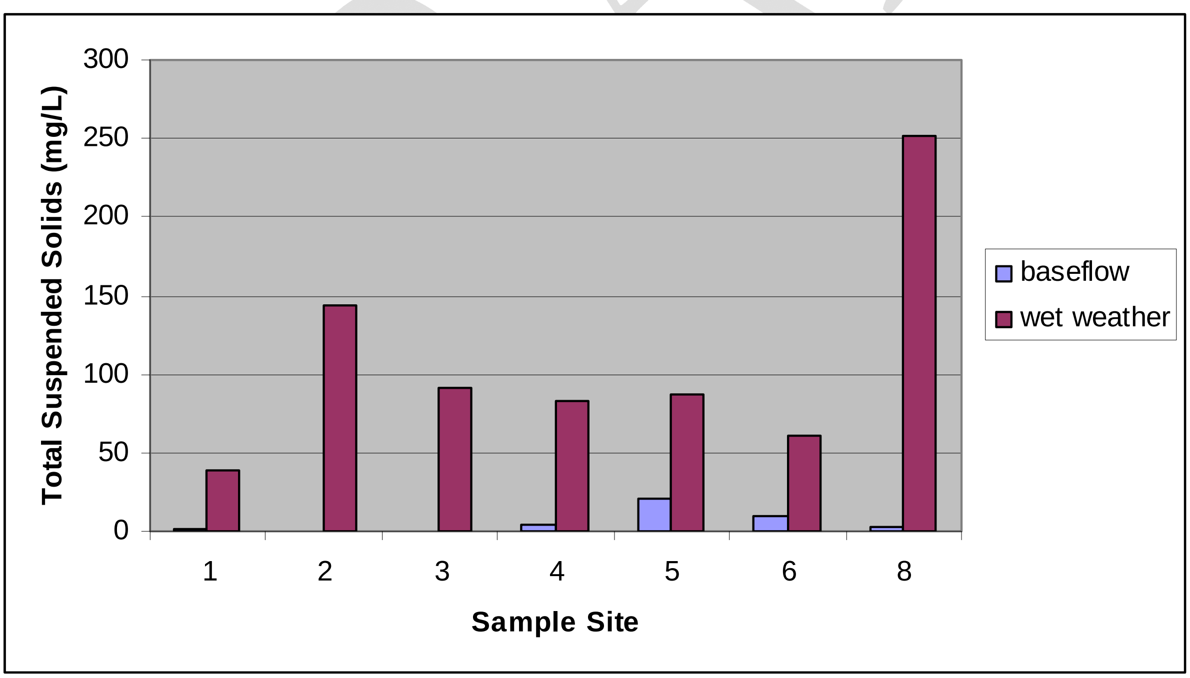

Figure 8. Comparison of Baseflow and Wet Weather Flow for Total Suspended Solids

As expected, most wet weather samples showed significant elevation in values as compared to baseflow results. Appendix A provides full results from all watershed sampling.

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 topography of the creek is nearly level in the upper two-thirds of the watershed where the creek flows through soils laid down from proglacial lakes (NYS Museum Surficial Geology GIS Datasets). These soils are termed lacustrine and are made up of fine-grained, laminated silts and clays and are generally calcareous with low permeability of variable thickness (up to 50 meters). The lower third portion of the creek flows over glacial-laid till soils where limestone rocks of various sizes begin to appear in the creek bed. These rocks are mixed with sands and silts so permeability varies by the amount of compaction and the thickness of the layer (typically 1-50 meters). It is in this lower reach that the stream in the summer and fall frequently “dries up” somewhere below Commonwealth Drive and above where it crosses under the 590 Expressway. It is speculated that stream flow travels on underlying Lockport bedrock layers until this layer daylights and stream flow “reappears” above Allen Creek Road in the Country Club of Rochester golf course.

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. However, the predominant soil class in Buckland Creek is termed “Urban Land” that denotes areas that have been so altered by land development that grouping a specific soil type is not feasible. The amount of each soil type in Buckland Creek is: A soils <1%, B soils 7%, C soils 14%, D soils 10% and Urban Land 68% (Figure 9).

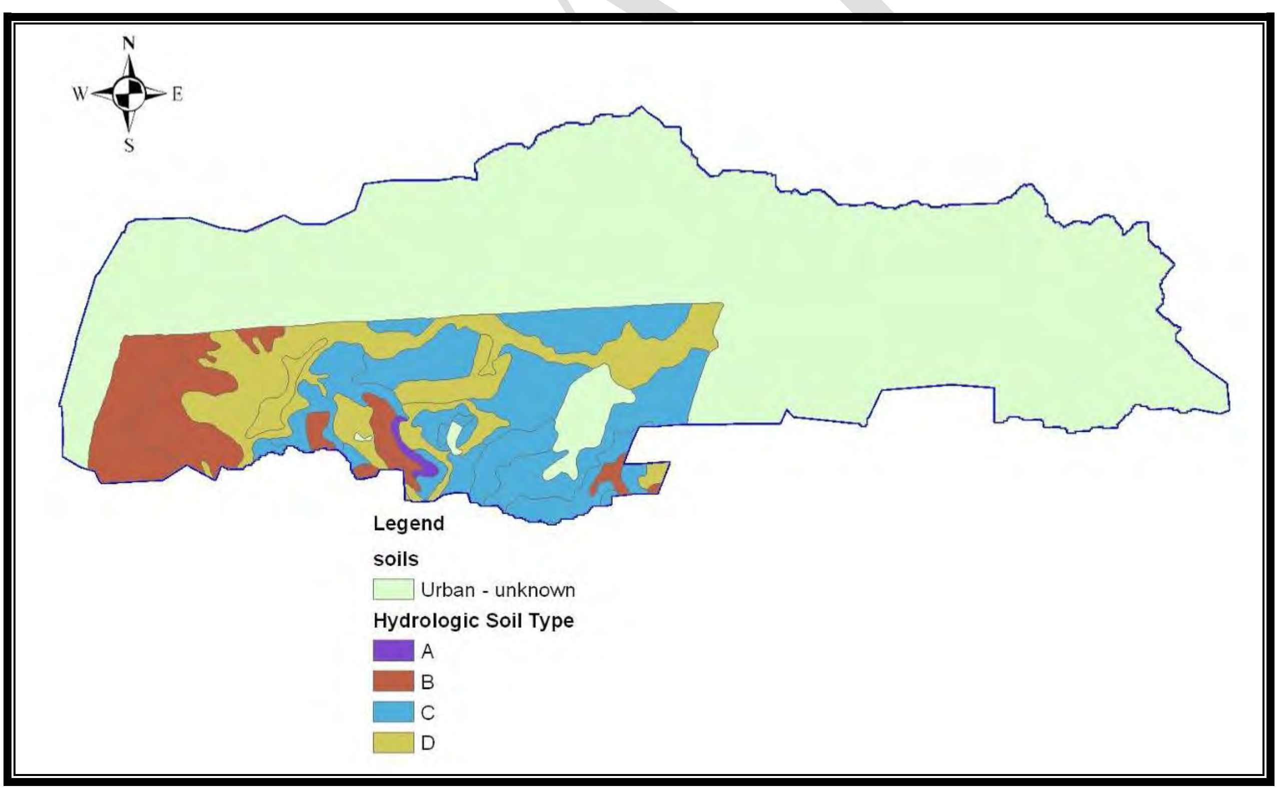

Figure 9. Buckland Creek Hydrologic Soil Types

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. Because so much of the soils in this watershed are classified as Urban Land, they are basically of unknown makeup. When calculating this watershed's restoration potential through modeling (see discussion on modeling under 2.1.6 below), a conservative estimate of the Urban Land portion was to define these soils as fairly impervous or hydrologic soil group C. Thus the model assumes a smaller pollutant removal through infiltration processes. Restoration projects in all areas will need simple soil testing to properly design the practices.

2.1.4 Drainage and Hydrology

The town of Brighton had engineers prepare a town-wide drainage study (O'Brien & Gere, 1978). The report describes Buckland Creek watershed terrain as nearly level resulting in substantial ponding and very low channel velocities. Low velocity stream flows allow silting-in of culverts and piped sections that the report states result in the need for periodic cleaning to maintain the channel's flow capacity and reduce the risk of flooding.

They were nine drainage problems sited in the watershed at that time that mostly included silt and debris causing frequent overtopping of the street cross culverts. An example was at Elmwood Avenue just above the Country Club of Rochester Golf Course. The report recommended cleaning, widening and lining the stream below Elmwood Avenue. These practices are discouraged today because they effectively move the capacity problems downstream to the neighboring community as well as destroy aquatic habitat and degrade water quality.

Recent extreme storm events have not caused any significant flooding and the stream rarely overtops its banks.

2.1.5 Biology

Staff conducted an assessment of Buckland Creek for habitat quality and biological diversity by looking at stream riparian area, 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 Dept. of Environmental Conservation 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.

At each sample location, macroinvertebrates were sampled with a kick net and each species was identified and counted. The stream bed and shoreline habitat were also assessed at each location. An indicator of stream health is a *population's pollution tolerance* which groups species present into their tolerance to polluted waters Examples of pollution intolerant species are mayflies and stoneflies. Pollutant tolerant specie examples are leeches and maggots. A second measure is the location's *water quality score* which measures species diversity and population within a species. The third measure is *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). The quality of the habitat can be a result of many factors. Results can be found in Table 3

Table 3. Buckland Creek 2009 Macroinvertebrate Sample Results[1]

Site (upstream to downstream)/subwatershed	Population's Pollution Tolerance	Water Quality Score	Habitat Quality
Allens Creek Road	Tolerant	Poor	good
Clover Street	No Macroinvertebrates[2]	NA	moderate
Commonwealth	Intermediate	Poor	moderate
Brighton School Campus near Monroe Ave	Intermediate	Fair	poor
Bonnie Brae	Intermediate	Fair	moderate
Lac De Ville	intermediate	Poor	moderate
St John's Meadows at Elmwood	Tolerant	Poor	moderate

1. Note: for the sample site at the Brighton School Campus, student monitoring over a nine year period also showed pollution tolerant macroinvertebrate results (see Appendix A).
2. The stream commonly runs dry in the Summer in this segment. See discussion in section 2.1.3, "Geology and Soils"

Further verifying the ICM, the macroinvertebrate population as a whole in Buckland Creek is typical of a stream in an urbanized watershed. Results indicate that the water quality were generally poor to very poor. The fauna and quality of habitat are degraded in all sections with mainly pollution tolerant and intermediate tolerant species present. Habitat scores indicated some variability between sample locations where impacts were channelization from either commercial or residential development, silting in of the stream bed and a lack of vegetation along the stream bank.

Channelization has, in some cases, both widened the stream and required the banks to be artificially armored. From a water quality perspective, a wide stream channel causes shallow, slow flow heating water in the summer which depletes oxygen since warm water holds less dissolved oxygen. Aquatic fauna breathe dissolved oxygen so measuring its concentration is one indication of a stream's aquatic health. 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. Figures 11 and 12 show dissolved oxygen and temperature data respectively provided by Brighton High School students sampling data. Samples were taken at the Brighton Twelve Corners School Campus (see Figure 13). This location has numerous problems. The stream reach has been channelized, armored and has no riparian corridor throughout the Campus making the stretch unsuitable habitat for benthic macroinvertebrates. In another example, the habitat was suitable for macroinvertebrates, but the population was tolerant of poor water quality, showing that the location may have been subjected to pollutants recently. This data should be supplemented with more summer months (outside of the school year when no data is available at the time of this writing).

Funding has been obtained to restore the 350 section of stream shown in Figure 13. The restoration would include the creation of a creek meander, two boulder grade control structures, and benched back stream banks, as well as the establishment of a vegetated and treed riparian zone. This project will help control creek velocity, reduce streambank erosion, improve water quality, and create aquatic habitat as well as demonstrate the value of Buckland Creek as a community resource. Teachers, students, and community residents will be involved in the planning and construction of the project so as to provide an educational component, scheduled for construction in summer 2011 (further details in Appendix G).

MEET WITH TOWN TO DISCUSS ANY EXISITING PROBLEM

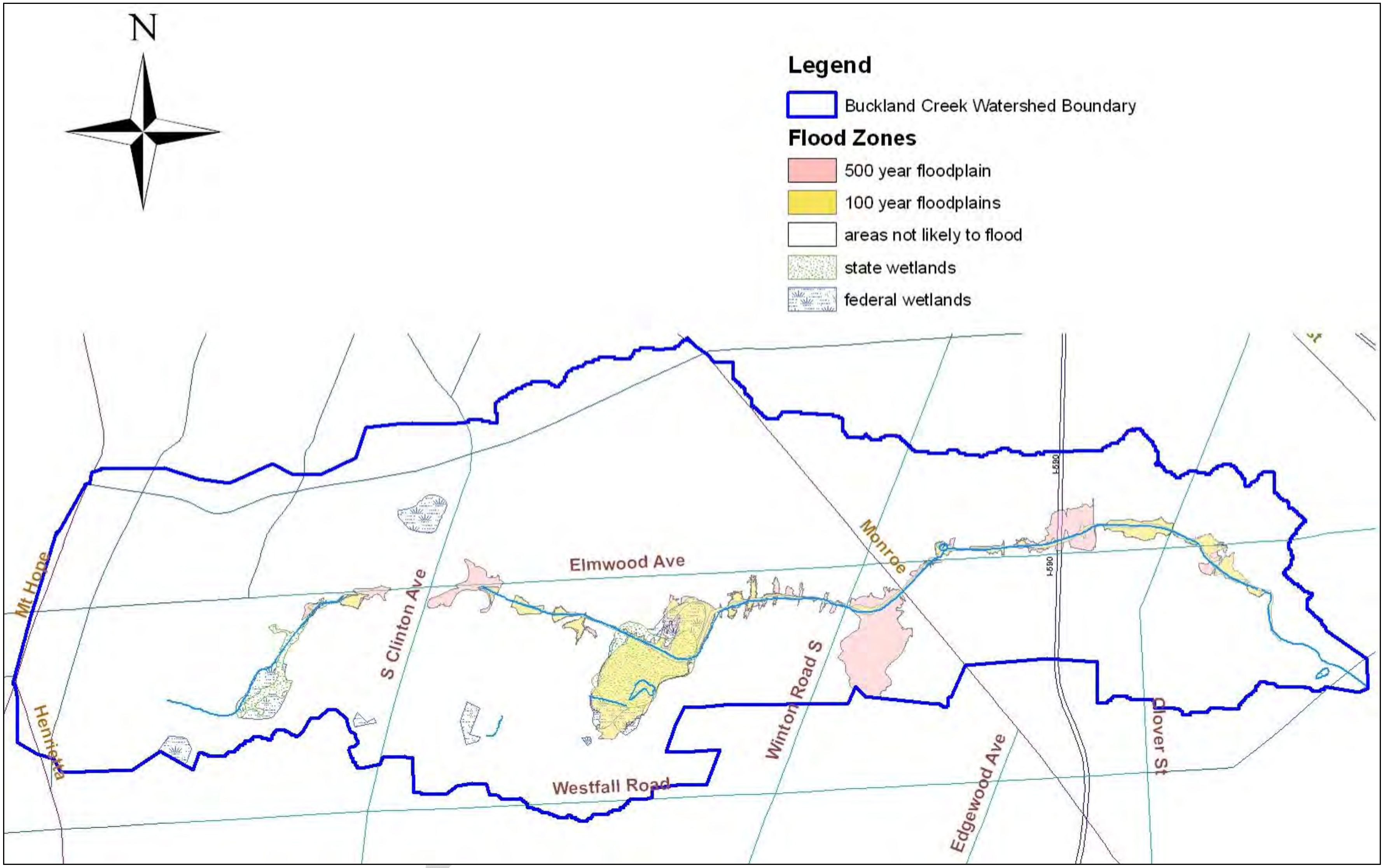

Figure 10. Buckland Creek Watershed flood plains and wetlands

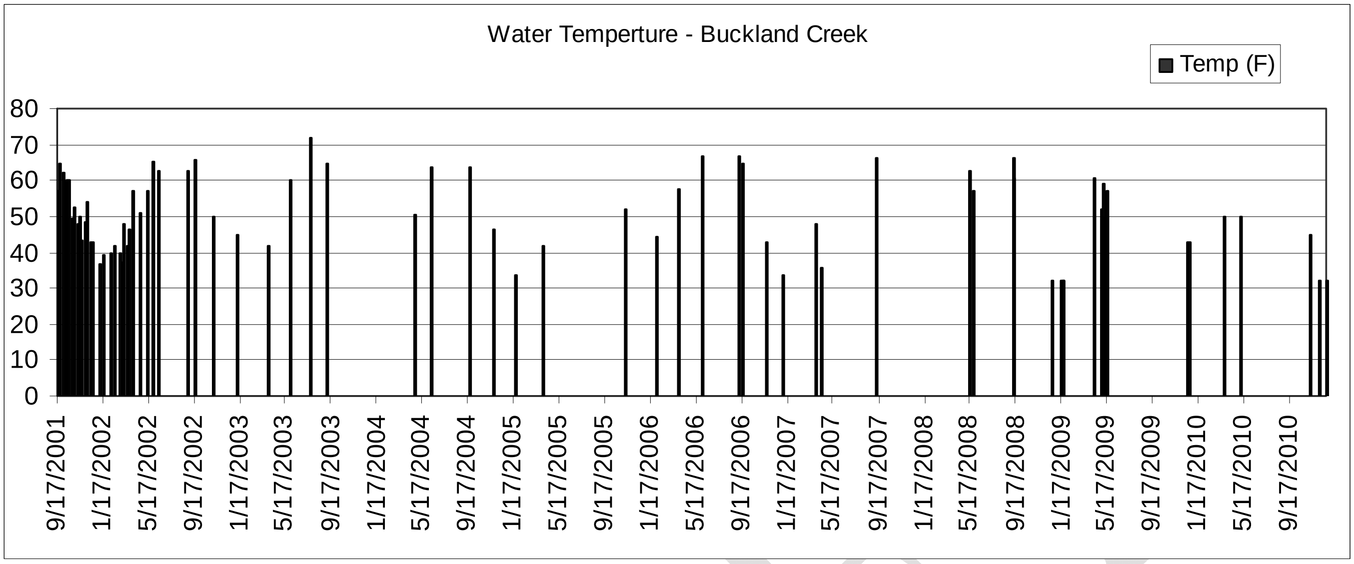

Figure 11. Stream Temperature for Non-Summer Months in Buckland Creek by Brighton HS Students

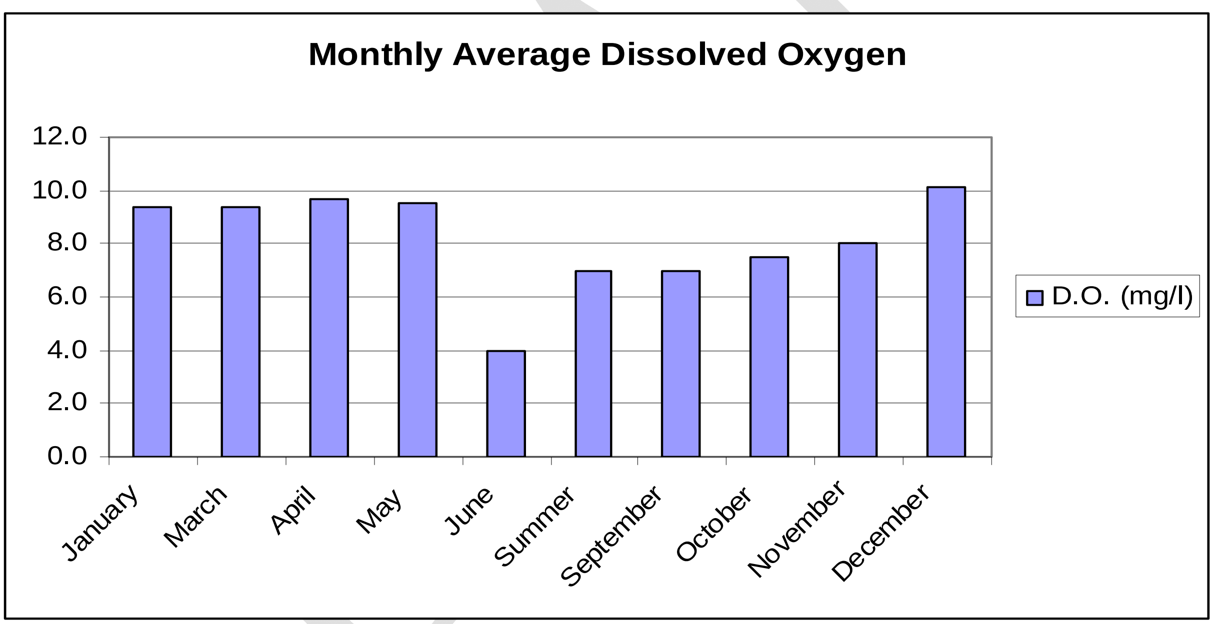

Figure 12. Dissolved Oxygen in Buckland Creek by Brighton HS Students

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 Buckland Creek 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. For a more detailed description of how WTM was applied in local Shipbuilders Creek Watershed, see Appendix D.

Figure 13. Channelization of Buckland Creek looking east from Winton Road

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 Buckland Creek 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, and industrial lands are inputs to primary pollutant sources. Vacant and park land in the watershed (19 percent) was lumped into the "Rural Land" category.

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 were 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: There are no combined sewers in the watershed.

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 Tables 4 for: Total Nitrogen (TN); Total Phosphorus (TP); total suspended solid (TSS); fecal coliform; and, runoff volume for existing and future conditions.

Similarly, roughly half of the current vacant land in the watershed was projected to be developed in 2021. Table 5 shows the pollutant load increases from existing if current stormwater management requirements were applied to the construction of those developments.

Table 4. Buckland 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)
41	21,568	4,349	779,965	1,452,625	41,182

Table 5. Buckland Watershed Treatment Model - Future Load Estimates for year 2021

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)
45	**22,140**	**4,510**	**809,604**	**1,508,973**	**44,208**

Section 3. Results of Stream Corridor and Upland Assessment

3.1 Stream Corridor Assessment

Stormwater Coalition staff conducted field assessments of Buckland Creek watershed measuring the stream's quality and the 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. Examples of the field forms used are provided in Appendix E.

The majority of the stream was assessed at, and adjacent to, public road crossings. Table 6 shows results from the stream corridor assessment. The table provides the number of identified impacts for the 6 categories assessed.

Table 6. Stream Corridor and Riparian Impacts

Impacted Buffer	3.4 miles impacted (out of 4.7 mile stream length = 72%)
Channel Erosion	20 locations have significant bank erosion and or downcutting
Length of Piped Stream	0.9 miles (out of 4.7 mile stream length = 20%)
Channel Modification	All but the upper 0.5 mile has been channelized = 89%
Road Stream Intersections	30 crossings
Trash & Debris	3 sites had significant yard wastes debris
Outfalls	89

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.

As with most urban streams, most of Buckland Creek has been impacted by land development. Therefore, scoring potential reforestation was based on whether space was available (one point for a minimum of 25 feet per side) and landowner type (three points for public, two for commercial and, one for private). A high restoration score is five points. As mentioned in section 2, Figure 13 shows an impacted buffer looking east from Winton Road into the Brighton Twelve Corners Schools Campus. Restoration of this section of stream is scheduled to be completed in August 2011 with a grant from the NYS Environmental Protection Fund.

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 low-gradient of the stream has reduced these typical effects however, erosion problems are present and mainly consist of stream widening (as opposed to headcutting- prevalent on streams with steeper slopes). 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 14 shows an example of active stream bank erosion in Brighton where a town crew is installing about 30 feet of gabion baskets to prevent damage to a nearby home foundation.

Figure 14. Stream Bank Erosion site being stabilized with rock-filled gabion baskets

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 Buckland Creek is the segment that is piped under Elmwood Avenue after it flows through St Johns Meadows and runs eastward crossing under Clinton Avenue. Figure 15 is an example of a stream reach on Buckland Creek 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 14 are candidates for restoration.

Figure 15: 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 30 culverted stream intersections in the watershed, 15 were evaluated. Of those, two were candidates for upstream storage, and four for stream repair.

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.

Data on outfalls was obtained in 2008 when 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 spots all from yard waste where the stream flows through residential neighborhoods. The fact that highly-urbanized Buckland Creek does not suffers from excessive trash likely speaks to an educated citizenry and active municipality. A proposed action of this SWAAP is to increase the residents' awareness that yard waste is indeed a pollutant that adds pollutants to the stream, namely nutrients and decreases dissolved oxygen through the biological break down of organic substances by microorganisms. Figure 16 shows yard waste and topsoil dumped in creek bed in a residential area of Brighton.

Figure 16. Trash and Debris – sod and topsoil wasted along the stream's bank and bed in Brighton.

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, 24 potential hotspots were identified in the Buckland Creek watershed. Made up of gas stations, fast food restaurants and auto repair garages.

Each type of commercial hotspot can generate its own blend of pollutants which can include nutrients, hydrocarbons, metals trash or pesticides. (CWP, 2005). Figure 17 is an example of a small public works facility in Rochester where an uncovered fueling station and vehicle repair shop can generate hydrocarbon pollutants that travel to nearby Buckland Creek.

Figure 17. An example of a potential watershed Hotspot in Buckland Creek – an uncovered fueling station

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. All sites were given a status of confirmed hotspot. Two 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 aerial photos. 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 land use impacts to Buckland Creek is the Elmwood Heights neighborhood in Brighton built in 1950s. The neighborhood has well manicured lawns, indicative of large inputs of lawn care chemicals (see Figure 18).

Figure 18. A residential neighborhood identified for its highly manicured lawns

Treating the runoff from these neighborhoods presents a challenge. In addition to lawn chemicals, many neighborhoods in the Buckland Creek watershed were built before the onset of modern stormwater management practices such as water quantity and quality control ponds. Stormwater managers will need to 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 of the stream corridor. During the upland survey staff looked specifically at existing vegetative cover, potential impacts, and site constraints at various 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. Using aerial photos and land use mapping information, no sites with significant turf cover were identified for reforestation.

3.2.4 Future Build Out

While all but 13 percent of the watershed is built out, several large, privately-owned parcels are expected to be developed in the next ten years. From its headwaters that start just east of the Mount Hope Cemetery, Buckland Creek daylights in a largely wooded 16 acre parcel that is currently under construction, being developed into a senior living community. The portion of the parcel that contained wetlands was recently subdivided and deeded to the Town of Brighton for permanent protection of Buckland Creek (see Figure 19).

Downstream, Buckland Creek also flows through the largest remaining undeveloped parcel that is mostly wooded. The 82 acres parcel is located across from the Brighton Town Hall and is currently being offered for sale for residential development. Approximately 50 acres of this parcel is jurisdictional wetlands that will limit the buildable property acreage.

Woodlands are the most beneficial land use for stream health, especially those adjacent to streams. Woodlands act like a sponge, soaking up typically all but five percent of all the annual stormwater they receive. As stormwater becomes groundwater, soils slowly ration water, over time, to the stream - helping to minimize dry stream beds thereby promoting perennial aquatic habitat. To protect Buckland Creek, future development will need to incorporate infiltrating stormwater management practices and protect the remaining wooded stream corridors.

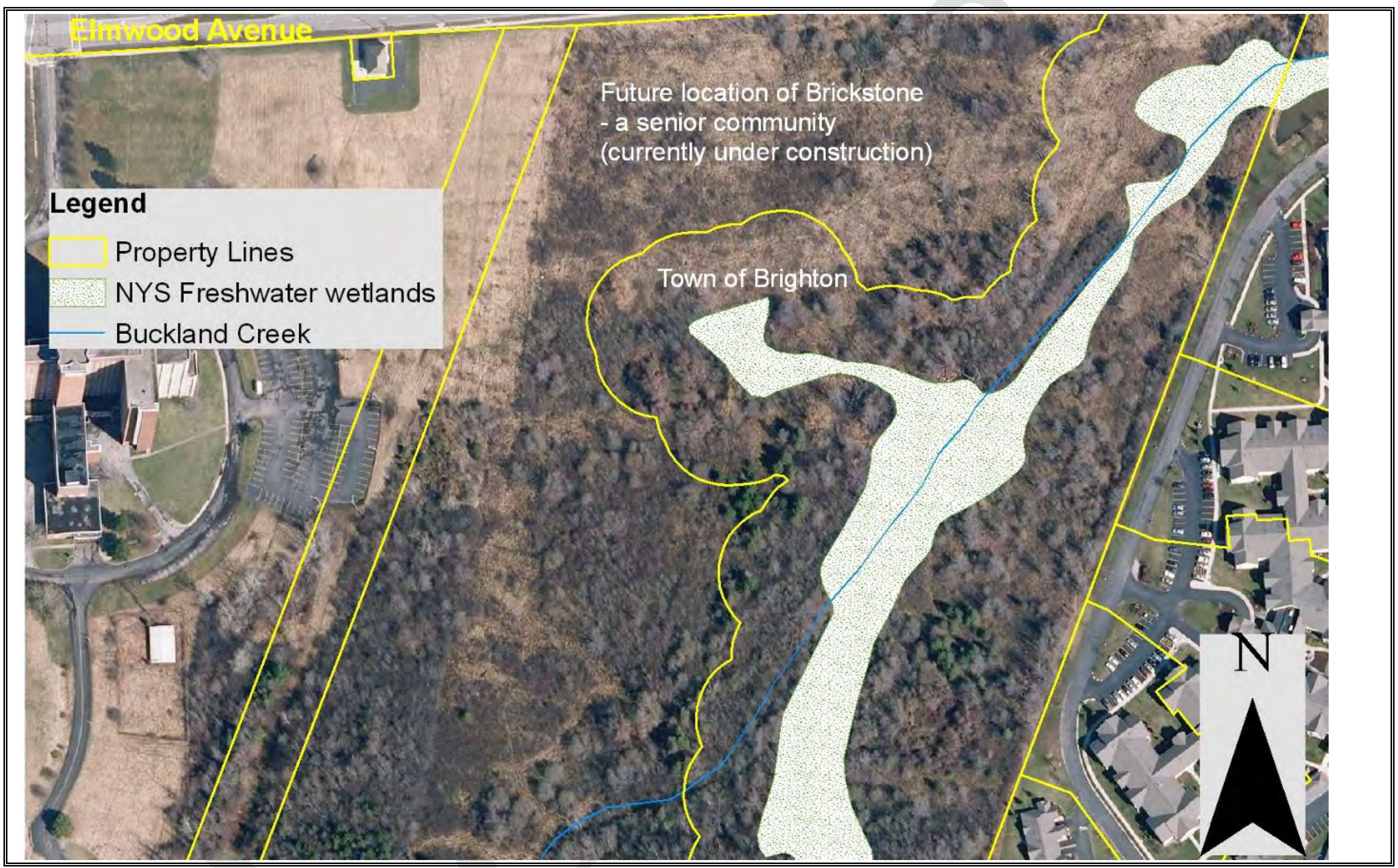

Figure 19. Parcel currently under construction located in the headwaters of Buckland Creek

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. Treating and managing stormwater helps to restore streams by removing pollutants and promoting more natural hydrology (by increasing the amount of stormwater that is infiltrated in to the ground). Increasing infiltration in a watershed both improves a stream's aquatic habitat and reduces the occurrence of "bank full" flow (frequent bank full flow is a primary cause of streambank 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 aerial photos, 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 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 Buckland Creek watershed.

The target volume and flow rate controls for retrofits are:

- *Recharge* (R)*:* capture and either infiltrate or filter stormwater runoff from small rainfall events – typically those under one-half inch of rain. Recharging this stormwater volume into the ground helps restore baseflows to streams, reducing pollution loads and helping to restore aquatic habitat.

- *Water Quality* (WQv): targets rainfall events that deliver the majority of the stormwater pollutants during the course of a year. The WQv 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 and is managed by increasing the detention time that stormwater is stored in a practice – ideally for 24 hours. 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 Retrofits

Stream retrofit 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. When space allows, 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 a street or building such as in dense urban areas, "hard" solutions such as riprap and rock walls may be used to protect and reinforce stream banks (see Figure 14).

Other communities around the country have done similar retrofit assessments such as Frederick Maryland (Tetra Tech Inc, 2009), providing a framework for this SWAAP. More detailed descriptions and examples of the seven types of retrofit project types being considered are described with examples below (please note that the names of these project types are used as descriptors in Table 7):

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 18 shows the location of a future pond that has been proposed to be built adjacent to the main stem of Buckland Creek 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. (see Figure E.2).

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 13 mapped ponds that were built to provide flood control with only a fraction of those ponds providing more advanced water quality design features. To retrofit these ponds, outlet control structures should be modified and the basin reshaped and landscaped to enhance pollutant removal, throttle small storm events, improve aesthetics and aquatic habitat and, to reduce facility maintenance requirements. An example of a proposed conversion of a conventional flood control pond is shown in Figure 20.

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

- Capture large particulates in a sump at pond entrance with easy access for dredging,
- 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 using multiple pollutant removal pathways,
- Promote soil saturation/groundwater recharge.

Figure 20.   Potential Retrofit of a Conventional Flood Control Pond on Elmwood Avenue in Brighton

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 (i.e. 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.

A basic bioretention detail is shown in Figure 21 and potential retrofit projects in the watershed are shown in Figures 22.

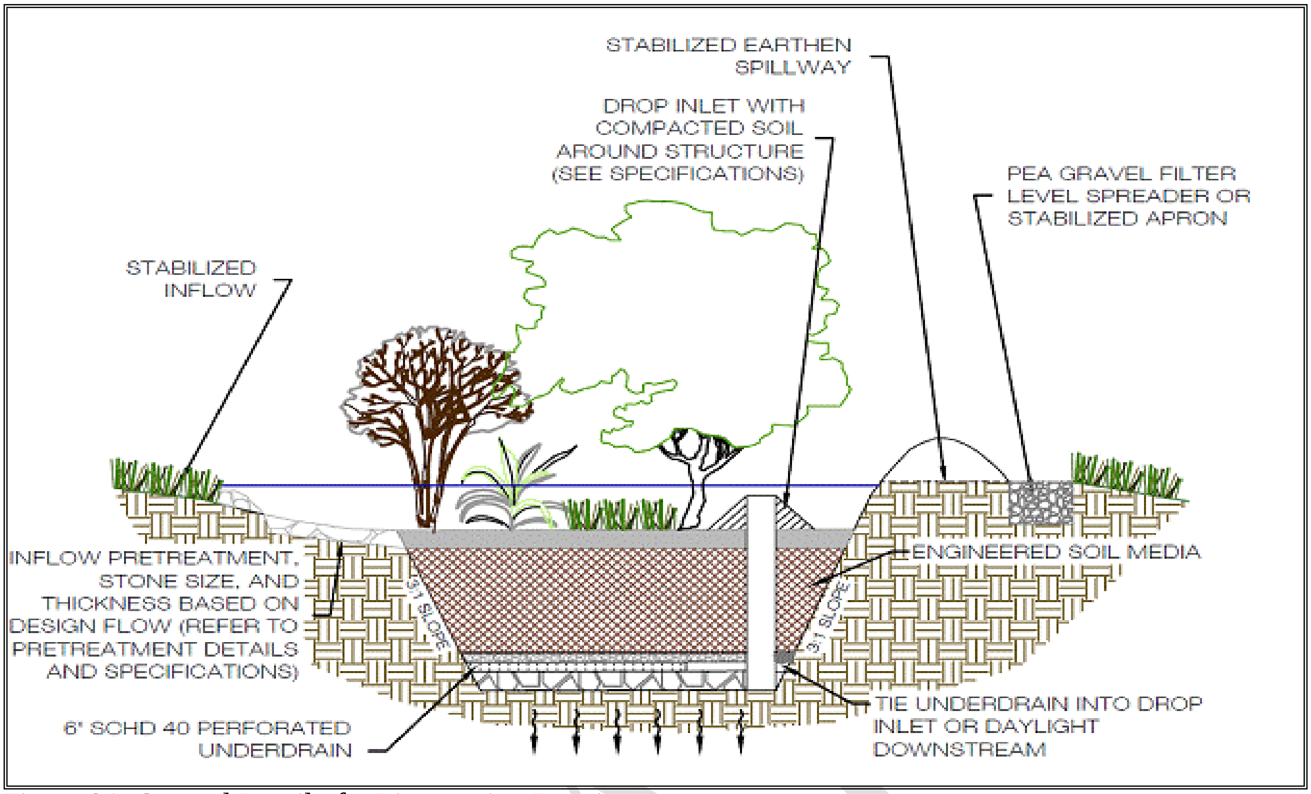

Figure 21. General Detail of a Bioretention Practice

Figure 22: Proposed Cul-de-sac Bioretention in Brighton

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.

5. Stream Buffer Enhancements

The stream project to be completed in August 2011 in the Brighton Twelve Corners School Campus is an excellent example of this type of project (see discussion in section 2.1.5). 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.

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 Buckland 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 Buckland Creek restoration objectives. Criteria were 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 Buckland7 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 criterion. 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 23 illustrates the cost effectiveness of several stormwater practices and provides the basis for this criteria ranking.

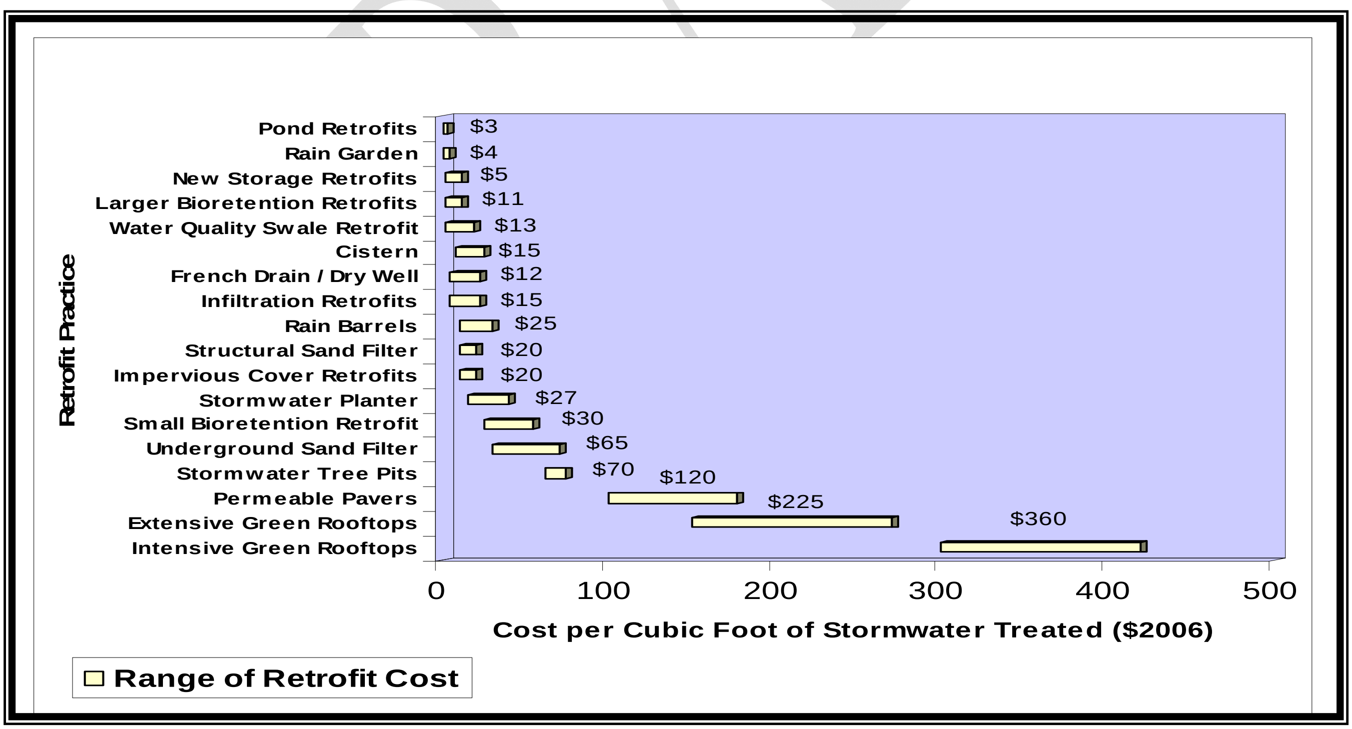

Figure 23. Range of Base Construction Costs for Various Watershed Retrofits (CWP, 2007).

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.

4.2.2 Priority Retrofit Projects

Project List

The projects listed in Table 7 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 H. 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 7, according to the seven categories described in section 4.2.1 above.

Table 7. Potential Retrofit Projects

Project Name/ Project Location	Project Type (s)[1]/ Description	Area Treated (acres)	Stream Length Restored (ft)	Reason for Prioritization	Planning-Level Cost Estimate
Brighton Parcel (next to Brickstone)	1/New Stormwater Pond	30	NA	-Treats large upstream developed area w/o treatment -Public property	$125.000
Finger Lakes Developmental Disabilities Services Office (DDSO) 620 Westfall Road	1/New Stormwater Pond	20	NA	-Treats large area upstream developed area w/o treatment -Public property	$110,000
Brighton DPW Facility/Brightonian Nursing Home	1/New Stormwater Pond	9	Proposed below	-Downstream erosion -Available space adjacent to stream	$55,000
Rochester Science Park Empty Parcel	1/New Stormwater Pond	15	NA	-Treats upstream developed area w/o treatment -Localized drainage issues	$70,000
Highland Park open space along S. Goodman	1/New Stormwater Pond	30	NA	-Treats upstream developed area w/o treatment -Localized drainage issues	$125,000
2100 S Clinton Ave, Rochester, NY 14618	2/Upgrade of Conventional Flood Control Pond	4	NA	-Downstream erosion -Available space property	$60,000

Table 7. 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**
398 Science Pkwy, Rochester, NY 14620	2/Upgrade of Conventional Flood Control Pond	37	NA	-Upstream developed area w/o treatment -Public property	$60,000
23 Songbird Ln, Rochester, NY 14620	2/Upgrade of Conventional Flood Control Pond	6	NA	Capture channel protection volume	$10,000
Johnsarbor Dr. East, Rochester, NY 14620	2/Upgrade of Conventional Flood Control Pond	21	NA	-Treats large area -Downstream erosion -Upstream developed area w/o treatment	$30,000
2053 S Clinton Ave, Rochester, NY 14618	2/Upgrade of Conventional Flood Control Pond	10	NA	Capture channel protection volume	$10,000
1752 S Clinton Ave, Rochester, NY 14618	2/Upgrade of Conventional Flood Control Pond	14	NA	-Capture Chanel Protection Volume -Education potential	$10,000
94 Lilac Dr, Rochester, NY 14620	2/Upgrade of Conventional Flood Control Pond	15	NA	-Treats upstream developed area w/o treatment	$60,000
89 Lilac Dr, Rochester, NY 14620	2/Upgrade of Conventional Flood Control Pond	15	NA	-Treats upstream developed area w/o treatment	$60,000
249 Highland Avenue Rochester ny 14620	2/Upgrade of Conventional Flood Control Pond	2	NA	-Education potential	$10,000
2190 Lac De Ville Blvd, Rochester, NY 14618	2/Upgrade of Conventional Flood Control Pond	80	NA	-Treats large area -Public property -Downstream erosion	$100,000
112 Barclay Square Dr, Rochester, NY 14618	2/Upgrade of Conventional Flood Control Pond	30	NA	-Downstream erosion -Upstream developed area w/o treatment	$30,000
47 Chelmsford Ln, Rochester, NY 14618	2/Upgrade of Conventional Flood Control Pond	10	NA	-Downstream erosion -Upstream developed area w/o treatment	$60,000
Johnsarbor Dr. West, Rochester, NY 14620	2/Upgrade of Conventional Flood Control Pond	7	NA	Capture channel protection volume	$10,000

Table 7. 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**
Markay Circle	3/Green Infrastructure Retrofit	3	NA	-Upstream developed area w/o treatment -Public Land -Education opportunity	$20,000
Brittany Circle	3/Green Infrastructure Retrofit	3	NA	-Upstream developed area w/o treatment -Public Land -Education opportunity	$20,000
Brandywine Circle	3/Green Infrastructure Retrofit	3	NA	-Upstream developed area w/o treatment -Public Land -Education opportunity	$20,000
Gailhaven Circle	3/Green Infrastructure Retrofit	10	NA	-Adjacent to stream -Available space -Public Land -Hot spot reduces runoff volume	$15,000
Rowland Parkway	3/Green Infrastructure Retrofit	3	NA	-Adjacent to stream -Available space -Public Land -Education opportunity	$15,000
Sutton Place	3/Green Infrastructure Retrofit	6	NA	-Adjacent to stream -Available space -Public Land -Hot spot reduces runoff volume	$15,000
Beekman Place	3/Green Infrastructure Retrofit	.5	NA	-Downstream erosion -Upstream developed area -w/o treatment -Public property	$15,000
Glen Ellyn Way	3/Green Infrastructure Retrofit	.5	NA	-Downstream erosion -Upstream developed area -w/o treatment -Public property	$15,000
Monroe Aveue	3/Green Infrastructure Retrofit	.5	NA	-Downstream erosion -Upstream developed area -w/o treatment -Public property	$15,000
St Regis	3/Green Infrastructure Retrofit	2	NA	-Downstream erosion -Upstream developed area w/o treatment -Public property	$15,000
Antlers Drive	3/Green Infrastructure Retrofit	2	NA	-Adjacent to stream -Available space -Public Land -Hot spot reduces runoff volume	$15,000
Union Free School	3/Green Infrastructure Retrofit	2	NA	-Adjacent to stream -Available space -Public Land -Hot spot reduces runoff volume	$15,000

Table 7. 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
Brighton Town Hall	3/Green Infrastructure Retrofit	2	NA	-Adjacent to stream -Available space -Public Land -Hot spot reduces runoff volume	$15,000
Country Club of Rochester	4,5/Stream Retrofits, Stream Buffer Enhancement	NA	NA	-Upstream developed area w/o treatment -Public property	$5,000
Brighton Twelve Corners School campus west	4,5/Stream Retrofits, Stream Buffer Enhancement	NA	NA	-Reduces runoff volume & pollutants	$22,000
Brighton Twelve Corners School campus east	4,5/Stream Retrofits, Stream Buffer Enhancement	NA	350	-Public property -w/ available space -Education opportunity -Impacted Stream Buffer	$15,000
Elmwood Court Apartarments	4,5/Stream Retrofits, Stream Buffer Enhancement	NA	100	-Public property -w/ available space -Education opportunity -Impacted Stream Buffer	$8,000
Meadowbrook	4,5/Stream Retrofits, Stream Buffer Enhancement	NA	50	-property w/ available space -Education opportunity -Some erosion	$5,000
Meadowview	4,5/Stream Retrofits, Stream Buffer Enhancement	NA	50	-property w/ available space -Education opportunity -Some erosion	$5,000
St John Meadows	4,5/Stream Retrofits, Stream Buffer Enhancement	NA	50	-w/ available space -Education opportunity -Impacted Stream Buffer	$5,000
Town Of Brighton DPW	4,5/Stream Retrofits, Stream Buffer Enhancement	NA	100	-w/ available space -Education opportunity -Impacted Stream Buffer	$8,000
Multiple Businesses on Mt Hope Ave	6/Hotspot and Discharge Prevention	300	NA	-Hotspot discharge removal	$160,000
Multiple Businesses on Monroe Ave	6/Hotspot and Discharge Prevention	10	NA	-Good cost-benefit ratio	$280,000
Multiple Businesses on Elmwood Ave	6/Hotspot and Discharge Prevention	10	NA	-Source Control	$220,000
Multiple Residential Areas in Brighton	7/Residential Management Practices	6	NA	-Source Control	$520,000
Multiple Residential Areas in Rochester	7/Residential Management Practices	25	NA	-Source control	$150,000
TOTAL ALL PROJECTS					$1,323,000

1. Project types are numerically listed in the second column of Table 7, according to the seven categories described in section 4.2.1 above.

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 Buckland 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 7 were added to the model and the predicted pollutant loads and corresponding reductions are shown in Table 8.

Table 8. Pollutant Loads from Various Sources w/Retrofit Practices

	Total Nitrogen	Total Phosphorus	Total Suspended Solids	Fecal Coliform	Runoff Volume
Pollutant Source	**lb/year**	**lb/year**	**lb/year**	**billion/year**	**(acre-feet/year)**
Urban Land	16,219	2,985.78	444,649	760,134	41,092
Active Construction	38	8	26,025	-	25
Sanitary Sewer Overflows	340	57	2,266	257,191	-
Channel Erosion	803	763	200,723	-	-
Road Sanding	-	-	448	-	-
Undeveloped Land	2,190	333	47,600	18,564	36
Illicit Connections	298	86	2,223	169,605	-
Septic Systems	113	19	751	4,536	-
Open Water	128	5	1,550	-	-
Total Load w/Practices	**20,031**	**4,256**	**719,160**	**1,199,676**	**41,153**
Existing Load (from Table 4)	21,568	4,349	779,933	1,452,595	41,182
Percent Reduction with Restoration	**7%**	**2%**	**8%**	**17%**	**1%**

At the time this writing, NYS had not yet prepared a Total Maximum Daily Load Analysis for Allen Creek (where Buckland Creek discharges to) so it is not known whether the reductions shown here would be adequate for a future TMDL. As previously noted, Allen Creek "known" pollutant sources are nutrients, suspected pollutant sources are salts, sediment and pathogens from urban runoff. Measures to address each of these are discussed separately below:

To lower nutrient loads through a retrofit program, education of residents would include the water quality benefits of reducing the amount of phosphorus used on lawns. 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 Buckland 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 70 percent of watershed residents will hear the lawn care message. Of that 70%, model inputs were that 10 percent would switch to organic fertilizer, and 50 percent would reduce their use, either where 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 Buckland Creek (see Ecoli sampling results shown in Figure 6). 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 Buckland Creek 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 xy 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 Buckland 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 Buckland Creek 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 Buckland Creek Draft Watershed Goal

The watershed assessment and planning effort began with the goal to: *improve water quality in Buckland Creek 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 were developed for the Buckland Creek subwatersheds with input from local stakeholders, observations made during the stream and subwatershed assessments and best professional judgment from the project staff. These recommendations are 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.

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.

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 Buckland Creek. Of the small-scale priority restoration projects identified in Buckland Creek, 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.

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 Buckland Creek 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 Buckland Creek.

3M. Conduct an annual State of the State of Buckland 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 Buckland Creek 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 Webster and Penfield 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 Buckland Creek. Of the proposed large-scale priority restoration projects identified in Buckland Creek, 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 the streams in Buckland Creek, and the success of restoration efforts. As restoration projects are implemented in Buckland Creek, 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 Buckland Creek each year. Specific tasks include identifying potential funding mechanisms, submitting proposals for funding and/or soliciting potential funders.

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. The manual emphasizes 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 on-site stormwater management and increased groundwater infiltration as a means to minimize stormwater discharge and limit the amount of surface pollutants entering New York streams. It is recommended that Webster and Penfield 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 Buckland 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 Buckland Creek 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 Buckland 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 Buckland Creek 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 Buckland Creek 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 9.

Table 9. 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	Although flow meters were used with the auto samplers, the flow data proved not to be as useful as was hoped. 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

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	Although flow meters were used with the auto samplers, the flow data proved not to be as useful as was hoped. 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
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APPENDICES

Appendix A: Monroe County Buckland Creek Sampling Data

Sample date	Day	Sample name	Analyte	Value	Units	Sample Type
08/12/10	THU	Buckland 1	EC COL QUANT	105	MPN/100mL	dry weather
08/12/10	THU	Buckland 3	EC COL QUANT	>2420	MPN/100mL	dry weather
08/12/10	THU	Buckland 4	EC COL QUANT	345	MPN/100mL	dry weather
08/12/10	THU	Buckland 5	EC COL QUANT	579	MPN/100mL	dry weather
08/12/10	THU	Buckland 6	EC COL QUANT	291	MPN/100mL	dry weather
08/12/10	THU	Buckland 7	EC COL QUANT	>2420	MPN/100mL	dry weather
08/12/10	THU	Buckland 8	EC COL QUANT	1553	MPN/100mL	wet weather
08/23/10	MON	Buckland 1	CHL	51.1347	mg/L	wet weather
08/23/10	MON	Buckland 1	EC COL QUANT	10170	MPN/100mL	wet weather
08/23/10	MON	Buckland 1	NH3L	<0.01	mg/L	wet weather
08/23/10	MON	Buckland 1	NOX L	0.25677	mg/L	wet weather
08/23/10	MON	Buckland 1	OP L	0.06772	mg/L	wet weather
08/23/10	MON	Buckland 1	TKN		mg/L	wet weather
08/23/10	MON	Buckland 1	TP	0.062	mg/L	wet weather
08/23/10	MON	Buckland 1	TSS	3	mg/L	wet weather
08/23/10	MON	Buckland 2	CHL	87.2608	mg/L	wet weather
08/23/10	MON	Buckland 2	EC COL QUANT	9060	MPN/100mL	wet weather
08/23/10	MON	Buckland 2	NH3L	0.01087	mg/L	wet weather
08/23/10	MON	Buckland 2	NOX L	0.31777	mg/L	wet weather
08/23/10	MON	Buckland 2	OP L	0.04249	mg/L	wet weather
08/23/10	MON	Buckland 2	TKN		mg/L	wet weather
08/23/10	MON	Buckland 2	TP	0.0604	mg/L	wet weather
08/23/10	MON	Buckland 2	TSS	4.6	mg/L	wet weather
08/23/10	MON	Buckland 3	CHL	100.9177	mg/L	wet weather
08/23/10	MON	Buckland 3	EC COL QUANT	6770	MPN/100mL	wet weather
08/23/10	MON	Buckland 3	NH3L	0.04568	mg/L	wet weather
08/23/10	MON	Buckland 3	NOX L	0.35443	mg/L	wet weather
08/23/10	MON	Buckland 3	OP L	0.05357	mg/L	wet weather
08/23/10	MON	Buckland 3	TKN		mg/L	wet weather
08/23/10	MON	Buckland 3	TP	0.0822	mg/L	wet weather
08/23/10	MON	Buckland 3	TSS	7.2	mg/L	wet weather
08/23/10	MON	Buckland 4	CHL	116.0134	mg/L	wet weather

Sample date	Day	Sample name	Analyte	Value	Units	Sample Type
08/23/10	MON	Buckland 4	EC COL QUANT	6050	MPN/100mL	wet weather
08/23/10	MON	Buckland 4	NH3L	0.02319	mg/L	wet weather
08/23/10	MON	Buckland 4	NOX L	0.35656	mg/L	wet weather
08/23/10	MON	Buckland 4	OP L	0.03628	mg/L	wet weather
08/23/10	MON	Buckland 4	TKN		mg/L	wet weather
08/23/10	MON	Buckland 4	TP	0.0825	mg/L	wet weather
08/23/10	MON	Buckland 4	TSS	7.6	mg/L	wet weather
08/23/10	MON	Buckland 5	CHL	108.9559	mg/L	wet weather
08/23/10	MON	Buckland 5	EC COL QUANT	9080	MPN/100mL	wet weather
08/23/10	MON	Buckland 5	NH3L	0.02117	mg/L	wet weather
08/23/10	MON	Buckland 5	NOX L	0.30216	mg/L	wet weather
08/23/10	MON	Buckland 5	OP L	0.03882	mg/L	wet weather
08/23/10	MON	Buckland 5	TKN		mg/L	wet weather
08/23/10	MON	Buckland 5	TP	0.091	mg/L	wet weather
08/23/10	MON	Buckland 5	TSS	8	mg/L	wet weather
08/23/10	MON	Buckland 6	CHL	140.034	mg/L	wet weather
08/23/10	MON	Buckland 6	EC COL QUANT	3790	MPN/100mL	wet weather
08/23/10	MON	Buckland 6	NH3L	0.024	mg/L	wet weather
08/23/10	MON	Buckland 6	NOX L	0.25174	mg/L	wet weather
08/23/10	MON	Buckland 6	OP L	0.02745	mg/L	wet weather
08/23/10	MON	Buckland 6	TKN		mg/L	wet weather
08/23/10	MON	Buckland 6	TP	0.059	mg/L	wet weather
08/23/10	MON	Buckland 6	TSS	3.4	mg/L	wet weather
08/23/10	MON	Buckland 7	CHL	63.6922	mg/L	wet weather
08/23/10	MON	Buckland 7	EC COL QUANT	6500	MPN/100mL	wet weather
08/23/10	MON	Buckland 7	NH3L	0.62444	mg/L	wet weather
08/23/10	MON	Buckland 7	NOX L	0.54453	mg/L	wet weather
08/23/10	MON	Buckland 7	OP L	0.0702	mg/L	wet weather
08/23/10	MON	Buckland 7	TKN		mg/L	wet weather
08/23/10	MON	Buckland 7	TP	0.0598	mg/L	wet weather
08/23/10	MON	Buckland 7	TSS	3	mg/L	wet weather
08/23/10	MON	Buckland 8	CHL	156.4583	mg/L	wet weather
08/23/10	MON	Buckland 8	EC COL QUANT	3990	MPN/100mL	wet weather
08/23/10	MON	Buckland 8	NH3L	0.01742	mg/L	wet weather
08/23/10	MON	Buckland 8	NOX L	0.48134	mg/L	wet weather
08/23/10	MON	Buckland 8	OP L	0.03561	mg/L	wet weather
08/23/10	MON	Buckland 8	TKN		mg/L	wet weather
08/23/10	MON	Buckland 8	TP	0.0488	mg/L	wet weather
08/23/10	MON	Buckland 8	TSS	3.4	mg/L	wet weather
08/30/10	MON	Buckland 1	CHL		mg/L	dry weather
08/30/10	MON	Buckland 1	NH3L	0.03647	mg/L	dry weather
08/30/10	MON	Buckland 1	NOX L	0.40009	mg/L	dry weather
08/30/10	MON	Buckland 1	OP L	0.02569	mg/L	dry weather
08/30/10	MON	Buckland 1	TKN		mg/L	dry weather

Sample date	Day	Sample name	Analyte	Value	Units	Sample Type
08/30/10	MON	Buckland 1	TP		mg/L	dry weather
08/30/10	MON	Buckland 1	TSS	1.2	mg/L	dry weather
08/30/10	MON	Buckland 4	CHL		mg/L	dry weather
08/30/10	MON	Buckland 4	NH3L	0.04976	mg/L	dry weather
08/30/10	MON	Buckland 4	NOX L	0.28934	mg/L	dry weather
08/30/10	MON	Buckland 4	OP L	0.0312	mg/L	dry weather
08/30/10	MON	Buckland 4	TKN		mg/L	dry weather
08/30/10	MON	Buckland 4	TP		mg/L	dry weather
08/30/10	MON	Buckland 4	TSS	4.5	mg/L	dry weather
08/30/10	MON	Buckland 5	CHL		mg/L	dry weather
08/30/10	MON	Buckland 5	NH3L	0.05102	mg/L	dry weather
08/30/10	MON	Buckland 5	NOX L	0.59311	mg/L	dry weather
08/30/10	MON	Buckland 5	OP L	0.06018	mg/L	dry weather
08/30/10	MON	Buckland 5	TKN		mg/L	dry weather
08/30/10	MON	Buckland 5	TP		mg/L	dry weather
08/30/10	MON	Buckland 5	TSS	20.4	mg/L	dry weather
08/30/10	MON	Buckland 6	CHL		mg/L	dry weather
08/30/10	MON	Buckland 6	NH3L	0.01626	mg/L	dry weather
08/30/10	MON	Buckland 6	NOX L	0.15417	mg/L	dry weather
08/30/10	MON	Buckland 6	OP L	0.02493	mg/L	dry weather
08/30/10	MON	Buckland 6	TKN		mg/L	dry weather
08/30/10	MON	Buckland 6	TP		mg/L	dry weather
08/30/10	MON	Buckland 6	TSS	10	mg/L	dry weather
08/30/10	MON	Buckland 7	CHL		mg/L	dry weather
08/30/10	MON	Buckland 7	EC COL QUANT	149	MPN/100mL	dry weather
08/30/10	MON	Buckland 7	NH3L	<0.0100	mg/L	dry weather
08/30/10	MON	Buckland 7	NOX L	0.29346	mg/L	dry weather
08/30/10	MON	Buckland 7	OP L	0.02426	mg/L	dry weather
08/30/10	MON	Buckland 7	TKN		mg/L	dry weather
08/30/10	MON	Buckland 7	TP		mg/L	dry weather
08/30/10	MON	Buckland 7	TSS	3.47	mg/L	dry weather
08/30/10	MON	Buckland 8	CHL		mg/L	dry weather
08/30/10	MON	Buckland 8	NH3L	0.05298	mg/L	dry weather
08/30/10	MON	Buckland 8	NOX L	1.1559	mg/L	dry weather
08/30/10	MON	Buckland 8	OP L	0.02743	mg/L	dry weather
08/30/10	MON	Buckland 8	TKN		mg/L	dry weather
08/30/10	MON	Buckland 8	TP		mg/L	dry weather
08/30/10	MON	Buckland 8	TSS	3	mg/L	dry weather

INSERT BRIGHTON SCHOOL _ GEORGE SMITH DATA

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, habitat water quality, riparian zone	Steepest decline of biological functioning after 6% imperviousness. There was a steady decline, with approx 50% of initial biotic integrity at 45% impervious area.	Horner, *et al*.	1996	Puget Sound 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,	Steedmen	1988	Ontario

	with a sharp decline at 10% I. Riparian 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:

Limitations of the Impervious Cover Model

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 Allen Creek Information Sheets

Allen Creek and tribs (0302-0022) MinorImpacts

Waterbody Location Information

Revised: 03/19/2002

Water Index No:	Ont 108/P113- 3- 8	**Drain Basin:**	Lake Ontario
Hydro Unit Code:	04140101/010 **Str Class:** B		Irondequoit/Ninemile
Waterbody Type:	River	**Reg/County:**	8/Monroe Co. (28)
Waterbody Size:	59.8 Miles	**Quad Map:**	ROCHESTER EAST (I-10-2)
Seg Description:	entire stream and tribs		

Water Quality Problem/Issue Information

(CAPS indicate MAJOR Use Impacts/Pollutants/Sources)

Use(s) Impacted	Severity	Problem Documentation
Public Bathing	Stressed	Suspected
Aquatic Life	Stressed	Known
Recreation	Stressed	Known

Type of Pollutant(s)

Known: NUTRIENTS
Suspected: Salts, Silt/Sediment
Possible: Pathogens

Source(s) of Pollutant(s)

Known: URBAN/STORM RUNOFF, Construction, Other Sanitary Disch
Suspected: Agriculture, Deicing (stor/appl), Streambank Erosion
Possible: - - -

Resolution/Management Information

Issue Resolvability: 1 (Needs Verification/Study (see STATUS))
Verification Status: 4 (Source Identified, Strategy Needed)
Lead Agency/Office: ext/WQCC **Resolution Potential:** Medium
TMDL/303d Status: n/a

Further Details

Aquatic life support, public bathing and various recreational uses (fishing, boating, etc) in Allen Creek are affected by impacts from various urban/stormwater sources and other nonpoint sources in the watershed.

A biological (macroinvertebrate) assessment of Allen Creek near Penfield was conducted in 1999 and again in 2004. Field sampling results indicated slightly impacted water quality conditions in 1999. The field assessment was verified by laboratory-sorting of the sample to order level. In 2004 the stream was found to have been significantly altered - perhaps relocated - due to construction in the area. Moderate impacts were indicated, but these results may have been influenced by habitat conditions. Additional monitoring to verify the impacts is recommended. A 1998 assessment conducted by Dr. William Sutton in cooperation with NYSDEC found slight to moderate impacts. Both assessments indicate the presence of nutrient enrichment in the stream. (DEC/DOW, BWAM/SBU, January 2001)

Urban and stormwater runoff related to the high degree of impervious surface area (shopping plazas, parking lots, roadways, etc) has been identified as the primary source of nutrients and other pollutants (pathogens, oil and grease, floatables) to the creek. A significant portion of one tributary (Buckland Creek) is enclosed and serves primarily as a storm sewer for Elmwood Avenue. Agricultural activities in the upper watershed, impacts from failing and/or inadequate on-site septic systems, tributary stream erosion and residential and commercial development throughout the watershed are also thought to contribute to nutrient and silt/sediment loadings. (Monroe County WQCC, May 2001)

Considerable bay and watershed water quality management and monitoring efforts are continuing. Municipalities within the watershed have formed the Irondequoit Watershed Collaborative. IWC activities have focused on comprehensive stormwater management efforts and (with USGS) hydrologic modeling to predict the impact of land use changes. Efforts within Monroe County include the establishment of a collaborative to assist with the implementation of phase II stormwater regulations. The Monroe County WQCC has evaluated road salt use and conducted a residential lawn care education project. A town highway facility is the focus of a pollutant removal demonstration project being conducted with NYS DEC funding. (Monroe County WQCC, May 2001)

The Monroe County Environmental Health Laboratory has maintained a cooperative monitoring program with USGS which grew out of a Nationwide Urban Runoff Program effort on Irondequoit Basin in 1980s. Subsequent USGS reports on water quality in the basin have been published in 1996, 1997 and 1999. (Monroe County Environmental Health Laboratory, May 2001)

This segment includes the entire stream and all tribs. The waters of the stream are primarily Class B, B(T); the upper reaches are Class C. Tribs to this reach/segment, including West Brook (-1), are Class B, B(TS) and C. (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
	☐ Open channel	☐ Concrete ☐ Earthen ☐ Other:	☐ Trapezoid ☐ Parabolic ☐ Other:	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: (*Facing downstream*)	Private	Institutional	Golf Course	Park	Other Public
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 ☐ no ☐Active reforestation ☐Greenway design ☐ Natural regeneration ☐ Invasives removal ☐ 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 ☐ Fish barrier removal ☐ Culvert repair/replacement ☐ Upstream storage retrofit
☐ no ☐ 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
Depth of flow ___________(in)
Defined low flow channel? ☐ Yes ☐ No
% of channel bottom _________%

ADJACENT STREAM CORRIDOR
Available width LT________(ft) RT_______(ft)
Utilities Present? ☐ Yes ☐ No
Fill in floodplain? ☐Yes ☐ No

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

WHO CAN DO IT: ☐ Volunteers ☐ Local Gov ☐ Hazmat Team ☐ Other

DUMPSTER WITHIN 100 FT: ☐ Yes ☐ No ☐ Unknown

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

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 #*)			
	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.
Leaking= ☐ 5	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.

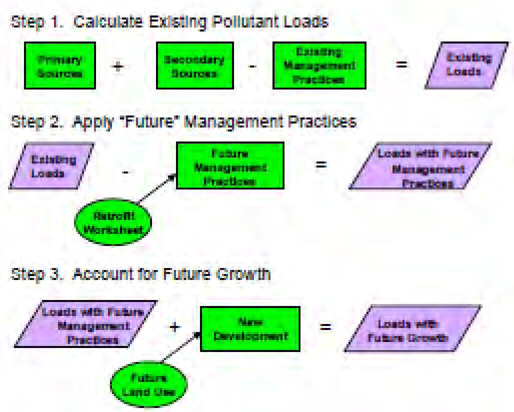

Figure 1. Model structure of the WTM. Note that the purple boxes refer to loads, including both pollutant loads and runoff volumes. The oval shapes are "support" worksheets of the WTM that provide input to another calculation sheet.

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.

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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c Water Resources Engineer, Center for Watershed Protection
**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.

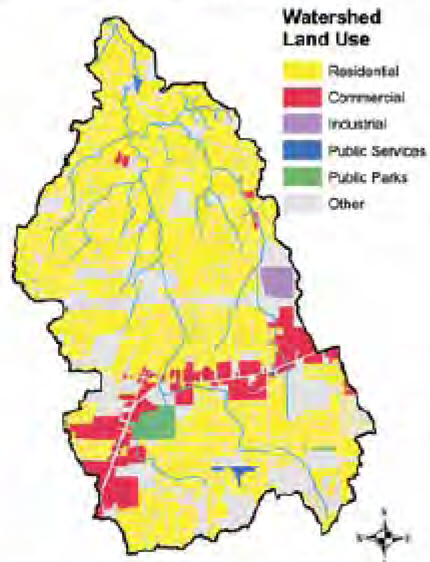

Figure 3. Land use data derived from Monroe County's parcel layer.

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%

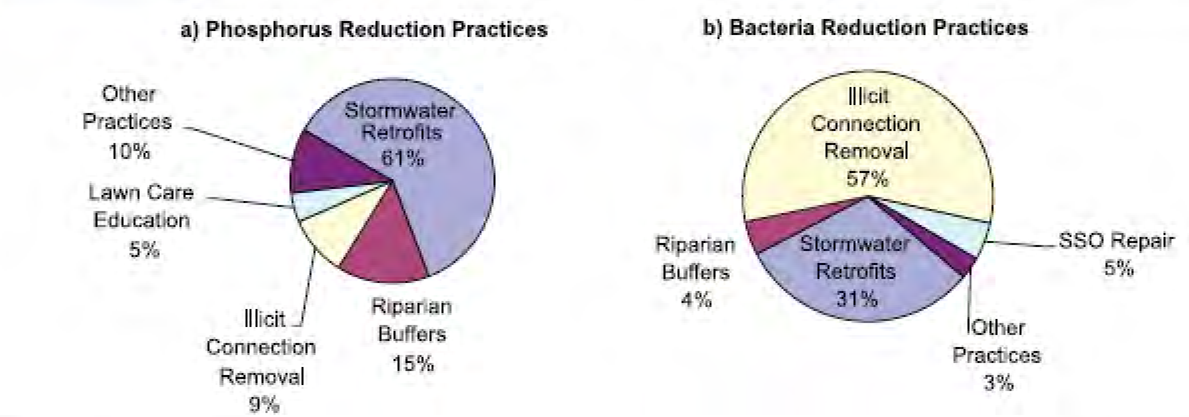

Figure 4. Estimated pollutant removal attributable to various management practices for phosphorus (a) and for bacteria (b).

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

POTENTIAL STREAM RESTORATION PROJECTS						
Stream site	**Project Type**	**length restored**	**Ownership**	**Feasibility[1]**	**Field Score[2]**	**Total Score**
Example	Erosion	TBD	Commercial	2	3	**5**
Country Club of Rochester	buffer and erosion	1000	Commercial	3	2	**5**
Brighton Twelve Corners School campus west	buffer and erosion	350	public	3	1	**4**
Brighton Twelve Corners School campus east	buffer and erosion	200	public	3	1	**4**
Elmwood Court Apartments	buffer and erosion	440	Commercial	2	1	**3**
Meadowbrook	buffer and erosion	500	private	0	1	**2**
Meadowview	buffer and erosion	100	private	0	1	**1**
St John Meadows	buffer and erosion	100	Commercial	2	1	**3**
Town Of Brighton DPW	buffer and erosion	50	Commercial	2	3*	**5**
total		2740				

POTENTIAL HOTSPOT RESTORATION PROJECTS			
Owner Name	**Location**	**Business**	**Project Type**
Cook Corners Llc	83 Cook St	Auto body	P2
Psyllos Peter T	1142 Mt Hope	Bar	bioretention
Dean Paul R Jr	1256 Mt Hope	Restaurant	bioretention
Mamasan's Monroe Llc	1360 Mt Hope	Fast food	bioretention
Mamasan's Monroe Llc	1378 Mt Hope	Fast food	bioretention
Gandell David L	1400 Mt Hope	Fast food	bioretention
Hess Realty Corp	1431 Mt Hope	Mini-mart	bioretention
Blaisdell Jeanne M As	1432 Mt Hope	Fast food	bioretention
Solomon Jeffrey	1471 Mt Hope	Auto body	P2
Db Real Estate Assets I	1500 Mt Hope	Fast food	bioretention
The Southland Corp	1660 Elmwood	Mini-mart	bioretention
Amerada Hess Corporation	1677 Elmwood	Gas station	P2
Grinnell, David	1690 Monroe	Restaurant	bioretention
South Avenue Auto	1721 South	Auto body	P2
Cam Realty Corp	1760 Monroe Ave	Restaurant	bioretention
Elmers Brighton Garage	1803 Monroe Ave	Gas station	P2
Chiariello, Peter G	1821 Monroe Ave	Auto body	P2
1848 Monroe Ave, LLC	1848 Monroe Ave	Auto body	P2
Michaels, Albert	1886 Monroe Ave	Gas station	P2
GE Capital Franchise Finance C	1890 S Clinton Ave	Restaurant	bioretention
Town Of Brighton	1941 Elmwood Ave	Highway gar	P2
1950 Monroe Ave Holdings LLC	1950 Monroe Ave	Gas station	P2
Poon, Karen	2185 Monroe Ave	Restaurant	bioretention
Brighton Commons Prtship LP	2600 Elmwood Ave	Restaurant	bioretention

POTENTIAL HOTSPOT RESTORATION PROJECTS			
Owner Name	**Location**	**Business**	**Project Type**
Psyllos Peter T	1118-1120 Mt Hope	Diner/lunch	bioretention

POTENTIAL STORMWATER STORAGE RESTORATION PROJECTS									
#	**Project**	**Project Type**	**Acres Treated**	**Ownership**	**Feasibility**[1]	**Cost Effective-ness**[2]	**Environmental Benefit**[3]	**Multiple Benefits**[4]	**Total Score**
1	Markay Circle	C-D-S Bioreten	*1*	public	4	1	2	**S,WQ**	**8**
2	Brittany Circle	C-D-S Bioreten	*1*	public	4	1	2	S,WQ	**8**
3	Brandywine Circle	C-D-S Bioreten	*1*	public	4	1	2	S,WQ	**8**
4	Gailhaven Circle	C-D-S Bioreten	*1*	public	4	1	2	S,WQ	**8**
5	Rowland Parkway	C-D-S Bioreten	*1*	public	4	1	2	S,WQ	**8**
6	Sutton Place	C-D-S Bioreten	*1*	public	4	1	2	S,WQ	**8**
7	Beekman Place	C-D-S Bioreten	*1*	public	4	1	2	S,WQ	**8**

POTENTIAL STORMWATER STORAGE RESTORATION PROJECTS									
#	**Project**	**Project Type**	**Acres Treated**	**Ownership**	**Feasibility[1]**	**Cost Effective-ness[2]**	**Environmental Benefit[3]**	**Multiple Benefits[4]**	**Total Score**
8	Glen Ellyn Way	street lawn bioretention	*0.5*	public	4	1	1	S,WQ	**7**
9	Monroe Aveue	street lawn bioretention	*1*	public	4	1	1	S,WQ	**7**
10	St Regis	street lawn bioretention	*0.5*	public	4	1	1	S,WQ	**7**
11	Antlers Drive	street lawn bioretention	*0.5*	public	4	1	1	S,WQ	**7**
12	Union Free School	parking lot bioretention	*0.5*	public	4	1	1	S,WQ,E	**8**
13	Brighton Town Hall	parking lot bioretention	*0.5*	public	4	1	1	S,WQ,E	**8**
14	Elmwood Manor	street lawn bioretention	*1*	commercial	3	1	1	S,WQ	**7**
15	Science Parkway	street lawn bioretention	*1*	commercial	3	1	1	S,WQ	**7**
16	NYS Psychiatric Campus	parking lot reduction	*2*	commercial	3	1	1	S,WQ	**7**
total			*14.5*						

New Ponds and Pond Retrofits											
pond #	Project	Project Type	DA Captured	IC treated	Feasibility[1]	Cost Effectiveness[2]	Environmental Benefit[3]	Ownership	Multiple Benefits[4]	% Capture[5]	Total Score
NP 1	Brighton Parcel nxt to Brickstone	New Pond	30	*10*	4	3	2	Brighton	S, WQ, CP,	0.9	**12**
NP 2	Finger Lakes Developmental Disabilites Services Office 620 Westfall Road	New Pond	20		4	3	2	NYS	S, WQ, CP,	0.9	**12**
NP 3	Brighton DPW Facility	New Pond	9	*8*	3*	3	1	Brighton	S, WQ, CP,	0.9	**11**
NP 4	Rochester Science Empty Parcel	New Pond	15	*10*	4	3	2	Rochester	S, WQ, CP,	0.9	**12**
NP 5	Highland Park open space along S. Goodman	New Pond	30	*10*	4	3	2	Monroe	S, WQ, CP,	0.9	**12**
total			104	*38*	37% IC						

New Ponds and Pond Retrofits											
pond #	Project	Project Type	DA Captured	IC treated	Feasibility[1]	Cost Effectiveness[2]	Environmental Benefit[3]	Ownership	Multiple Benefits[4]	% Capture[5]	Total Score
1	398 Science Pkwy, Rochester, NY 14620	dry pond conv	37	22	4	3	2	city of Rochester	WQ,CP, I	0	**12**
6	94 Lilac Dr, Rochester, NY 14620	dry pond conv	15	9	3	3	2	Elmwood Manor Assoc	WQ,CP,	0	**10**
7	89 Lilac Dr, Rochester, NY 14620	dry pond conv	15	9	3	3	2	Elmwood Manor Assoc	WQ,CP,	0	**10**
13	2100 S Clinton Ave, Rochester, NY 14618	dry pond conv	4	3	2	3	1	Word Christian	WQ,CP, I	0	**9**
total			71	43	61% IC						
2	23 Songbird Ln, Rochester, NY 14620	wet pond retrro	6	5	2	3	1	St John Inc	CP	0.5	**7**
3	Johnsarbor Dr. East, Rochester, NY 14620	wet pond retrro	21	19	3	3	2	St John Inc	**CP**	**0.5**	**9**
4	2053 S Clinton Ave, Rochester, NY 14618	wet pond retrro	10	6	2	3	2	Brookdale LLc	CP	0.5	**8**
5	1752 S Clinton Ave, Rochester, NY 14618	wet pond retrro	14	7	3	3	2	McQuaid	CP, E	0.	**10**

New Ponds and Pond Retrofits

Pond #	Project	Project Type	DA Captured	IC treated	Feasibility[1]	Cost Effectiveness[2]	Environmental Benefit[3]	Ownership	Multiple Benefits[4]	% Capture[5]	Total Score
										5	
8	249 Highland Avenue Rochester ny 14620	wet pond retrro	2	2	2	3	1	Cornell Coperative Ext.	CP,E	0.5	**8**
9	2190 Lac De Ville Blvd, Rochester, NY 14618	wet pond retrro	80	40	4	3	3	Brighton	CP,E	0.5	**12**
10	112 Barclay Square Dr, Rochester, NY 14618	wet pond retrro	30	8	4	3	3	Brighton	CP	0.5	**11**
11	47 Chelmsford Ln, Rochester, NY 14618	wet pond retrro	0	0	1	3	0	Multi private owners	CP	0.5	**5**
12	Johnsarbor Dr. West, Rochester, NY 14620	wet pond retrro	7	6	3	3	1	St John Inc	CP	0.5	**8**
13	170 Science Parkway	wet pond retrro	3	1.5	3	3	1	Microwave data	CP	0.5	**7**
	TOTALS		*173*	94.5	55% IC						

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

[2] Low medium and high costs = 3 , 2 or 1 respectively based on table of cost per cubic foot of storage

[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 add

erosion site is w/in 2500 feet add 1 point)

(5) 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 a
ponds

* The land adjacent to the creek is owned by the Brightonian (a nursing home).

Appendix G: Brighton Twelve Corners School Campus Stream Restoration Demonstration Project